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Year 1938

11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

| Mine | Occupation | | Description | Days Lost |
|---|---|---|---|---|
| Cliffs Shaft | Scraper Operator | 8. | Took off glove to be better able to screw a nut on a rope clamp. Wire punctured finger. Infection developed later. | 75* |
| | Miner | 9. | Putting up ladder and caught finger between bottom of ladder and piece of iron. Lacerated finger. | 11 |
| Gardner - Mackinaw | | | | |
| | Miner | 1. | Barring at chute and a chunk of ore dropped and squeezed his hand between bar and the ground. Fractured finger and lacerated hand. | 46 |
| | Timberman | 2. | Plank slipped out of his hand while standing on a ladder in shaft ladderway. Solar broke due "sulphur water" destroying nails in solar planks. He fell 20 feet. Sprain ankle and body bruises. | 90* |
| Lloyd | | | | |
| | Miner | 1. | Walking along the side of a haulage drift and tripped on a ground wire. Traveling road on the other side. Contusion of knee. | 11 |
| | Cage Rider | 2. | While pulling truck of timber off cage he tripped on rail guard and fell. Fractured fibula. | 88 |
| | Miner | 3, | Lashing a load of plank to hoist up raise. He called for more slack rope but the hoist man hoisted the rope instead of lowering. Hand caught. Loss of distal portion of thumb. | 98 |

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents. (Continued)

| Mine | Occupation | Description | Days Lost |
|---|---|---|---|
| Lloyd | | | |
| | Miner | 4. While looking up into a raise a drop of water fell into his eye. | 16 |
| | Miner | 5. Drilling on a stage and stepped between planks, hitting a leg. Contusion. | 22 |
| Maas | | | |
| | Miner | 1. His partner was barring a high back with a piece of one inch pipe. A chunk of ore fell, hit the pipe, causing it to swing. Man was struck on side of face. Fractured cheek bone. | 65 |
| | Miner | 2. Was securing a forepole when a chunk rolled down the dirt pile, knocking him down. Bruised ankle and hip. | 91 |
| | Miner | 3. Trimming ground under an old raise. Piece of cribbing fell on his foot. Fracture of two metatarsals. | 63 |
| | Miner | 4. While moving rope block a chunk of ore rolled down dirt pile. Bruised knee and ankle. | 51 |
| | Miner | 5. Went into slice drift that had been blasted down to recover a piece of timber. Caught under a fall of ground. Broken back. (Total disability). | 1800* |
| | Pumpman | 6. Lifting a large valve cover, kinked his back. | 12 |
| | Mechanic | 7. Soreness developed in hand. Infection. | 90 |
| | Miner | 8. Raising a timber leg and jumped to one side to avoid falling dirt. Sprained ankle. | 200* |
| | Miner | 9. Putting in forepoles and chunk rolled down dirt pile. Contused ankle. | 41 |

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11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents (Continued)

| Mine | Occupation | Description | Days Lost |
|---|---|---|---|
| Maas | | | |
| | Miner | 10. Making wedge axe handle struck cribbing and blade struck his hand. Fractured thumb. | 54 |
| | Timberman | 11. Picking ground and chunk fell over on his foot. Contusion of foot. | 72* |
| | Miner | 12. Stooped down to lift a plank and knocked switch box off hanger. Struck his back. Fractured vertebra. | 120* |
| Negaunee | | | |
| | Miner | 1. While holding leg of timber up he slipped and fell. Timber struck his leg. Fractured left femur. | 600* |
| | Miner | 2. Picking dirt pile and chunk rolled against his leg. Fractured tibia. | 204 |
| | Timber Framer | 3. Moving logs in yard and one rolled on his foot. Fractured metatarsal. | 49 |
| | Miner | 4. Standing on the outside of a curve in narrow drift as timber was being pulled by hoist. End of timber swung around and struck his leg. Fracture. | 184 |
| | Miner | 5. Drilling and attempted to brush aside some dirt. Machine turned and fell against his leg. Sprained knee. | 50 |
| | Miner | 6. Climbing ladderway in raise carrying axe and lunch pail. Lost footing and fell 30 feet. Fractured right tibia and left fibula. | 140 |

Safety Department

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Year 1938

11. ACCIDENTS AND PERSONAL INJURY.

b. Non-Fatal Accidents (Continued)

| Mine | Occupation | Description | Days Lost |
|---|---|---|---|
| Negaunee | | | |
| | Miner | 7. Sitting on a plank drilling a bottom hole. Chunk fell on his leg. Contusion. | 70 |
| | Miner | 8. Lifting scraper but it fell back on his foot. Bruised foot. | 43 |
| | Oiler | 9. Top tram car caught sampler's bench, pushed it forward against him. Contused thigh. | 66 |
| | Miner | 10. Fell 100 feet in incline raise. Failed to nail center cribbing. Stepped on it; it rolled, throwing man head first down raise. He passed through a 24 inch opening. Fractured left fibula. | 67 |
| Spies-Virgil | | | |
| | Blacksmith | 1. Riveting cars. Machine was on floor. Air hose was struck causing machine to turn over and opened the air valve. Struck on ankle. | 18 |

* - Estimated lost time.

Slight Accidents

Only with respect to the number of slight injuries does the year's record compare favorably with that for 1937. There were 350 of this nature in 1938 and 717 the year previous. Based on number of man-days worked the reduction was from 9.3 accidents to 7.1 per 1000 days.

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE IV

Number of Accidents

| Mine or Plant | Slight Accidents | Compensable |
|---|---|---|
| Athens | 44 | 6 |
| Canisteo | 31 | 1 |
| Cliffs Shaft | 59 | 11 |
| C. P. & L. Co. | 2 | 0 |
| Gardner-Mackinaw | 11 | 2 |
| Hill-Trumbull | 3 | 0 |
| Lloyd | 28 | 5 |
| Maas | 73 | 12 |
| Negaunee | 68 | 10 |
| Spies-Virgil | 4 | 1 |
| Shops & Storehouse | 12 | 0 |
| Tilden | 3 | 0 |
| Miscellaneous | 12 | 0 |
| | 350 | 48 |

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE V

Classification of Fatal Accidents 1911 to 1938, inclusive by the Central Safety Committee.

| | | | |
|---|---|---|---|
| I | Trade Risks . . . . . | | 109 |
| II | Negligence of the Company: | | |
| | Violation of Rules . . . . . | 4 | |
| | Failure to Provide Safety Devices . . . . . | 5 | |
| | Improper Method of Doing Work . . . . . | 10 | |
| | Failure to Provide Tools or Safe Place to Work . | 4 | |
| | Failure to Instruct Men . . . . . | 4 | 27 |
| III | Negligence of Workmen: | | |
| A | Injured Men: | | |
| | Improper Method of Work . . . . . | 18 | |
| | Violation of Rules . . . . . | 8 | |
| | Failure to Use Tools or Appliances Provided . . . | 4 | |
| | Failure to Use Safety Devices . . . . . | 2 | 32 |
| B | Other Workmen: | | |
| | Improper Method of Doing Work . . . . . | 14 | |
| | Violation of Rules . . . . . | 4 | |
| | Failure to Use Tools or Appliances Provided . . . | 1 | 19 |
| | Total. . . . . | | 187 |

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE VI

Classification of Causes of Fatal Accidents
From December 1st, 1898 to December 31st, 1938

| | | | |
|---|---|---|---|
| A | Fall of Ground | 97 | |
| | Run of Mud or Sand | 60 | |
| | Fall of Chunk of Ore From Chute | 2 | |
| | Stray Chunk or Stick Down Raise or Stope | 3 | 162 |
| B | Shaft Accidents: | | |
| | Falling Down Shaft | 14 | |
| | Rock or Timber Falling Down Shaft | 2 | |
| | Struck or Caught by Cage, Skip, Bucket, Tool | 8 | |
| | Falling from Cage, Skip, or Bucket | 11 | |
| | Falling from Ladder in Shaft | 5 | |
| | Carried or Pushed into Shaft by Car | 3 | |
| | Jumping On or Off Cage, Skip, or Bucket | 3 | |
| | Struck by Crosshead | 5 | 51 |
| C | Use of Explosives: | | |
| | Explosion of Powder | 16 | |
| | Premature Blast | 3 | |
| | Fall of Ground or Timber Due to a Blast | 4 | |
| | Overcome by Gas | 3 | |
| | Miscellaneous Causes | 1 | 27 |
| D | Mine and Railroad Cars: | | |
| | Caught by Haulage Cars | 13 | |
| | Riding or Attempting to Ride Cars | 6 | |
| | Falling With Car from Trestle | 4 | |
| | Run over by Railroad Car | 7 | |
| | Miscellaneous Causes | 1 | 31 |
| E | Miscellaneous Causes: | | |
| | Falling in Raise, Stope or Pocket | 8 | |
| | Contact With Electric Wire | 9 | |
| | Falling from Ladder, Stage, or Trestle | 7 | |
| | By Moving Machinery | 5 | |
| | Mine Fires | 3 | |
| | Stockpile Slide | 2 | |
| | Miscellaneous Causes | 3 | 37 |
| | Total | | 308 |

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11. ACCIDENTS AND PERSONAL INJURY.

TABLE VII

Classification of All Compensable Accidents 1938
By the Central Safety Committee

| | | | |
|---|---|---|---|
| I | Trade Risk. (Incidental and Non-Preventable) | 16 | 16 |
| II | Negligence of Company: | | |
| | 1. Failure to Use Safety Devices Provided | 0 | |
| | 2. Failure to Use Proper Tools or Appliances Provided | 0 | |
| | 3. Violation of Rules | 0 | |
| | 4. Improper Act or Selection of Improper Method of Doing Work (By Foreman) | 0 | |
| | 5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto | 0 | |
| | 6. Failure to Provide Safety Devices | 1 | |
| | 7. Failure to Provide Proper Tools, Appliances or Place of Work | 2 | 3 |
| III | Negligence of Workmen: | | |
| A | 1. Failed to Use Safety Device Provided | 2 | |
| | 2. Failed to Use Proper Appliances or Tools Provided | 1 | |
| | 3. Violation of Rules | 2 | |
| | 4. Improper Act or Selection of Improper Method of Doing Work | 23 | 28 |
| B | Other Workmen: | | |
| | 1. Failed to Use Safety Devides 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 | 1 | 1 |
| | Total | | 48 |

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection.

The writer inspected the local mines monthly, the Spies-Virgil Mine once in two months and the Canisteo Mine once during the course of the year. A complete tour of the underground working places requires 19 trips. G. R. Whittington continued in the capacity of safety inspector of the Canisteo and Hill-Trumbull Mines. There was only one compensable accident at those mines, which would indicate that he rendered valuable service in promoting safety.

The heavy blanket of snow that fell in January destroyed many sections of the fences around the shafts, caves and pits on our abandoned mines. They were repaired and in addition the work of erecting fences around the Empire Mine large pit and several of the larger cuts at the Republic Mine was completed. New fences were put up around the openings on the old Michigamme Mine, by request of Mr. Mather, who paid the expenditure involved in the same.

Major Safety Measures.

In our soft ore mines the extraction of the ore is limited to the top slicing and sub-level stoping methods, although the latter process is feasible only in the Lloyd and Spies-Virgil Mines. It has taken much time and educational work to erase from our mines thepractice of running ore, which followed in the wake of the caving method of mining. The change brought an increase in the use of heavy timber and poles and an extensive covering down off the floors of subs with wire netting. Miners will be found who prefer old methods, because the new way sometimes slows up production and lowers their wages. The measure of safety that has come with our present methods can be gauged by citing our records under both methods. During the 33 years period from 1898 to 1931, inclusive, there were only four years when the company's soft ore mines were exempted from fatal accidents by falls of ground and the number that did occur amounted to more than a third of the total accidents by all causes. Our soft ore mines have had two fatal accidents by falls of ground during the past eight years but other causes are chargable with eight fatalities at the same mines.

Mechanical equipment is ever increasing and with it new hazards arise. Scrapers and scraper hoists are heavy pieces of machinery and they are frequently subjected to terrific strains. Crushing ground may leave a limited space for the convenient operation of this equipment, and consequently when the miners are not careful accidents are inevitable. Whereas, formerly men received finger and toe injuries when moving ore or timber by hand now a fractured limb may be the penalty when standing too close to objects being moved by mechanical power. Scraper hoists, ropes and pulleys demanded special guards and they must be provided and maintained in every stope and drift where miners are engaged in breaking ore.

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection. (Continued)

We are making rapid progress in advancing eye protection. Goggles with "safety glass" lenses are the best security against eye injuries. Corrected lenses for men with imperfect vision is the order of the day. Such goggles are available and many of our workers are wearing them. The men paid the difference in cost between the ordinary goggle and the corrected type. The company bought last year 726 pairs of goggles of various types, 420 goggle cases, and 30 extra lenses. The cost for these articles was $959.61, which is less than what one eye accident in 1937 is now costing us. The number of slight eye injuries is rapidly dropping with the increased use of the safety goggles.

A hazard that always goes along with deep mining and cannot be side tracked is the chance of men falling when climbing or working in stopes and raises. Perfecting devices or working out new ones is an ever present problem because accidents of this nature have not been entirely mastered. Ladderways in high raises that pass through our crushing ground require many repairs and at times it is not possible to maintain a rigid application of the safety standards with respect to sollars. Precaution is always taken to keep strong ladders, firmly anchored and with ample foot clearance, which are essential to safe climbing, and with which the man is in no danger of falling if careful in climbing.

The electric cap lamps have proved their merit and our miners would regard it as a backward step to return to carbide lamps. In wet places or where strong air currect prevails miners no longer are caught in darkness. They have brought added safety in charging and firing of bore holes. There is a saving of time in using them, for miners were compelled to recharge carbide lamps and water was not always available when required. Fire risks underground have been reduced by their introduction in all of our mines.

A new explosive device called the "Master Fuse Lighter" was brought to us for testing by the Ensign-Bickford Fuse Company. In appearance it is similar to an empty shot gun shell, in the bottom of which is a shallow coating of powder. The shell has a rubber seal through which as many as seven fuses may be pushed, one of which on being ignited will set off the powder, which in turn ignites the other fuses. It is very useful in firing a round of holes in raising, in wet working places, and in places when many fuses, close together, must be lighted. In one of our tests in blasting down timber, a miner, single handed, fired 60 shots which would have required the assistance of three more men without the time saving element that the Master Fuse Lighter gives. It now costs two cents and we have been advised that when it is marketed on a fairly large scale it should cost a half a cent less. It is also acceptable to the miners because less fuse need be burnt and hence less smoke produced in blasting.

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection. (Continued)

The Central Safety Committee.

This Committee met five times with full membership present at each conference. The mining captains attended two meetings. Mr. Gries was designated secretary on the retirement of Mr. W. H. Moulton. Minutes of each session were sent to all officials concerned with the subjects that are referred to this committee for consideration.

Foremen's Conferences.

Each superintendent held group conferences which were attended by his own foremen. Several general conferences for all our foremen in this county also were held.

Safety Flags.

Banner flags for the best accidents records established during the year went to the Spies-Virgil mine for the underground mines. For surface and open pit operations the Tilden, Shops and the C. P. & L. Co. won the award for the second consecutive year. Other mines floated the Safety Flag in accordance with this regulation, "each lost time accident necessitates that the flag be lowered for one week immediately after it occurs."

Lake Superior Safety Conference.

This annual conference represents the Lake Superior Mining Chapter of the National Safety Congress. The conference was held at Duluth, on June 23 and 24, and there were 334 delegates in attendance, 10 of whom were from our company.

National Safety Council.

Our membership in this organization was renewed and from it our superintendents received each month a copy of the"National Safety News" and the Safety Department, on its own selection, approximately 600 safety posters.

Miners' Safety Bulletin.

We continued to distribute once every two months copies of the "Miners' Safety Bulletin" to all employees. Since the first number was issued the Bulletin has invited attention to the hazards incidental to mining and the precautions that must be taken to guard against accidents. Beginning with the January number for 1939 a "Health Column" will appear, which will be prepared by Mr. Gries.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection. (Continued)

Inspection Reports.

The number of inspection reports received from the mines and plants by this Department is given in the following table.

TABLE VIII

| | |
|---|---|
| Hoisting cables | 1550 |
| Skip and Cage Roads | 336 |
| Ladderways | 328 |
| Hoists | 82 |
| Cage Catches | 80 |
| Slack Rope Device | 59 |
| Fire Equipment | 30 |
| Fire Doors | 21 |
| Rescue Apparatus | 25 |
| | 2511 |

A total of 30 fire inspection reports may not on its face value appear to cover thoroughly this important work but these reports represent quite a field as is apparent from the following data.

TABLE IX

Showing Number of Individual Inspections Made of Fire Extinguishers by Mines and Plants.

| Mine or Plant | Pyrene | Others | Totals |
|---|---|---|---|
| Spies-Virgil | 45 | 38 | 83 |
| Cliffs Shaft | 54 | 9 | 63 |
| Gardner-Mackinaw | 47 | 14 | 61 |
| Maas | 38 | 22 | 60 |
| Negaunee | 30 | 16 | 46 |
| Tilden | 9 | 37 | 46 |
| Hard Ore Shops | 31 | 12 | 43 |
| Athens | 26 | 14 | 40 |
| Ishpeming Hospital | 20 | 9 | 29 |
| Lloyd | 23 | 5 | 28 |
| Rented Dwellings | 28 | | 28 |
| Central Office | 14 | 7 | 21 |
| Hill-Trumbull | 10 | 10 | 20 |
| Holman | 16 | 4 | 20 |
| Canisteo | 10 | 7 | 17 |
| Totals | 401 | 204 | 605 |

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11. ACCIDENTS AND PERSONAL INJURY.

c. Safety Inspection. (Continued)

Rules and Regulations.

A book entitled "Surface Safety Rules for Foremen" was distributed in September. It has 19 headings with a total of 150 rules. Another rule book, for underground foremen, is being compiled.

TABLE X

Number of Rule Books Distributed.

| Mine | Explosives | Haulage | Mining | Surface | Total |
|---|---|---|---|---|---|
| Athens | 8 | 8 | 8 | 4 | 28 |
| Cliffs Shaft | 9 | 9 | 9 | 6 | 33 |
| Gard.-Mack. | 10 | 10 | 10 | | 30 |
| Maas | 7 | 8 | 7 | | 22 |
| Negaunee | 6 | 13 | 6 | 6 | 31 |
| Lloyd | 9 | 10 | 9 | 7 | 35 |
| Spies-Virgil | 20 | 13 | | | 33 |
| Tilden | 3 | 3 | 3 | 6 | 15 |
| Miscellaneous | 1 | 1 | 1 | 27 | 30 |
| Totals | 73 | 75 | 53 | 56 | 257 |

Cash Awards.

The awarding of cash prizes, to stimulate interest in safety, was continued for the third consecutive year, but with a number of changes being made in the regulations for the distribution of the same. Each drawing was limited to one $10 prize and the balance of the amount allowable for each drawing was divided into $5 and $2 prizes, the number of each varying according to the number of men participating in a drawing. Prizes were awarded twice a month at the Athens, Cliffs Shaft, Negaunee, Maas, and Lloyd mines and once monthly at all the other properties, providing no compensable accident occurred in a given period.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY.

C. Safety Inspection (Continued)

Cash Awards. (Continued)

TABLE XI

Showing Tabulation of Cash Awards.

| Mine or Plant | Drawings | No. of Prizes | Men Won Prizes | Men Won More Than One Prize* | Amount |
|---|---|---|---|---|---|
| Cliffs Shaft | 17 | 238 | 199 | 35 | $765.00 |
| Negaunee | 17 | 242 | 200 | 42 | 785.00 |
| Maas | 15 | 225 | 191 | 34 | 750.00 |
| Athens | 19 | 209 | 181 | 28 | 648.00 |
| Lloyd | 15 | 152 | 120 | 30 | 584.00 |
| Shops & Sthse. | 12 | 89 | 75 | 14 | 332.00 |
| C.P.&L. Co. | 12 | 68 | 57 | 11 | 262.00 |
| Gard.-Mack. | 5 | 40 | 39 | 1 | 176.00 |
| Spies-Virgil | 11 | 44 | 38 | 6 | 176.00 |
| Tilden | 10 | 40 | 29 | 13 | 160.00 |
| Canisteo | 11 | 95 | 85 | 10 | 427.00 |
| Hill-Trumbull | 2 | 8 | 8 | 0 | 32.00 |
| | 146 | 1450 | 1222 | 224 | $5097.00 |

*220 men won two cash prizes
4 men won three cash prizes

The accident record for the year indicates very clearly that the beneficial effect of awarding cash prizes for the promotion of safety had ran its course during 1936 and 1937. It was a new method of attracting interest in safety that lost its effectiveness once the novelty had worn off. It brings to mind our experience of many years ago. During 1911 and 1912 the first two years of the history of the Safety Department, there were 11 men killed by accidents, compared with 33 killed during 1909 and 1910. We then thought that we were on the highway to success in accident prevention, but the record for 1913 and 1914, when the accidental deaths numbered 21, showed how badly mistaken was our conclusion. "Safety First" was a new slogan in 1911, which had a wonderful appeal but lost its charm with the passing of time.

d. First Aid and Mine Rescue Work Training.

The service of H. F. Rogers, Tilden Mine captain, was available in April and December and he was assigned to this Department. From April 19th to 29th he carried on training practices with our mine rescue apparatus at all our Michigan mines, when 54 men received instruction. From November 28th to December 29th, we had with us a representative of the U. S. Bureau of Mines, who gave instruction in both first aid and mine rescue methods. 163 men completed in first aid and 25 in mine rescue. Captain Rogers

11. ACCIDENTS AND PERSONAL INJURY.

d. First Aid and Mine Rescue Work Training. (Continued)

arranged the details for this work. First aid training was given when the men were off shift and the only expense involved with respect to them was paying their transportation. The mine rescue men received their usual daily wage, which in the case of each individual amounted to five lessons of two hours each. A total of 410 employees have received the Bureau's First Aid certificate and 50 the Mine Rescue certificate since 1936.

The variety and amount of first aid supplies distributed during the year appear in the following table.

TABLE XII

First Aid Supplies Distributed.

| Material | Number Distributed |
|---|---|
| Mercurochrome Compresses | 6,601 |
| One Inch Roller Gauze | 587 |
| Mercurochrome Applicators | 456 |
| Plain Gauze (12" X 18") | 433 |
| Three Inch Roller Gauze | 305 |
| Leather Finger Cots | 199 |
| Ounces of Mercurochrome and Merthiolate | 177 |
| Rolls of Adhesive Tape | 92 |
| Picric Gauze (12" X 18") | 66 |
| Ounces of Aromatic Spirits of Ammonia | 18 |
| Tubes of Ointment | 14 |
| Pairs of Scissors | 4 |
| Large Triangular Bandages | 12 |
| | 8,964 |

e. Ventilation

The ventilation situation in the Spies-Virgil Mine improved rapidly early in the year and there was no need to use the oxygen apparatus such as was required in 1937. Superintendent C. W. Allen and C. C. Hawes, our Chief Chemist, must be credited with a fine accomplishment when they succeeded in controlling the air within the mine.

A new machine was utilized in our ventilation work, called the "Clean Air Blower", which is made by the Mine Safety Appliances Company. This is a device which passes water and air through a rotor chamber and removes dust and other foreign matter from the air. In brief, the air is actually washed, cooled and humidified in passing through one of these machines. It has a fool-proof pressure relief valve so that the full delivered volume does not exceed 10 pounds per square inch.

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11. ACCIDENTS AND PERSONAL INJURY.

e. Ventilation. (Continued)

These machines have been used at the Negaunee, Lloyd, and Tilden mines. They are put in service only in places where our other methods of controlling the dust prove inefficient. Raising, shaft sinking and drifting in rock having high silica content or crushing silica ore are operations where this machine solves the dust problem.

Collecting air samples and counting dust particles is work that cannot be speeded up. To cover our field intelligently and thoroughly this work demands the entire time of an active and competent worker. We are fortunate to have such an employee in the person of T. W. Hill, who has done most of this work the past four years. He is very observant and renders valuable assistance in cooperating with the writer in the enforcement of the company's ventilation standards.

Air samples are collected regularly at all faces where breaking rock is in progress which covers drilling, scraping and dumping operations. It is extended to the crushing of rock or ore, cleaning cars and pockets by compressed air and all other jobs where abnormal air conditions may arise. A record is kept of the air analyses of each rock operation, the methods used to control high dust counts, and a time chart of the men engaged at this work.

Toward the end of the year Mr. D. E. Cummings suggested a recording of the dust conditions that prevails throughout a 24 hour period for each job within every mine where the making of much dust accompanies the work.

TABLE XIII
Number of Air Analyses

| Mine or Plant | Light Field Count | Dark Field Count |
|---|---|---|
| Cliffs Shaft | 106 | 106 |
| Negaunee | 53 | 53 |
| Lloyd | 52 | 52 |
| Maas | 32 | 32 |
| Athens | 20 | 20 |
| Spies-Virgil | 17 | 17 |
| Brownstone Shops | 4 | 4 |
| Tilden | 3 | 3 |
| Totals | 287 | 287 |

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11. ACCIDENTS AND PERSONAL INJURY.

f. Department Expenses.

| | |
|---|---|
| Salaries | $4,209.09 |
| Auto Expense | 140.89 |
| Heat, Light and Power | |
| Insurance | 2.06 |
| Postage | 10.60 |
| Repairs | 2.02 |
| Stationery and Printing | 262.90 |
| Supplies | 48.24 |
| Taxes | 1.73 |
| Travel and Entertainment | 271.82 |
| Telephone and Telegraph | 41.86 |
| Papers and Periodicals | |
| Personal Injury Expense | 86.36 |
| Unemployment Insurance Tax | 135.95 |
| General - Unclassified | 230.17 |
| Old Age Benefit Tax | 34.40 |
| Depreciation Mine Rescue Equip. | 199.84 |
| Total | $5,677.93 |

Respectfully submitted,

William Counter

Assistant Superintendent

## 22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1938

### A. STAFF

The staff of the Geological Department for the year 1938 is shown in Table I below. The personnel has remained unchanged throughout the year.

TABLE I

| Name | Occupation | Hours Lost Sickness | Hours Lost Absence | Hours Overtime | Net % Hours Worked |
|---|---|---|---|---|---|
| E. L. Derby, Jr. | Chief Geologist | 32 3/4 | 105 1/4 | 140 3/4 | 100.15 |
| Stanley W. Sundeen | Asst. Geologist | 38 | 75 1/4 | 47 3/4 | 96.39 |
| Gustav Afuhs | Draftsman | 43 1/2 | 125 3/4 | 38 | 92.77 |
| E. A. Allen | Assistant | - | 7 1/4 | 3 3/4 | 99.81 |

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

TABLE II

| | |
|---|---|
| Total Working Days | 249½ days (1814¼ hours) |
| Sundays | 52 " |
| Saturdays | 45 " |
| Holidays | 13½ " |
| Vacation Period | 5 " |
| Total | 365 days. |

Table III, below, shows the average number of men regularly employed on a full time basis on the staff of the Geological Department during the past five years.

TABLE III

| Year | Average Number of Men |
|---|---|
| 1934 | 1.0 |
| 1935 | 1.0 |
| 1936 | 2.4 |
| 1937 | 4.0 |
| 1938 | 4.0 |

B. GENERAL DESCRIPTION OF THE WORK OF THE DEPARTMENT

The work of the Geological Department was divided between the various mines, explorations, and miscellaneous items shown in Table IV, below:

TABLE IV

| ITEMS | HOURS WORKED | PERCENT |
|---|---|---|
| MINES | | |
| Athens | 12 1/4 | .2 |
| Canisteo | 102 1/2 | 1.4 |
| Cliffs-Shaft | 1065 | 15.1 |
| Hill-Trumbull | 362 1/2 | 5.1 |
| Holman-Cliffs | 86 3/4 | 1.2 |
| Lloyd | 79 1/2 | 1.1 |
| Maas | 261 | 3.7 |
| Mackinaw | 103 3/4 | 1.5 |
| Negaunee | 355 | 5.0 |
| Pontiac | 35 1/4 | .5 |
| Ravenna-Prickett Lease | 2 3/4 | .1 |
| Tilden | 5 1/4 | .1 |
| Virgil | 103 3/4 | 1.5 |
| Total Mines | 2575 1/4 | 36.5 |
| EXPLORATIONS | | |
| Cliffs-Shaft Mine | 222 1/2 | 3.1 |
| Negaunee Mine | 42 1/4 | .6 |
| Negaunee, Section 5, 47-26 | 37 1/2 | .5 |
| Negaunee, Section 32, 48-26 | 120 1/2 | 1.7 |
| Section 2, 47-27 | 2007 1/4 | 28.4 |
| Maas Mine | 54 | .8 |
| Mackinaw Mine | 32 1/2 | .5 |
| Total Explorations | 2516 1/2 | 35.6 |
| MISCELLANEOUS | | |
| Annual Report | 44 3/4 | .6 |
| Beneficiation of Iron Ores | 10 1/2 | .1 |
| Delinquent Tax Lists | 7 | .1 |
| Depletion Estimates | 45 | .6 |
| General Departmental | 1324 3/4 | 18.8 |
| Geological Surveys on Company's Mineral Estate | 339 1/4 | 4.8 |
| Gold Leases on Company's Estate | 4 | .1 |
| Investigating Mineral Land Offers | 82 1/4 | 1.2 |
| Investigating Outside Explorations | 33 1/2 | .5 |
| Manganese Ore | 17 | .2 |
| Michigan Mineral Land Company | 6 1/2 | .1 |
| Tax Commission Estimates | 57 | .8 |
| Total Miscellaneous | 1971 1/2 | 27.9 |
| GRAND TOTAL | 7063 1/4 | 100.0% |

E. L. DERBY, JR. Approximately thirty-two percent of my time during the year was taken up with the routine work of the office and the numerous miscellaneous duties peculiar to the Geological Department. About twenty-three percent of my time was spent in planning and supervising the diamond drilling in the Cliffs-Shaft, Maas, Mackinaw and Negaunee Mines, and on the Negaunee Mine surface and at the Section 2 Golf Club area exploration. The balance of my time, or about forty-five percent, was spent in connection with the geological work at the Company's mining properties. The geological surveys and explorations are treated separately and in more or less detail later in this report. My activities, in addition to the strictly routine work of the office, may be summarized as follows:

In January, I prepared additional data for the Cleveland office in connection with the annual Depletion estimates of our various mines, including depreciation of plant and equipment and amortization of development. I went over the engineer's estimates of our Michigan properties to be reported to the State Tax Commission together with the maps supporting these estimates before they were forwarded to our Cleveland office for ultimate transmission to the State Appraiser of Mines. I also checked over preparations being made for large size jig tests on Hill-Trumbull lean ore which ultimately were made at the Mines Experiment Station, University of Minnesota at Minneapolis. Three carloads of this lean ore was shipped from the Trumbull Pit for this test at the end of the shipping season in 1937.

In February, I went to the Mesaba Range with headquarters at our Hibbing office. While there I compiled revised estimates of all of our Mesaba-Cliffs properties and conferred with Messrs. Holt and Matson of Butler Brothers at Cooley on their investigation of the metallurgical and concentrating possibilities of our Pontiac ore if treated in their new mill at Crosby. I joined Messrs. Barber and Bubb in a conference with the Congdons and Mr. Garber at the Congdon office in Duluth, relative to Canisteo Mine matters. I spent four days at the Mines Experiment Station in Minneapolis during the jig tests on the first carload lot of Trumbull lean ore. Mr. Pardee, State Appraiser of Mines, and his assistant Mr. Eddy, came to my office. Mr. Jackson and I spent two days in conference with them going over the maps and estimates of all our operating mines which had been reported to them. The superintendent and engineer of the several properties were present as their particular properties were discussed.

In March, I went to the Mesaba Range and joined Mr. Bolthouse in classifying several old Hill Mine drill holes drilled years ago before our acquisition of the property which we needed in making up a new set of cross-sections of this mine. Mr. Barber and I had a conference with Messrs. Whitney and Matson of Butler Brothers in connection with the estimates they were making of the ore in our Pontiac Mine and its treatability. I spent three days at the Mines Experiment Station in Minneapolis during the jig tests on the second carload of our Trumbull lean ore. Later in the month I again went to Hibbing and went over the three newly completed sets of whiteprint cross-sections of the Canisteo Mine made by Mr. Everett Sterling and posted to include the 1937 operations and the revised estimate of reserve open pit wash ore. Two sets of these sections were prepared for and at the request

of Mr. Congdon. In passing through Duluth, I was able to get a copy of the results of drilling by the Republic Steel Corporation at the old Cornell-Clifford property near Iron Mountain during their operation of this mine about 1920 and 1921. This data was valuable to us in connection with our option from Mr. John T. Spencer to lease this property. This option, however, was not exercised. I prepared data in connection with our Michigan State Tax Commission valuations currently being considered and in preparation for our annual conference with Mr. Pardee at Lansing during April.

In April, I joined with Mr. Archibald in a report embodying recommendations to be used at the Public Tax Sale on May 3rd covering the delinquent tax list of lands of which the Michigan Mineral Land Company owns the minerals. I also joined with Mr. Brewer in a similar report on the delinquent tax list of lands on which the Company owns the minerals. I spent several days on the Mesaba Range in connection with the Canisteo Mine. During this time I went through the Pit with Mr. J. C. Richards, Mining Engineer, representing the Congdon interests, examining the exposures of possible jig material remaining on the property. We mapped out a number of areas where samples were taken and classifier tests made on them to determine the possibility of jig concentration. I delivered to the Messrs. Congdon and Mr. Garber, the two complete sets of white print cross-sections of the Canisteo Pit mentioned in connection with my trip to the Range in March. I went over the sections with them and answered the various questions which they raised. I spent one day in Minneapolis making final arrangments for the third and last jig test on Trumbull lean ore which was made in May. I attended a conference in Chicago on the State Appraiser's valuations of our Michigan properties with Messrs. Geffine, Elliott, Jackson and Adams. We then went to Lansing for our annual conference on these valuations with Messrs. Pardee and Eddy.

In May, I spent three days at the Mines Experiment Station in Minneapolis during the jig tests on the third and last carload lot of Trumbull lean ore. From there, I went to the Mesaba Range and went over the revised estimate and cross-sections of the Trumbull Mine prepared by Mr. Everett Sterling. I also had a further conference with Mr. Matson of Butler Brothers, at his office in Cooley, in connection with the various estimates they were preparing on the Pontiac Mine. I spent some time preparing data on our Michigan State Tax Commission figures and attended the public hearing of the Commission at Marquette on May 27th.

In June, I went to the Mesaba Range in connection with the revised estimate of ore reserves in the Hill-Trumbull Mine which was used in our ad valorem tax report. I went to St. Paul and discussed this estimate in a general way with Mr. Ernest Johnson, Engineer for the Minnesota State Tax Commission at his office in the Capitol. At this time I also went to the Mines Experiment Station in Minneapolis and discussed the results of the jig tests on our Trumbull lean ore with Mr. Wade, Metallurgist at the Station. In this connection, I planned with him the scope of his report on all of the tests which we had made on this material.

In July, I spent one day at our Cleveland office going over Depletion and other miscellaneous matters. I attended a public hearing in the Ely Township Hall held by the Michigan State Tax Commission to review the valuation which they had placed on the Morris Mine. I visited and reported on the explorations being conducted by the Calumet & Hecla Company on the Company's gold leases in the vicinity of the Ropes Gold Mine. I spent several days on the Mesaba Range assisting in working up prospective operating plans upon the reopening of the Holman-Cliffs Mine, and supervising the work being done in our research laboratory in making classifier tests on possible jig material in our structure drill hole samples from the Trumbull Pit. I also visited the Patrick washing plant of Butler Brothers with Mr. Barber and his staff where we saw in operation the double inverted cone using the heavy gravity method of concentration on jig feed material. This is a new departure being developed by the Research Department of Butler Brothers in which Ferro-Silicon, ground to pass a 65 mesh screen is used as a heavy gravity medium. We arranged to have some of our Trumbull lean ore, similar to that used in the jig tests at the Mines Experiment Station during the spring, tested by this method later in the season.

In August, the first of the month, before returning from my trip to the Mesaba Range late in July, I visited the district on the North shore of Rainy Lake, about 25 miles East of Fort Frances, Ontario, and examined Land Offer No. 1988, which had been offerred to us as a possible source of molybdenum. Two days were spent on this trip and I was accompanied by Mr. Bolthouse. Mr. McClure and I went to the vicinity of Gould City in Mackinac County in the Southern part of the Upper Peninsula, and interviewed two men in connection with Land Offer No. 2018. It was reported, in churn drilling for oil several years ago, that a 4' seam of specular hematite had been found bedded in with the limestone rock of the District. Pieces of high grade specular ore, very similar to that produced in the old Republic Mine, were given us and it was stated that they had been recovered from this hole. After talking with these men, we concluded that, unbeknown to them, a piece of Republic ore had been dropped into the hole or else had been mixed in with the material recovered from it. We have heard nothing further of this.

In September, I made two trips to the Mesaba Range with headquarters at our Hibbing office. The larger part of my time, while there, was spent in arranging for and in witnessing a test made on Trumbull lean ore with the heavy density cone process at the Patrick washing plant of Butler Brothers at Cooley. The ore was crushed to pass a $1\frac{1}{4}$" screen and that part between $-1\frac{1}{4}$" and $+\frac{1}{4}$" was treated in the cone. The $-\frac{1}{4}$" material, or about 25% of the weight of the sample was concentrated in a jig. Also, while in Hibbing, I supervised an estimate of the probable jig material reserves within the present stripped limits of the Trumbull property. I joined with Messrs. Barber, Walter Sterling and Moore in a trip through the Canisteo Pit with Mr. Archibald and McIntosh, preparatory to a complete examination and appraisal of the property by Mr. Archibald for Mr. E. C. Congdon. In passing through Duluth, I conferred with Mr. Congdon, at his request, relative to Canisteo Mine reserves, retreating possibilities of lean ore, etc. My remarks to Mr. Congdon were of a general nature and I made no commitments that, in any way, would involve the Company.

In October, I spent one day at the Capitol in St. Paul in conference with Messrs. Johnson and Pesonen, Engineers for the Minnesota State Tax Commission, going over the new cross-sections submitted to them which support our revised ad Valorem tonnage estimate on the Trumbull Mine. I then spent three days at our Hibbing office supervising the preparation of additional data requested by Mr. Johnson. Mr. Pesonen, accompanied by Mr. O'Connell (Secretary for the State Tax Commission), spent part of one day with me at our Hibbing office, going over some of the details on which we had built up our revised estimate and appeared to be entirely satisfied with our conclusions. The following day I accompanied Mr. Barber to St. Paul for a conference on this Trumbull tax problem with Mr. Holten, our attorney.

In November, I went to the Mesaba Range and supervised preliminary bucket tests with heavy gravity media (ferro-silicon) which were made on samples of Crushed Cliffs-Shaft Ore at the research laboratory of Butler Brothers in Cooley. The results of the heavy gravity cone test on Trumbull lean ore were so encouraging that I felt it might be possible to improve materially the grade of the Cliffs-Shaft Crushed Ore when this grade dropped down below the point of merchantability. The results of this bucket test was sufficiently satisfactory to warrant sending a carload of this ore to the Mines Experiment Station in Minneapolis for large scale testing, both in jigs and the heavy gravity cone, during the winter. This will be done. Also, while on the Range, I went over the preliminary work of a new estimate of the Holman-Brown ore reserves with special consideration of the so-called jig material. Following this, I accompanied Messrs. Barber and Donovan to St. Paul, where, on the 15th, we attended the public ad Valorem tax hearing at the State Capitol. Mr. Geffine joined us for this hearing. I spent one day at our Cleveland office going over with Messrs. Geffine and Sadler our Depletion problems for the years 1937 and 1938 and also conferring with Mr. Raymond on the anticipated tests to beneficiate the high Silica Crushed Cliffs-Shaft Ore.

In December, I spent one day with Mr. Wade, Metallurgist, at the Mines Experiment Station in Minneapolis and another day with Mr. Holt of Butler Brothers in St. Paul, going over with them plans for the large scale tests on a carload of off-grade Crushed Cliffs-Shaft Ore to be made during the winter at the Station. On this trip I also attended the annual meeting of the Minnesota Section of the American Institute of Mining & Metallurgical Engineers held at the University of Minnesota. The attendance of mining men was large and the meeting both interesting and beneficial. Mr. Barber joined me in attendance at this meeting. I also spent about 10% of my time during the month working on Depletion estimates and figures for the Cleveland office in preparation for closing the books of the Company for the year 1938.

STANLEY W. SUNDEEN. Mr. Sundeen continued as Assistant Geologist throughout the year. His time was divided 48% directly connected with the geological surveys of our operating mines; 13% with the drilling explorations; and 39% on miscellaneous duties included in the routine work of the Department. He has made periodic underground geological surveys and posted this information on the geological maps of the Cliffs-Shaft,

Lloyd, Maas, Mackinaw, Negaunee and Virgil Mines. The Cliffs-Shaft Mine continues to be our biggest and most important underground geological problem. This property alone required about 30% of Mr. Sundeen's time. The geology of the current extensions in the operating mines has been posted up to date on the geological maps and cross-sections. There still remains, however, some underground geological surveying in portions of the Cliffs-Shaft Mine where, years ago, this work was omitted or where the results can not be reconciled with our present and more advanced knowledge of the complicated geological conditions prevailing in this property. I had hoped that Mr. Sundeen would have an opportunity to go underground periodically in the Morris Mine, become familiar with its geology and post the geological extensions on our own maps and cross-sections. This was not possible but we anticipate a schedule of this kind during the coming year. General geological mapping is being done by the Engineering Department of the Inland Steel Company and we have access to this information. For our own protection, however, it is essential that we make occasional independent surveys.

That part of Mr. Sundeen's time referred to above as miscellaneous duties included a continuance of the work which he started more than a year ago on a new surface geological map of the Eastern and more important portion of the Marquette Range. We will compile on this map all of the surface geological information in the Company's records and files and will augment this with field examinations and surveys as time will permit. Our objective is a complete surface geological map of the Marquette Range which can be kept up to date as additional information is acquired in years to come. This is invaluable in future and deep diamond drilling in exploring the Company's mineral estate. In this connection Mr. Sundeen made several field examinations of outcrops in Sections 1, 2 and 4, 47-27.

GUSTAV AFUHS. Mr. Afuhs continued as our Draftsman throughout the year. His work, as in the past, has, in part, consisted of preparing cross-sections of all our current drilling, recording all the drill data in our files, and copying all exploration data submitted to this office in the form of land offers, outside explorations, etc. About 53% of his time was spent directly in connection with the geology of our operating mines, posting current extensions on the geological maps and cross-sections, and making new maps where necessary. In the latter connection he has continued the work of making a new set of geological maps and cross-sections of the Cliffs-Shaft Mine to take the place of the old ones which are in very bad shape after 30 odd years of constant handling. This work was started two years ago and he has continued it as time would permit. He completed, during the year, a new set of geological cross-sections through the Maas-Negaunee ore body. Mr. Afuhs also assisted us in taking samples of drill water for the determination of soluble sulphur during the time ore was encountered in the Section 2 drilling exploration. About 10% of his total time was spent in connection with all of our drilling explorations. The balance of his time, about 37%, was spent in general drafting work, and with a variety of small jobs comprising the routine work of the Department.

E. A. ALLEN. Mr. Allen spent 95% of his time during the year collecting, sampling, labeling and filing diamond drill samples from the current explorations and making tests for the dip and bearing of the several drill holes with the Maas Compass as this data was required. The sampling also included taking samples of drill water whenever drill holes at the Section 2 Exploration encountered ore. This was necessary in order that we might determine the amount of soluble sulphur contained in the ore and lost in the drill water during the drilling operations. He made thin sections of rock samples and diamond drill core, whenever necessary, for microscopic study by Mr. Sundeen and me. The rest of his time was spent on routine office duties.

C. SURFACE GEOLOGICAL SURVEYS

The principal surface geological surveying accomplished during the year was that done by Mr. Sundeen in connection with the new surface geological map of the Eastern and more important portion of the Marquette Range which we are making up as we have the opportunity. I have mentioned the work done in the field in this connection in discussing Mr. Sundeen's activities above. In the course of our studying of the geology of the Marquette Range, we have started to build up several North-South cross-sections based on this surface geological study, drill hole information, geological structures disclosed in the mines, etc. All of this work is invaluable in planning the deep diamond drilling necessary to explore the Company's mineral estate in the future. It is necessary for us, first, to correlate and try to reconcile the vast amount of more or less disconnected geological information amassed by our predecessors through the many years of the Company's existence and fill in as many gaps as possible from additional surface geological surveys and information acquired currently from explorations, underground operations, etc.

Mr. Sundeen spent two days on the old Menominee Range, in the districts of Norway, Vulcan and Iron Mountain in company with Dr. C. E. Dutton, who is a personal friend of his. Dr. Dutton has started a general surface geological survey of the old Menominee Range under the auspices of the Michigan State Geological Survey. It is our understanding that he will continue this work during succeeding summers until completed.

D. MINE GEOLOGICAL SURVEYS

With minor exceptions, underground geological surveys of all current mining extensions and development work, were made during the past year at all of our operating mines. We made complete geological surveys of the current extensions in the Cliffs-Shaft Mine and of the new development work, principally on the main levels, in the other mines. Geological information was supplied to us by the engineers at the various soft ore properties within the limits of the actual stoping operations and all of the information posted on the geological maps and cross-sections.

All of the underground mines, with the exception of the Princeton, were active during the year but on a curtailed basis. The Mackinaw Mine, however, was closed down June 1st. From January 1st to April 16th, all mines, excepting the Cliffs-Shaft, were operated four days per week,--

the Cliffs-Shaft worked five days per week. From April 16th to June 1st, all mines, except the Cliffs-Shaft, were operated six days per week but each man averaged three days per week,--the Cliffs-Shaft worked with full crews four days per week. From June 1st to November 1st, all mines, excepting the Cliffs-Shaft, worked four days per week with each man averaging two days per week,--the Cliffs-Shaft continued at 3 days per week with a full crew. From November 1st to December 31st, all mines, except the Cliffs-Shaft, were operated six days a week with each man working three days,-- the Cliffs-Shaft Mine was operated four days per week with a full crew.

The Tilden Mine open pit operations began on June 8th and continued intermittently on a single shift basis until November 1st.

D-1. - ATHENS MINE

All of the Athens production continued to come from the blocks of ore between the 4th and 6th Levels. The development of the new 7th Level, which was being carried on at the beginning of the year, was completed. Ten raises were completed from this level to the top of the ore. Six of these raises had been started at the beginning of the year. Also, the development drift on the 9th Level, and the transfer drift on the -550' Sub-Level, underway at the beginning of the year, were completed.

It was expected that No. 2 cross-cut on the 7th Level would encounter some ore but this proved not to be the case and reduced the developed ore area on this level. On the other hand, however, during the mining of ore in the West half of Block 4 on the -500' Sub and vicinity, the ore limits were expanded materially. As a result, the developed reserves at the end of 1938 were approximately 58,000 tons more than at the end of 1937.

D-2. - CLIFFS-SHAFT MINE

In "A" Shaft, the production continued to come chiefly from the Bancroft Lease on the North, the main deposit,--both the central part and the area adjacent to the old Incline mine and No. 3 mine on the East, and from the Southeast deposit. Approximately 70% of the total mine production was mined from "A" Shaft deposits.

The important developments in "A" Shaft during the year were as follows:

On the Bancroft Lease, a drift was driven Westerly from the Northwest end of the 10th Level to reach the ore in diamond drill hole No. 456. This drift holed into the ore near the end of the year. A new stope has been opened about 200' South of this drift, also on the 10th Level, in ore that we now believe is the same body as encountered in the drill hole and drift. Also, a stope has been opened up at the 9th Level elevation in this same ore body from a raise from the 10th Level. In this latter stope, ore is still exposed on three sides and there is every evidence that a large ore body exists at this location. Also, on the Bancroft Lease, a drift is being driven Westerly from the main North cross-cut on the 15th Level to get under this 10th Level ore and to tap it with raises.

Stoping continues in large volume to the East of the Bancroft Lease on fee property at several elevations. This ore was first discovered in drill holes Nos. 417 and 418, drilled from the 8th and 9th Levels, respectively.

"B" Shaft deposits produced about 30% of the total mine production. The ore continued to come mainly from the floors, raises and stopes in ore areas already developed on the various levels.

Ore had just been encountered at the West end of the 10th Level, "B" Shaft, in the Section 9 deposit, at the end of 1937. Development work in this deposit has been continuous during the year but the advance is slow on account of being relatively a long distance from the shaft. This limits the tramming capacity and the number of gangs of miners that can be employed until a larger area is opened up. Two raises have been put up in following the first ore encountered. At the end of the year, drifting had been resumed on the main level in anticipation of encountering the ore again to the West of the dike which cut off the first ore encountered. This area continues to be watched with a keen interest and with a reasonable expectation of developing an important addition to the reserves of the Cliffs-Shaft Mine.

D-3. - JACKSON LEASE

The Cambria Mine, through which the Jackson Lease is operated by the Republic Steel Corporation, was closed down for most of the year in order that the mine might be entirely electrified. For this reason, no geological surveys were made during the year on this property.

D-4. - LLOYD MINE.

The production from the Lloyd Mine has come from the East Lloyd ore body and was divided between three principal areas,--namely, that portion of the East end of the ore body above the 4th Level; the center part of the ore body between the +690' Sub-Level and the 4th Level; and from stoping under the West end hanging wall above the 5th Level.

The new drift on the 6th Level in the slate footwall, which was started from the shaft in 1937, was extended about 950' to the contact with the iron formation and carried Easterly in this formation an additional 450'. Two cross-cuts were driven to the South when indications pointed to the proximity of ore. Also, three raises were put up, one from the first cross-cut and the other two from the main drift. Only a small amount of ore so far has been found in these raises. They are all in the hanging wall portion of the main ore body. Drifting Easterly will be continued in order to encounter and develop the main ore body.

D-5. - MAAS MINE

The production during the year continued to come principally from three areas,- namely, from the East and West footwall pillars above the 3rd Level; the main deposit above the 4th Level, both to the East and South of the Race Course; and the main deposit above the 5th Level on the

Race Course and south of it. About 16% of the total mine product was of Bessemer grade. This ore is confined to the horizon immediately below the hanging wall.

On the 4th Level, the 4000 cross-cut was continued Southeasterly to the property line, a distance of about 420'. Seven raises were put up from this drift, all in ore, for mining in the third block East of the Race Course, which is a part of the main deposit. A raise was started from the North side of the 300 drift from which will be driven a transfer drift to be used in mining the ore lying in the West footwall pillar on the 3rd Level.

On the 5th Level, No. 3 cross-cut was extended Southeasterly in footwall jasper for a distance of about 400'. This will be extended until it intersects the East end of the South footwall drift and a series of raises will be put up through which will be mined the ore in the main deposit above. No. 7 cross-cut was extended an additional 50' during the year Northwesterly along the West boundary of the Race Course to accomodate one additional raise which was put up to serve the newly developed extension of the ore body under the hanging wall first encountered on the 90' sub-level.

D-6. - MACKINAW MINE

The Mackinaw Mine operated only until June 1st. It was then closed down, due principally to the Sulphur and Phosphorus contents of the remaining reserves being above marketable limits at the present time. The lower levels of the mine have filled with water but pumping is being carried on to keep the water just below the 5th Level.

During the operation of the mine, the production came from stopes above the 6th, 7th, 8th, 9th and 10th Levels, but 73% of it came from above the 6th and 7th Levels. The stoping areas are all centralized in the Northwest end of the ore body which is its widest part. The development work was confined to the 6th, 7th and 10th Levels. The 10th Level was extended 275' almost due West from its previous Northwest end. The 7th Level was extended a short distance to the Northwest. Near the end of this drift, a raise was put up to the 6th Level elevation and the 6th Level extended to hole into it. This raise was in ore the entire distance but the Phosphorus and Sulphur contents were too high to make it merchantable at the present time.

D-7. - MORRIS MINE

The Morris Mine continued to be operated under lease by the Inland Steel Company. Mining was on a five shift per week basis until the middle of May when the mine was closed for six weeks to install new hoisting equipment. From July 1st to the end of the year the mine operated four days per week. We had hoped to make periodic trips through the underground workings during the past year in order to make geological surveys of the new development work and the more important stoping areas but other more important work has made this impossible to do with our present personnel. I have, however, gone over the maps outling the work for the year with Mr. Satterly, Superintendent, and have the following to report relating to the production and new developments.

The production during 1938 came principally from the No. 9 lease and the Cleveland-Cliffs Iron Company fee land to the East and South of this lease. The balance of the ore was mined from Lease No. 24 lying directly West of lease No. 9. In the years immediately preceding 1938, production was about evenly divided between sub-level stoping and slicing operations. During the past year, from 60 to 70% of the ore has come from slicing and the balance from sub-level stoping. The topmost workings are at the +170' elevation in the old "B", now called No. 75 deposit, which is 70' above the 7th Level. The lowest workings remained on the -90' Sub-Level in the main, or No. 33 deposit, which is 35' above the 8th Level.

The development work done during the year was confined to the -10' Sub-Level, the 8th and 9th main levels. The ore limits of the No. 75 deposit had previously been somewhat extended to the West on the +30, +20', and +10' Sub-Levels. In order to open this up for stoping, a drift was driven Westerly on the -10' Sub-Level which has been an intermediate timber handling and transfer level in this part of the mine. A considerably larger area of ore was outlined at this elevation in this deposit and a new ore body, No. 77 deposit, opened up just South of a dike which limits the No. 75 deposit of ore on the South. This new ore extends only a short distance above the -10' Sub and may be the top of an important deposit in depth. Several raises were put up from this elevation in the No. 75 deposit ore.

On the 8th Level, a small drift was driven from the back of the level Southerly from the West end of the main deposit and encountered about 70' of high grade ore. This ore corresponds in width and structure to the main deposit but is off-set to the South about the width of the deposit. This may be a fault off-set of the ore horizon in which this concentration was effected or it may be the beginning and top of a separate ore body. A raise put up from this small drift indicated a height above the level of about 40 to 45' or approximately the same height as the corresponding ore in the main deposit. This ore is all on Lease No. 24. Four small exploration cross-cuts were driven South from the back of the main footwall drift on the 8th Level about 120' apart. The first of these is on Lease No. 9 about 50' East of Lease No. 24 boundary line. The remaining three are all on Lease No. 24. All of these last three cross-cuts encountered high grade ore which apparently is continuous between these cross-cuts. This ore does not go very high above the level but, again, may be the top of a very important ore body in depth. Such are the characteristics of the numerous ore bodies in the Morris Mine. They start with small horizontal areas at the top and open out in dip and pitch below. This ore body is called the No. 79 deposit and its development from the 9th Level will be watched with a great deal of interest.

The Morris shaft was sunk 200' and the 9th main level cut out 200' below the 8th Level or at an elevation of -338'. A shaft plat has been cut out and a tail drift put in for a distance of 130' North of the shaft. Drifting, to open up the level, is now progressing South and Southwesterly toward the several ore bodies as outlined on the 8th Level and had advanced a distance of approximately 350' from the shaft at the end of the year.

Several years ago, a small amount of high sulphur ore was found on the -10' Sub-Level in the Eastern portion of the main, or No. 33 deposit. Its limited extent gave it little importance in the ore reserves as a whole or in the operation of the mine. During the past year, however, high sulphur ore has been found in two other places. The first of these is in the Westerly extension of the No. 75 deposit on the -10' Sub-Level and the second is in the new, or No. 79 deposit, developed in the three small cross-cuts just South of the footwall drift on the 8th Level on Lease No. 24. The high sulphur content cuts off sharply in a horizontal plane about 20' above the -10' Sub in No. 75 deposit, and about the same distance above the 8th Level in the No. 79 deposit. Above that, the ore is of average sulphur content. We have no knowledge of the downward extent of this high sulphur ore but its occurrence in these new locations is a disturbing factor and will be so long as it continues in depth. Sulphur in such quantities in iron ore deposits on the Marquette Range is very erratic in its occurrence and I hesitate in making any predictions. The development of these ore bodies will be watched with an intensified interest.

D-8. - NEGAUNEE MINE

The production in 1938 came from four localities,-namely, the main deposit between the 11th and 13th Levels; the footwall pillar above the 11th Level; the area between the two South dikes, also above the 11th Level; and the shaft pillars around old No. 1 and No. 2 shafts above the 9th Level.

A small amount of drifting was completed on the 13th main level and three raises put up in the main deposit. A small amount of development work was necessary to reopen old No. 1 and No. 2 shaft pillars. Mining in these areas will be more or less of a scram operation, for some little time.

No. 3 shaft was sunk 117' to a sump elevation below the 14th main level. The 14th main level was cut out at a distance of 121' below the 13th Level. The shaft plat was being cut out at the end of the year. The development work and drilling done during the year resulted in an estimate of developed ore at the end of 1938 about 22,000 tons in excess of the reserves at the end of 1937.

D-9. - TILDEN MINE

It was not necessary to make any geological surveys during the year at the Tilden Mine. The production all came from previously stripped areas in the East and West Pits. The total production was 85,589 tons, of which 18,774 were mined from the East Pit and 66,815 from the West Pit.

New development work was confined to three stripping operations, namely, At the East Pit, the West half of the West Pit on the upper bench, and in the lower bench of the West Pit. Some of the stripped material from the West Pit was used to construct an approach between the lower bench and the West side of the crusher.

D-10. - VIRGIL MINE

The entire production from the Virgil Mine during 1938 came from stopes on the Northwest side of the deposit between the 6th and 8th Levels. Stoping was interrupted several times during the year due to caving in some of the stopes which seriously impaired ventilation. This produced an excess of $CO_2$ gas and entailed a considerable amount of rock drifting and raising to re-establish safe ventilation.

The main level development was confined entirely to the 8th Level and raising above it. The level was extended Southwesterly to the Virgil boundary and a cross-cut driven coincident with this boundary to the South. Three raises were put up from this cross-cut to develop the Southwest portion of the main ore body. This latter development was being carried on as the year closed.

E. OPTIONS AND LEASES

No new options to explore, nor leases, were taken by the Company during the year. At the beginning of the year, negotiations were underway for an option and lease with Mr. John T. Spencer of Iron Mountain, Michigan, on the old Cornell-Clifford property lying North of Iron Mountain in Section 30, T. 40 N., R. 30 W. These negotiations were discontinued as a result of Mr. Spencer's being unable to clear the title on these lands.

The mining lease on the Canisteo Mine on the Mesaba Range, formerly held by the Mesaba-Cliffs Mining Company, was cancelled, effective December 31st, 1938.

F. EXPLORATIONS AND COSTS

Drilling explorations were carried on in 1938 in the following districts and mines:

F-1. - FROM SURFACE

| DISTRICT | RANGE | MINE |
|---|---|---|
| Negaunee | Marquette | Negaunee |
| Ishpeming | Marquette | Sec. 2 Exploration. |

F-2. - FROM UNDERGROUND

| | | |
|---|---|---|
| Ishpeming | Marquette | Cliffs-Shaft |
| Negaunee | Marquette | Maas and Negaunee. |
| Gwinn | Swanzey | Mackinaw |

Table V, which follows, gives the footage drilled, the ore encountered, and the cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was $6.03 per foot, excluding certain items which are not actual drilling expense but which customarily are charged to these explorations. By including these items, the average cost of drilling was $6.93 a foot. The cost of underground drilling in the same way was $3.16 per foot and $3.54 per foot, respectively. All drilling costs for 1938 were increased somewhat by the expense of a one week holiday. In the case of the Cliffs-Shaft drilling, which is the only underground drilling carried on for two consecutive years, we were confronted with a very much larger footage of extremely hard ground in 1938 in comparison with 1937. In the case of surface drilling, in the Section 2 Exploration, a materially larger proportion of the footage drilled was from zones of greater depth in 1938 as compared with 1937. Furthermore, a larger percentage of ore per foot of drilling was encountered and this entailed expensive sampling of the drill water, all of which is charged directly against the cost of drilling.

Table VI, also shown below, gives a comparative cost of drilling for the past five years. The comparatively high costs in 1938 are explained in the paragraph above.

TABLE V.

SUMMARY OF DRILLING FOR 1938

| PROPERTY | DESCRIPTION SEC. | T. | R. | STAND-PIPING FT. | CHURN DRILLING FT. | DIAMOND DRILLING FT. | TOTAL DRILLING FT. | FIRST CLASS ORE FT. | SECOND CLASS ORE FT. | LEAN ORE FT. | TOTAL COST "A" | COST PER FT. "A" | TOTAL COST "B" | COST PER FT. "B" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURFACE DRILLING** | | | | | | | | | | | | | | |
| Negaunee Mine | 5 | 47 - 26 | Mich. | 242 | 123 | 302 | 667 | 0 | 5 | 30 | $ 2,272.54 | $ 3.41 | $ 2,182.44 | $ 3.27 |
| Negaunee Mine | 32 | 48 - 26 | " | 880 | 2 | 520 | 1,402 | 10 | 20 | 17 | 5,106.29 | 3.64 | 4,855.11 | 3.46 |
| Section 2 Exploration | 2 | 47 - 27 | " | 176 | 9 | 9,898 | 10,083 | 477 | 180 | 413 | 76,892.34 | 7.63 | 66,277.47 | 6.57 |
| TOTAL SURFACE DRILLING | | | | 1,298 | 134 | 10,720 | 12,152 | 487 | 205 | 460 | $84,271.17 | $6.93 | $73,315.02 | $ 6.03 |
| **UNDERGROUND DRILLING** | | | | | | | | | | | | | | |
| Cliffs-Shaft Mine | 3, 4, 9 & 10 | 47 - 27 | Mich. | - | - | 1,757 | 1,757 | 191 | 58 | 63 | $ 7,069.63 | $4.02 | $ 6,232.90 | $ 3.55 |
| Maas Mine | 6 | 47 - 26 | " | - | - | 577 | 577 | 239 | 96 | 105 | 1,869.48 | 3.24 | 1,684.84 | 2.92 |
| Mackinaw Mine | 35 | 45 - 25 | " | - | - | 384 | 384 | 140 | 77 | 4 | 956.47 | 2.49 | 865.86 | 2.25 |
| Negaunee Mine | 6 | 47 - 26 | " | - | - | 874 | 874 | 357 | 184 | 62 | 2,831.76 | 3.24 | 2,552.08 | 2.92 |
| TOTAL UNDERGROUND DRILLING | | | | - | - | 3,592 | 3,592 | 927 | 415 | 234 | $12,727.34 | $3.54 | $11,335.68 | $ 3.16 |
| GRAND TOTAL DRILLING | | | | 1,298 | 134 | 14,312 | 15,744 | 1,414 | 620 | 694 | $96,998.51 | $6.16 | $84,650.70 | $ 5.38 |

Note: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.
Cost "B" excludes " " " " " " " "

TABLE VI.

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

| YEAR | TOTAL FEET DRILLED. | COST PER FOOT "A" | COST PER FOOT "B" | |
|---|---|---|---|---|
| 1934 | 8,230 | $ 2.01 | $ 1.64 | Canisteo Structure Drilling only. |
| 1935 | 4,321 | 3.16 | 2.70 | |
| 1936 | 12,094 | 3.46 | 3.00 | |
| 1937 | 21,008 | 5.32 | 4.69 | |
| 1938 | 15,744 | 6.16 | 5.38 | |

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F-3. - DIAMOND DRILL CARBON

We had on hand, January 1st, 1938, a total of 608.15 carats of diamond drill carbon, which inventoried at $64,161.04. We purchased, during the year, 27 stones having a weight of 149.40 carats, at a cost of $12,292.15. We consumed, during the year, a total of 192.81 carats, having a value of $19,626.48. This left on hand, December 31st, 1938, a total of 564.74 carats, which inventoried at $56,826.71. In addition to this carbon, we have on hand 15.37 carats of Bortz, at a cost of $49.95. Bortz is used in the place of chipped carbon when we encounter ore in our surface drilling, but we had enough of the chipped carbon for use during the past year so that none of the Bortz was used. This is carried separately and not inventoried with our carbon.

F-4. - DRILL SECTIONS

Cross-sections of all diamond drilling, showing analyses and classification of material encountered during the year will be found in the Annual Report books of maps of the Michigan ranges which are submitted as a part of the Annual Report of the Engineering and Geological Departments. No structure or other drilling, at our properties on the Mesaba Range, was done during the past year.

G. SURFACE EXPLORATIONS

G-1. - EXPLORATIONS ON THE NEGAUNEE MINE SURFACE IN SECTION 5, 47-26 AND SECTION 32, 48-26, MICHIGAN.

A series of three diamond drill holes were drilled in Section 32, 48-26 beginning with Hole No. 3, in the latter part of June. These holes were planned to find out if the ore in the old No. 2 Shaft pillar extended Northeasterly and connected with that mined many years ago through the old Barassa shaft and, if no connection existed, to delimit this ore in its Easterly and Northeasterly extent. This work was made advisable in connection with the development work underground in reopening and mining the ore in these old pillars. Only one seam of ore was cut and that only 10' in thickness. The drilling, therefore, eliminated any important ore connection between this shaft pillar and the Barassa workings and confirmed the approximate Easterly limits of the shaft pillar ore about as assumed in the past.

Three standpipes, Nos. 6, 6A and 7, were sunk, also in Sec. 32, to the North of and on the same meridian as the three diamond drill holes mentioned above. These were sunk with the Armstrong churn drill outfit in order to determine the depth of ledge, the ground water level, and to classify carefully the surface material passed through. This data is necessary to contour the ledge surface and to find out if it is possible that a water channel exists in this vicinity which may be draining into the Negaunee Mine workings through the caved area in the vicinity. If such is the case, deep well holes may be sunk to catch this water before it gets into the mine and thereby facilitate materially mining the ore affected by it. In sinking Pipe No. 6, the lower section broke off at a depth of 148' before ledge was encountered and it was considered cheaper

to sink another pipe along side of it than to try and recover the other hole and complete it. This is the reason for pipe No. 6A. This work was discontinued the latter part of December because of severe weather conditions but it is planned to sink at least one or two more pipes in the spring.

The Armstrong churn drill was also used to put down two holes, Nos. 23 and 24 in Section 5, 47-26. The object here was to determine the depth of surface material to ledge directly above the old stopes in No. 1 shaft pillar before starting the work of recovering the ore in this pillar and caving the ground above. In work of this kind, it is essential to know how much rock capping exists between the top of the ore and the ledge surface. Hole No. 24 was located where it should encounter the ore in this pillar if the ore extended to the ledge surface or close to it. The hole was chopped into ledge for nearly 100' without encountering ore, the interpretation being that the upper limit of the ore in this pillar is about as developed by the old workings.

Hole No. 25, in Section 5, was put down to ledge by the Armstrong churn drill outfit, after which a diamond drill was used. This hole was located some 300' Northeast of old No. 2 shaft and was a part of the program mentioned above in connection with holes 3, 4 and 5 in Section 32 to develop a possible connection of the No. 2 shaft pillar ore with that mined from the old Barassa shaft. Here, also, as was the case in Section 32, no extension or connection of ore was found and the hole was bottomed at a depth of 397'.

G-2. - <u>EXPLORATIONS IN SECTION 2, 47-27, MICHIGAN</u>

Diamond drilling at this exploration was carried on continuously throughout the year in 1938. It was confined to the S½ of the NE¼ of Section 2. Three drill rigs were used until the middle of June, after which it was necessary to confine the work to two rigs until the results from the holes being drilled were obtained, in order to facilitate the location of additional holes. Drilling with two rigs continued for the balance of the year.

This exploration was commenced in the spring of 1937 to explore what appeared, from our study of surface geological conditions, to be one of the most favorable areas for high grade ores, at moderate depths, on the Company's estate. Our studies indicated a major thrust or reverse fault striking approximately East and West along the South side of the Golf Club area and dipping to the South. If our conclusions were correct, the effect of this fracture would be to raise the slate footwall on the South side of this fault several hundred feet with respect to its position on the North side, forming a fault crotch of iron formation very favorable for the concentration of a large body of high grade ore.

All of our drilling here in 1937 confirmed our theory of structure with remarkable accuracy. Furthermore, the first hole to reach the anticipated ore horizon just above the footwall slate, Hole No. 16, encountered 25' of high grade ore. This was not particularly important in quantity

but it proved that concentration is present in this geological structure and warranted a continuation of the exploration. Holes 27A, 37 and 38 were being drilled at the beginning of the year.

Hole No. 27A was located on the 12,000 W. meridian about 750' South of Hole No. 16 and about 350' Southeast of the Golf Club house. It had reached a depth of 1561' on the first of the year. The hole encountered the ore horizon at 2215' and between this point and the slate footwall, a total of 95' of high grade ore was encountered as follows:

| From | To | Amount | Iron | Phos. | Sul. |
|---|---|---|---|---|---|
| 2215 | 2235 | 20' | 60.60 | .069 | .018 |
| 2285 | 2330 | 45' | 61.36 | .153 | .016 |
| 2345 | 2350 | 5' | 58.24 | .105 | .017 |
| 2390 | 2415 | 25' | 59.92 | .188 | .016 |

The hole was bottomed in Siamo slate at a depth of 2475' early in April.

Following up our theory of the concentration and deposition of high grade ore bodies in major fault crotches formed by the displacement of the footwall slate, we would expect increasing thicknesses in any large ore body as the fault itself is approached. This hole, therefore, was the first to bear out our structural ideas of the area, and the results were tremendously encouraging.

Hole No. 37 was located on the 11,400 W. meridian, 600' East of No. 27A, and approximately 250' North of it. It had reached a depth of 1750' at the beginning of the year. The ore horizon was encountered at a depth of 2300' and 25' of high grade ore was cut, averaging 60.02% Iron, .126% Phos. and .026% Sulphur. The hole was bottomed in footwall slate at a depth of 2417' the early part of March. These results added further encouragement to the possibility of developing a high grade ore body of considerable extent. The footage of ore was relatively small, although mineable, but it is now apparent that this hole is a greater distance from the fault intersection with the footwall than we could have anticipated from any previous information.

Drilling at this exploration was not started until it was realized that a new mine would be needed as soon as it could be discovered and developed. If we had been able to start a year or two sooner, so to have had opportunity to put down a number of standpipes and inclined holes, we could have outlined the shallow portion of this favorable structure sufficiently to have located our deep holes where they would encounter the thicker portions of the ore body. The final stages of the depression prevented this but because of the urgent demand for the development of a new mine, we decided to go ahead with the deep drilling at once on the basis of our meager surface geological information. I am pleased to report that all of the holes in this area have successfully encountered ore of mineable thickness and the information obtained is essential for an intelligent exploring campaign. Further, as a result of these holes at some distance up the dip from

the main fault crotch, we encountered minor faulting that has materially complicated the ore bearing structure. The knowledge of this is extremely valuable in opening and developing this ore body for mining.

Hole No. 38 was located on the 12,600 W. meridian, 600' West and 150' North of Hole 27A, and approximately 1200' West of Hole 37. It is also about 250' West of the Golf Club house. It had reached a depth of only 154' at the beginning of the year. The ore horizon was reached at a depth of 2210' where 130' of high grade ore was encountered as follows:

| From | To | Amount | Iron | Phos. | Sul. |
|---|---|---|---|---|---|
| 2210 | 2300 | 90' | 60.05 | .104 | .018 |
| 2320 | 2360 | 40' | 62.51 | .174 | .024 |

The hole was bottomed in footwall slate at a depth of 2389'. Maas compass surveys of the hole showed it to have deviated about 180' Southwesterly at the ore horizon. Needless to say, these results were very encouraging. Later remarks will show that the fault crotch is several hundred feet farther South than would be indicated by any information up to the time of drilling this hole. This adds materially to the significance of the thickness of ore in this hole.

Hole No. 39 was located early in April on the 11,400 W. meridian, 500' North of Hole 37 and 600' East of No. 16. At that time we had completed and encountered the ore horizon only in Holes 16, 27A and 37.

Before approaching the fault crotch any closer, with our limited knowledge of its possible location at that time, we realized the importance of completing Hole No. 38. It must be remembered that we were attempting to do everything possible to extend the limits of the ore already encountered in the minimum time. There was a possibility that ore of mineable thickness pitched Southwesterly into this fault structure from the general direction of the ore in the Jackson Lease which is located to the Northeast. If such an ore shoot existed, its thickness might increase in extending Southwesterly and approaching the large structure. Therefore, ore of greater thickness than that encountered in either Hole 16 or 37 might pass between these holes and be indicated by the ore in Hole 27A. Hole No. 39 was located to determine this and also to further develop a geological cross-section on the 11400 W. meridian. Before completing this drilling campaign, it will be important to have at least one cross-section, through this entire structure, developed quite completely. Only in this way can underground development be directed intelligently.

Hole No. 39 encountered high grade ore at two horizons, the first quite unexpectedly and at a distance of over 500' above the slate footwall. At this point, 65' of ore was cut as follows:

| From | To | Amount | Iron | Phos. | Sul. |
|---|---|---|---|---|---|
| 1465 | 1495 | 30' | 59.90 | .028 | .016 |
| 1505 | 1540 | 35' | 58.37 | .012 | .015 |

This ore was very hard, blue in color, and extremely low in Phos., differing entirely from the soft hematite encountered in the horizon immediately above the Siamo slate. Also, it was porous and vuggy, showing recrystallization throughout and typical of fault zone or water course secondary deposition. I think the chances of this ore representing any material tonnage are rather remote and believe that it owes its existence to a relatively local underground water circulation along, or in the vicinity of, minor fractures, and not connected with the main large soft ore body lying on the slate.

Twenty-seven feet of high grade ore was encountered at the slate horizon between the depths of 2130 and 2157'. It averaged 61.60% Iron, .178% Phos. and .030% Sulphur. Rather strangely, slate was first encountered at 2074' and extended to the top of the ore. This upper slate, likely, is a transition phase between the typical cherty iron formation and the main Siamo slate member. Heretofore, in this area, we have found occasional ferruginous slate bands interbedded in the ore horizon but with the upper part of the ore above it, but in this case the ore is contemporaneous with the lower phase of the transition horizon. The hole was bottomed in typical Siamo slate at a depth of 2205' the middle of October.

The results of Hole No. 39 do not indicate an important extension of ore to the Northeast connecting the main ore body in this structure with the ore in the Jackson Lease. However, there may be important extensions of the ore in the Jackson Lease into this general faulted structure but to the East of this area. This possibility, undoubtedly, will be tested by exploration work in the future and after much more is known about the ore in the Jackson Lease itself as underground work progresses.

Hole No. 40 was located on the 12,000 W. meridian and 400' South of No. 27A, in April. The prime object of this hole was to encounter the ore horizon down the dip from the latter hole closer to the main fault itself and further develop the cross-section along this meridian. The main ore horizon was encountered at a depth of 2246'. A total of 115' of high grade ore was cut as follows:

| From | To | Amount | Iron | Phos. | Sul. |
|---|---|---|---|---|---|
| 2446 | 2530 | 84' | 60.24 | .121 | .031 |
| 2549 | 2580 | 31' | 63.38 | .139 | .018 |

The hole was bottomed in footwall slate at a depth of 2619' the first of November. Here, again, the results were very gratifying and the thickness of ore increasing with depth and as the main fault crotch is approached.

In order to develop a tonnage of ore sufficient to warrant the large capital expenditure to develop it at these depths, it is necessary to drill deeper into the structure with holes quite widely spaced. Hole No. 41, therefore, is being drilled on the 12,600 W. meridian, about 600' South of Hole No. 38 and the same distance West

of Hole 40. Fifteen feet of high grade ore, averaging 59.67% Iron, .063% Phos. and .012% Sulphur, was encountered from 245 to 260'. This ore was quite similar to that encountered in the upper part of Hole No. 39,-- hard, blue, recrystallized, and typical of that found in secondary water courses frequently encountered in zones of faulting, and we believe its laterial extent is unimportant. This hole started in a member of the main greenstone intrusive series on the South side of the major East-West fault and cut through this fault about where this ore seam was encountered. It was drilling in the thicker member of this greenstone intrusive at a depth of 1044' on the North side of the major fault, as the year ended. Barring unforeseen delays, it is anticipated that the ore horizon will be encountered at a depth below 2200' the early part of May.

We are confident that Hole 41 will encounter at least as much high grade ore as did Hole 40. Before drilling one more deep hole, which we had planned to do on the 11,400 W. meridian, and a considerable distance South of Hole No. 37, it seemed necessary to know more about the angle of dip of the major East-West fault and, therefore, to define more closely the limit and deepest part of the fault crotch in the slate. Accordingly, two relatively shallow inclined holes, each dipping 60° to the North, were planned to cut the plane of the fault at two points, one below the other, on the 11,400 W. meridian. These intersections, together with Holes 37 and 39 on this section, and the information from the drilling done on the 12,000 W. meridian, should give us a very good idea of the dip of the fault and its intersection with the footwall slate.

Hole No. 42 was located 375' South of Hole No. 37. It was drilled to an ultimate depth of 136' and cut the fault at approximately 100'.

Hole No. 43 was located 225' South of No. 42. It ledged in the thick central member of the main greenstone sheet in its upthrust position on the South side of the fault, at a depth of 34'. It was still drilling in this greenstone sheet at a depth of 263' on the last of the year. After cutting through the major fault, the hole will be carried down until it cuts through the upper horizon of greenstone, the interbedded iron formation,and into the thick, or central member, of the greenstone series, all of which are located on the North or downthrow side of the fault. In this way, we can confirm much of the structure that we have developed theoretically, in explaining the logs of the other holes on both the 11,400 W. and 12,000 W. meridians.

## H. UNDERGROUND EXPLORATIONS

### H-1. - CLIFFS-SHAFT MINE

One drill operated continuously in the Cliffs-Shaft Mine throughout the year, except for approximately one month during an illness of the drill runner. We were not able to fill his place during the interim. On account of the curtailed operating schedule of the mine, only six holes were drilled in addition to completing the hole

which was being drilled at the beginning of the year. These holes were numbered from 456 to 462, inclusive, and a total of 1757' was drilled. Of this footage, 191' represented high grade ore, 58' second class ore and 63' lean ore. Five of the holes were drilled from the 10th Level, four of them in "A" shaft and one of them in "B" shaft. The other two holes were drilled from the 7th Level, "B" shaft.

Hole No. 456 was drilled horizontally and due North from near the West end of the main East-West Bancroft drift on the 10th Level, "A" shaft, along the 1400 E. meridian and was drilling in dike at a depth of 225' on the first of the year. It cut 33' of high grade ore from 312 to 345', averaging 63.26% Iron and .080% Phos. This was followed by alternate seams of hanging wall slate, graywacke, and lean conglomerate ore to a depth of 402' where dike again was cut. The hole was bottomed in dike at a depth of 422'. The contact between the hanging material and dike at 402' represents a major East-West fault limiting, on the North, the hard ore horizon of the Cliffs-Shaft area. The ore run encountered in this hole is in a heretofore unexplored area. Subsequently, it has been proven that this ore connects with the main Bancroft deposit and adds materially to the proven reserves in this locality.

Hole No. 457 was drilled horizontally and due South from a point near the breast of the extreme West end of the 10th Level, "B" shaft, in the Section 9 ore body. It was located approximately on the 4300 W. meridian and planned to explore for the Southeasterly extension of this Section 9 ore. Only 3' of high grade ore was cut,-- from 60 to 63',-- and this averaged 59.58% Iron and .078% Phos. The hole was bottomed in footwall dike at a depth of 352'.

Holes 458, 459 and 460 were drilled from the Northeast end of the 10th Level, "A" shaft. This location is on the Company's fee property in Section 3, East of the Bancroft Lease, and is the first drilling that had been done in this hitherto unexplored area.

Hole 458 was drilled horizontally and due North to a depth of 256' and encountered 67' of high grade ore as follows:

| From | To | Amount | Iron | Phos. |
|---|---|---|---|---|
| 76 | 79 | 3' | 61.30 | .125 |
| 114 | 175 | 61' | 61.42 | .217 |
| 197 | 200 | 3' | 57.02 | .454 |

Finding such an ore occurrence in this unexplored area was most encouraging for the future of the Cliffs-Shaft Mine. It occurs in a block of ground which has been faulted down from the main Cliffs-Shaft ore bodies to the South. We have found ore directly beneath the hanging wall in this same block to the West, on the Bancroft Lease, but finding it again at this point gives us assurance that ore, likely, is to be continuous along the hanging contact through this entire block from East to West across the property.

Hole No. 459 was drilled due North with a dip of -10° directly under 458 to explore for the downward continuation of this new ore. Several runs of high grade ore were cut aggregating 67' as follows:

| From | To | Amount | Iron | Phos. |
|---|---|---|---|---|
| 80 | 94 | 14' | 63,34 | .094 |
| 97'9" | 100' | 2'3" | 59.55 | .045 |
| 191 | 204 | 13' | 60.76 | .130 |
| 211 | 213 | 2' | 63.27 | .401 |
| 217 | 221 | 4' | 62.30 | .331 |
| 227 | 235 | 8' | 59.15 | .193 |
| 248 | 249 | 1' | 58.79 | .071 |
| 261 | 280 | 19' | 57.63 | .187 |
| 290 | 293'6" | 3'6" | 63.08 | .144 |

The hole was bottomed in footwall dike at 330'.

Hole No. 460 was drilled from the same location but horizontally and due South. It was practically all in footwall siderite and dike and was bottomed in dike, at a depth of 127', without encountering high grade ore.

Hole No. 461 was drilled horizontally and due North from the Northwest side of the 7th Level, "B" Shaft, in order to explore for a continuation and possible widening of a high grade seam in the ore zone encountered in a small drift to the West. Most of the hole was in footwall dike. The ore zone, however, was cut from 84' to 106', but only 5'3" of high grade ore was encountered, from 100'9" to 106'. This averaged 57.80% Iron and .173% Phos. The balance of the zone was contaminated with seams of jasper but it is believed that most of it can be mined and mixed with high grade ore.

Hole No. 462 was drilled horizontally and N. 15° W. from the Northeast side of the 7th Level, "B" Shaft, to test the footwall area for a possible reoccurrence of an ore body to the West which had been stoped out to its apparent limits. The hole started out in ore extending to a depth of 12', averaging 60.15% Iron and .041% Phos. This was followed by 11' of second class ore, averaging 54.50% Iron and .053% Phos., much of which undoubtedly will be mined and mixed with the preceding high grade ore. Four feet of high grade ore, also, was cut from 32 to 36'. This averaged 57.45% Iron and .042% Phos. The balance of the hole, however, was practically all in footwall dike and it was bottomed the last of the year in dike at a depth of 275'.

H-2. - MACKINAW MINE

Before the final decision was reached to close the Mackinaw Mine, it was decided that a steep hole should be drilled down into the ore horizon below the 10th Level to determine if the Sulphur and Phos. contents of this ore showed any signs of decreasing. It will be remembered that the difficulties at this mine were not precipitated by

the depletion of ore reserves but, instead, the progressively increasing Phos. and Sulphur contents of the ore. Accordingly, Hole No. 6 was drilled the latter part of May with a dip of -60° S. 31° W. from a cross-cut near the Northwest end of the 10th Level. The hole started in ore and continued in it to a depth of 140'. This ore averaged 59.08% Iron, .969% Phos. and .986% Sulphur. This ore was followed by 80' of second class ore, too lean to be mixed with the high grade and also even higher in Phos. content. From 234 to 265', the hole was in mixed ore and jasper and passed into footwall slate at 265'. The hole was finally bottomed in arkose at a depth of 384' after passing from the footwall slate into arkose at 370'. This completed the drilling in the Mackinaw Mine.

H-3. - MAAS MINE

The main ore body in the Negaunee Mine extends to the West in pitch and off the property at an unknown depth below the 13th or present bottom level in the mine. Mining has progressed to the point where a new bottom level had to be opened and developed through which all of the ore on the property below the 13th Level can be mined. In order to do this intelligently and economically, it was necessary to determine the general shape and depth of the bottom of the ore body on the Negaunee property and as it passes across the Negaunee-Maas boundary line. A campaign of drilling was planned to get this information. Because some of the openings in the Maas Mine and near the Negaunee Mine boundary are below any of the workings in the Negaunee Mine, and also because of the convenience of these openings, the first two holes in this campaign were drilled from Maas Mine workings.

Hole No. 28, the first to be drilled, was located on the +90' Sub-Level early in February. It was drilled horizontally and S. 9° E. A total of 94' of high grade ore was encountered as follows:

| From | To | Amount | Iron | Phos. |
|---|---|---|---|---|
| 105 | 170 | 65' | 63.14 | .025 |
| 195 | 205 | 10' | 57.80 | .023 |
| 215 | 234 | 19' | 57.89 | .255 |

The hole was bottomed in footwall ferruginous slate at 379' after having encountered this slate at 370'. The Maas-Negaunee boundary was crossed in this hole at a depth of 162', which was in the first run of ore tabulated above.

Hole No. 29 was drilled approximately due South with a dip of -10° from the +50' Sub-Level. It started in ore and continued in it to a depth of 145'. This ore was divided into alternate runs of Bessemer and non-Bessemer grades with the following analyses:

| From | To | Amount | Iron | Phos. |
|---|---|---|---|---|
| 0 | 10 | 10' | 64.25 | .035 |
| 10 | 20 | 10' | 64.02 | .081 |
| 20 | 35 | 15' | 62.63 | .043 |
| 35 | 105 | 70' | 61.98 | .092 |
| 105 | 115 | 10' | 63.07 | .045 |
| 115 | 130 | 15' | 60.27 | .103 |
| 130 | 145 | 15' | 60.55 | .045 |

The above high grade ore was followed by lean ore and rich jasper to 195' and the hole was bottomed in typical footwall jasper at 198' the first part of April. This campaign of drilling was continued from openings in the Negaunee Mine.

H-4. - NEGAUNEE MINE

The first hole to be drilled in the Negaunee Mine, in the campaign outlined above, was Negaunee Mine Hole No. 28. It was drilled horizontally and S. 35°47' E. from near the Southwest end of the 13th Level. A total of 127', of high grade ore was encountered, having the following analyses:

| From | To | Amount | Iron | Phos. |
|---|---|---|---|---|
| 1 | 3 | 2' | 59.70 | .040 |
| 30 | 75 | 45' | 61.34 | .097 |
| 105 | 120 | 15' | 62.05 | .033 |
| 125 | 130 | 5' | 57.65 | .041 |
| 175 | 180 | 5' | 58.70 | .020 |
| 205 | 260 | 55' | 57.59 | .021 |

The ground between these ore runs was mainly second class and lean ore and some of it may be mined and mixed with the high grade ore. Footwall transition slate and jasper was cut at 306' and the hole bottomed in it at 326'.

The unusually low Phos. content of this ore, below a depth of 105', indicates its proximity to the hanging wall of the ore body and also probably explains why the ore was interrupted with seams of leaner material. In other words, the hanging contact is very irregular and the hole crossed and recrossed this contact a number of times. The drilling of this hole was interrupted between May 4th and November 28th while the drill crew was being used in the Mackinaw Mine and on the Negaunee Mine surface.

Hole No. 29 is being drilled horizontally and S. 69° E. from the +220' Sub-Level, approximately 24' above the 13th main level, to continue outlining the bottom contour of the ore bodies in the Negaunee Mine. The hole started in good ore, which extended to a depth of 75'. This ore averaged 64.15% Iron and .109% Phos. This ore was followed by lean ore and jasper to 83' and in turn by paintrock to 116' where typical soft ore jasper was cut. The hole was being drilled in this jasper, at a depth of 164', on the last of the year.

## I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES

The following activities on the Iron Ranges, that may be of especial interest, have come to my attention during the past year:

### I-1. - MARQUETTE RANGE

The Inland Steel Company, at its Greenwood Mine, continued to produce a small tonnage of hard ore in stringers extending between the 1st and 4th Levels. The 4th Level was a new development during the year, including the sinking of the shaft to this elevation which is 1500' below the collar of the shaft. The shaft is in the hanging wall quartzite and the drift from the shaft to the ore horizon encountered the quartzite-iron formation contact 30', sooner, or to the North, than expected. This indicates a slight flattening of the hanging wall contact below the 3rd Level. I have been told that the results of the development on the 4th Level have been quite encouraging but the property is still only in the class of a development. The production during 1938 amounted to 52,136 tons and the shipments to 29,556 tons.

The Inland Steel Company purchased the fee of the N½ of the NW¼ of Section 12, 47-28 from Dr. William Bell of Ishpeming, for a reported $8,000.00. This property lies a half a mile Southwest of the Morris Mine shaft and was first offered to the Company. I also learned that the Inland offered to purchase the Peterson undivided half interest in the mineral estate of three forties in the SW¼ of Section 2, 47-28, just Southwest of the Barnes-Hecker Mine for $15,000, but the owner refused to sell at this price.

At the Cambria Mine, the Republic Steel Corporation electrified their surface plant, including the hoists, and sank the Hartford shaft an additional 200'. They are now opening and developing the 7th main level 200' below the 6th Level.

The North Range Mining Company, R. S. Archibald and associates, have continued pumping at the old Mary Charlotte Mine, which they leased and pumped out in 1937. I believe that no underground work has been done by them as yet. At the Blueberry Mine, the shaft was sunk an additional 375', which took it down to the sump elevation below a prospective 14th Level. The bottom operating level of the mine is the 10th, 1000' below the collar, and the 12th Level is being opened. Hoisting is done on the even numbered levels. The odd numbered levels are used for timber tramming and man-ways , and no storage pockets are cut at these elevations. However, ore is trammed on these levels to transfer raises near the shaft that connect with the storage pockets on the even numbered levels. Production was discontinued several months during the year while the shaft sinking was underway, but now has been resumed.

The M. A. Hanna Company, which has acquired several descriptions of land in the vicinity of the old Saginaw Mine, has not yet started their anticipated campaign of diamond drilling.

There was no activity at the Ropes Gold Mine by the Calumet & Hecla Company during the year, but pumping was continued to keep the workings drained. Two men have been employed continuously on the Company's property in Section 30, 48-27, digging test pits and trenches in search for shear zones favorable for exploration. This satisfies the conditions of the lease.

Lack of sufficient capital continues to handicap activities at the old Michigan Gold Mine, located in the N½ of Section 35, 48-28. Very little work was done at the property during 1938 but the workings have been kept pumped.

I-2. - GOGEBIC RANGE

I should have mentioned in my Annual Report for 1937 that the Interstate Iron Company (Jones & Laughlin) acquired an option on some acreage of land in Section 21, 47-44 on what they thought might be an Easterly extension of the Gogebic Range. They did a considerable amount of diamond drilling, which was completed during the past year but I have no positive knowledge of their results. I understand, however, that the results were negative.

I-3. - MENOMINEE RANGE

The North Range Mining Company, Mr. R. S. Archibald and associates, continued to scram a small amount of ore from the old Forbes Mine, in the Iron River District, during the few months operation in 1938. I understand a small amount of ore remains and this will probably be mined during 1939.

Small tonnages of siliceous ore were shipped from the old Cornell property by the Globe Iron Company and from the West Chapin property for the account of the Jackson Iron and Steel Company by Mr. Bradley, under contract. Both of these properties are in the Iron Mountain District of the Old Menominee Range. Mr. John T. Spencer shipped a small tonnage of high grade siliceous ore from two stockpiles at the old Davidson Mine property in Florence, Wisconsin.

I-4. - MESABA RANGE

The chief interests during the year on the Mesaba Range are two,-- namely, open pit mining methods and experiments in the beneficiation of lean banded ore and taconite.

Under the heading of open pit mining methods, it is to be noted that both the conveyor system served by heavy truck haulage and truck haulage alone are on a steady increase in use. The conveyor system has reached its greatest development at the Spruce Mine in Eveleth, operated by the Oliver Iron Mining Company, whereas truck haulage has been developed most completely at several of the Butler Brothers properties in the Nashwauk District.

Under the heading of beneficiation of lean ores, an entirely new development for the Iron District has appeared the past year. The Butler Brothers research organization has designed a double inverted cone for the concentration of banded ore and taconite, commonly called jig ore. The crude ore is crushed to approximately 1" as a maximum size. All sizes between 1" and 4 mesh are fed to this cone through which there is a circulation of a heavy gravity medium. In this case the medium is made up of ferro-silicon and water. The ferro-silicon is crushed to pass 65 mesh but 60 or 70% of it will pass 200 mesh. The medium is built up to the desired specific gravity which will effect a separation of a merchantable product from its gangue material. There are two advantages in the use of ferro-silicon as a heavy density medium. In the first place, its hardness resists further reduction in size by abrasion which is a serious handicap in all other media tried. In the second place, because of its high magnetic quality, it can be readily separated from both the ore and gangue and returned to the mill circuit. The -4 mesh crude ore, which seldom amounts to more than 25% of the total crude, is treated in a jig.

At the present time, experiments are being conducted at the Mines Experiment Station, University of Minnesota, by Butler Brothers' engineers, to develop this heavy density process to a point where it will treat, successfully, sizes of feed finer than 4 mesh. If this can be done, the jig can be eliminated from the flow sheet and a simple classifier separation used on the material too fine to be treated with a heavy density medium.

Experiments continued during the past year on the new Wade-Gleason pneumatic--water pulsating jig. Also, Butler Brothers continued to operate the pilot plant at the Harrison Mill, near Nashwauk, in the treatment of jig tailings, effecting concentration after a magnetic roast. They built a new gas producer and substituted gas for oil as fuel in their roasting process with a material saving in cost. I understand the cost is still high and, it is my belief, that the new cone heavy density process will supercede any further commercial development along this line.

The North Range Mining Company had expected to start stripping operations at its wash ore leases located on the West side of Pokegema Lake, Southwest of Grand Rapids, during the past season, but nothing yet has been done.

I-5. - WISCONSIN

I have learned that interests controlling a large acreage of lean magnetite formation in the vicinity of Black River Falls, Wisconsin, are having magnetic concentration tests made on its ores at the Mines Experiment Station, University of Minnesota. I shall follow this up with interest to try and learn as much as I can of what operation is contemplated.

## J. EXAMINATION OF MINERAL LAND OFFERS

A total of 43 land offers were received by this office during the year 1938. Twenty-nine of these offers were mineral land offers. Of the remaining 14 offers, 12 were of surface property in the City of Negaunee; and the other two, of surface property in the City of Ishpeming. The offers and their numbers are as follows:

| Offer No. | Description | Remarks |
|---|---|---|
| 1996 | House on Bancroft Street in the City of Ishpeming. | Declined. |
| 1997 | Lot 4, Block 18, Pioneer Iron Co. Plat, Negaunee. | " |
| 1998 | Manganese and some barite in the State of Virginia. | " |
| 1999 | SE¼ of Section 19, 40-30, Dickinson County, Michigan. | " |
| 2000 | 186½ acres on the Cuyuna Range, Minnesota. | " |
| 2001 | Manganese in Craig County, Virginia. | " |
| 2002 | Klondike and Milford Mines, Cuyuna Range, Minnesota. | " |
| 2003 | Lots 6 and 7, Block 31, Pioneer Iron Co. Plat, Negaunee. | " |
| 2004 | 40,000 acres of mineral rights in Upper Michigan and Upper Wisconsin. | " |
| 2005 | Mesaba Iron Company's property - East end of Mesaba Range, Minnesota. | Pending |
| 2006 | Lot 6, Block 26, Pioneer Iron Company Plat, Negaunee. | Declined. |
| 2007 | The "Cemetery Property", Mineral Hills District, Iron River, Michigan. | Pending |
| 2008 | Aronson Lease, Mineral Hills District, Iron River, Mich. | Declined. |
| 2009 | Lot 1, Block 1, Gaffney's Addition, Negaunee. | Pending |
| 2010 | 80 acres of limestone, near Mackinaw, Michigan. | Declined. |
| 2011 | Manganese Deposit in Marquette County, Michigan. | " |
| 2012 | Prospective iron ore property on Cuyuna Range, Minnesota. | " |
| 2013 | N½ of NW¼ of Section 12, 47-28, Marquette Range. | " |
| 2014 | Brown iron ore and manganese ore, Birmingham District, Ala. | " |
| 2015 | Vermiculite deposit, location not stated. | " |
| 2016 | Lot 5 of Boyer Plat of Lot 2, Harvey Plat, Negaunee. | " |
| 2017 | Lot 8, Block 1, Jackson Iron Co. Addition, Negaunee. | " |
| 2018 | Property in Mackinac County, Michigan. | " |
| 2019 | Lot 20, Block 2, Corbit's Addition, Negaunee. | " |
| 2020 | Lot 5, Block 2, Maitland's Addition, Negaunee. | " |
| 2021 | Lot 5, Block 14, Pioneer Iron Co. Plat, Negaunee. | " |
| 2022 | Lot 12, Block 18, Pioneer Iron Co. Plat, Negaunee and SW¼ of SE¼ of Section 33, 48-26. | " |
| 2023 | Warner Mine, Amasa District, Iron County, Michigan. | " |
| 2024 | Lot 54, 5th Addition to City of Ishpeming. | " |
| 2025 | Lots 1 to 4, Block 2, Kirkwood & Kellan's Addition, Negaunee. | Pending |
| 2026 | 120 acres of iron ore lands near Baraboo, Wisconsin. | Declined. |
| 2027 | Lot 2, Block 18, Pioneer Iron Company Plat, Negaunee. | " |
| 2028 | ¼ interest in Section 8, 45-25, North of Gwinn District. | " |
| 2029 | Manganese property in Tennessee. | " |
| 2030 | Fullers earth deposit in Wexford County, Michigan. | " |
| 2031 | 52 acres of mineral lands in Canada. | " |
| 2032 | Half interest in Lot 4, Sec. 24, 55-26, Minnesota. | " |
| 2033 | 4,300 shares of stock in Escanaba River Land & Iron Co. | " |

| Offer No. | Description | Remarks |
|---|---|---|
| 2034 | Standard Mine, Northwest of Republic, Michigan. | Pending |
| 2035 | Section 22, 47-30, Marquette County, Michigan. | Declined. |
| 2036 | Cuff Iron Ore Property, Dickinson County, Michigan. | " |
| 2037 | 300 acres of pyrite lands in Schrieber District, Ontario, Canada. | " |
| 2038 | 15,000 acres of manganese ore lands, Independence County, Arkansas. | Pending. |

K. EXPENSE STATEMENTS

Tables VII and VIII, which follow, show a detailed statement of charges to Geological expense for the year 1938 and a comparative statement of these charges for the last three years. They are self-explanatory.

TABLE VII

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR THE YEAR 1938.

| | |
|---|---|
| Salaries | $ 12,344.00 |
| Travel & Entertainment | 1,405.75 |
| Operating Automobiles | 438.44 |
| Supplies & Office Expense | 873.39 |
| Personal Injury | 258.15 |
| Unemployment Tax | 391.82 |
| Old Age Benefit Tax | 93.91 |
| Unclassified | 152.32 |
| TOTAL | $ 15,957.78 |

TABLE VIII

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT FOR LAST THREE YEARS

| | 1938 | 1937 | 1936 |
|---|---|---|---|
| Salaries | $12,344.00 | $12,867.15 | $8,383.15 |
| Travel & Entertainment | 1,405.75 | 1,120.35 | 1,453.10 |
| Operating Automobiles | 438.44 | 546.40 | 463.95 |
| Supplies & Office Expense | 873.39 | 1,101.89 | 726.14 |
| Personal Injury | 258.15 | 249.08 | 168.27 |
| Accrual of Unempl. Tax | 391.82 | 249.08 | 80.86 |
| Old Age Benefit Tax | 93.91 | 124.53 | - |
| Unclassified | 152.32 | 29.42 | 37.29 |
| TOTAL | $15,957.78 | $16,288.00 | $11,312.76 |

## L. RESEARCH AND EXPERIMENTS

Although we have not maintained a separate Research Department for a number of years, we have followed closely the experimental and research work being done by other mining companies in the Lake Superior District and the Mines Experiment Station, University of Minnesota, at Minneapolis. Somewhat detailed references have been made to the work going on in 1938 elsewhere in this report. During the spring of the year we treated three carloads of Trumbull lean ore, commonly referred to as jig ore, in the Wade-Gleason pneumatic-water pulsating jig at the Mines Experiment Station. Concentrating results were successful and they are set forth in a special report. During the fall of 1938, similar Trumbull lean ore was treated for us by Butler Brothers at their Patrick Plant near Nashwauk, by their heavy density cone process currently being developed. These results were highly successful, more so than with the Wade-Gleason jig,and are set forth in a special report.

Preliminary laboratory tests were made for us last fall, by the Butler Brothers research department, on some of our lean crushed Cliffs-Shaft ore. These experiments indicated that the heavy density process would raise the grade of this ore, successfully, and make it salable without mixing with high grade ores. Accordingly, approximately 50 tons of this ore has been sent to the Mines Experiment Station where both jig and heavy density tests will be made during the early spring of 1939.

Mr. George H. Beasley, under my direction, has made a large number of glass classifier tests on "jig ores" which we have encountered in our recent structure drilling (done in 1937) in the Trumbull Pit. These results are indicative of what may be accomplished in concentrating this material, when mined, in either jigs or heavy density medium. The information is, therefore, quite necessary in making future estimates of "jig material" in our Mesaba Range reserves. We have fitted up a laboratory for this work at the Hill-Trumbull Mine.

We are experimenting at the Ishpeming office with heavy density liquids in making sink and float tests on certain rock forming minerals found in intrusive and sedimentary rocks on the Marquette Range which we hope will definitely identify one rock from the other. The difficulty of identification occurs when these rocks are altered and decomposed, which frequently is the case. We have always had this trouble at the Cliffs-Shaft Mine. In may cases, however, a study of the rocks in thin sections, under a microscope, has been sufficient. We hope we can develop a simple sink and float technique that will eliminate all doubt in rocks not amenable to microscopic determination.

Respectfully submitted,

E. L. Derby, Jr.

Geologist

ELD:DWC
2-18-39

ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1938.

The usual books of photographic maps, showing the areas mined on the various sub-levels in the operating mines during 1938, accompany this report. These books are loose-leaf, with stiff covers and contain views, maps or sections of the mines that were operated during the year. The maps show in red the work done since the last report and the sections show in color the unmined parts. Books have been prepared for the different companies interested in the various mines, the following list showing the companies for which books have been prepared, and the mines included therein:

| Company | Mines |
|---|---|
| The Cleveland-Cliffs Iron Company | Athens, Canisteo, Cliffs-Shaft, Gardner-Mackinaw, Hill-Trumbull, Lloyd, Maas, Negaunee, Spies-Virgil and Tilden. |
| Bethlehem Mines Corporation | Negaunee. |
| Hanna Ore Mining Company | Canisteo and Hill-Trumbull. |
| Inland Steel Company | Canisteo and Hill-Trumbull. |
| Jones & Laughlin Steel Corporation | Canisteo and Hill-Trumbull. |
| Otis Steel Corporation | Canisteo and Hill-Trumbull. |
| Pickands, Mather & Company | Athens. |
| Pittsburgh Steel Corporation | Canisteo and Hill-Trumbull. |
| Republic Steel Corporation | Canisteo, Hill-Trumbull and Lloyd. |
| Wheeling Steel Corporation | Canisteo and Hill-Trumbull. |

Two copies of The Cleveland-Cliffs Iron Company book were made, one for the Cleveland office and one for the Engineering office at Ishpeming. Two books were prepared for the Republic Steel Corporation and only one copy of each of the other books.

Similar books were prepared for the following:

| Person | Mines |
|---|---|
| Arthur Iron Mining Company, Fee owner | Hill-Trumbull. |
| E. C. Congdon, Fee owner | Canisteo. |
| M. H. Barber, District Superintendent | Canisteo and Hill-Trumbull. |
| H. C. Bolthouse, Superintendent | Canisteo and Hill-Trumbull. |
| W. W. Graff, Superintendent, | Athens and Negaunee. |
| H. O. Moulton, Superintendent, | Maas. |
| C. W. Allen, Superintendent, | Lloyd and Spies-Virgil. |

B. MAP REPORTS

Two sets of blue-prints of the mine maps, scale 1" = 50', were made at the end of each month showing in red the areas mined during that month. One of these sets was for the General Superintendent and the other for the Mine Superintendent. Similar maps were made of the Cliffs-Shaft Mine at quarterly

intervals as it was impossible to survey the mine completely oftener than every three months. Besides, the advances per month, except for development drifts, would hardly warrant more frequent surveys. These maps were also prepared for the General Superintendent and Mine Superintendent.

Besides the above map reports, other reports were prepared for outside parties as follows:

ATHENS MINE

Two sets of monthly report blue-prints of the Athens Mine were sent to the Cleveland office for the Pickands, Mather & Company, colored to show the areas mined during the month.

GARDNER-MACKINAW MINE

A set of blue-prints of the Mackinaw Mine were sent at the end of the first and second quarters to Mr. G. P. McCallum, Ann Arbor, Michigan, showing the areas mined and the work done during the previous three months. As the mine was closed down on May 31st, no further maps were forwarded.

MAAS MINE

Blue-prints of those portions of the Maas Mine workings in the Roman Catholic Cemetery were sent monthly to Mr. R. S. Archibald, Negaunee, Michigan, showing in red the areas mined.

NEGAUNEE MINE

Fourteen sets of the Annual Report maps of the Ninth, Eleventh, Twelfth, Thirteenth and Fourteenth Levels were sent, at the end of the year, to the Cleveland office for the fee owners. A set of blue-prints, scale 1" = 50', of cross-sections of the Negaunee Mine were sent at the end of the year to Mr. W. L. Cummings, Geologist, Bethlehem Mines Corporation, Bethlehem, Pennsylvania.

MICHIGAN STATE TAX COMMISSION

New estimates of ore reserves in the Athens, Cliffs-Shaft, Gardner-Mackinaw, Lloyd, Maas, Negaunee and Spies-Virgil Mines were made as of December 31st, 1938. A book of Annual Report maps were prepared to show the areas included in compiling the estimate, these maps also showing the general geology.

In October, sets of blue-prints of the operating mines, scale 1" = 50', were prepared for the Special Committee of the Michigan State Tax Commission reporting on ore reserves. The outline of the ore areas were indicated on these maps and followed the estimates as of December 31st, 1937 except where current mining caused a change.

C. REMARKS ON MISCELLANEOUS DOCUMENTS AND ABSTRACTS

All documents affecting the Company's lands and holdings, pass through the Engineering Department for record and approval, irrespective of the Department from which they originate. These documents have been handled

by Mr. Brewer and placed by him on the Mining Department records. After the descriptions are approved, they are initialed by him. Copies of those documents which affect the mineral lands are kept on file in the Department.

The following table shows the number and classification of such documents as have passed through the Department and have been initialed:

| CLASSIFICATION | | Number Received | Last File Number |
|---|---|---|---|
| Mining Leases | | 0 | 70 |
| Miscellaneous Documents | | 21 | 1351 |
| Easements | | 4 | 404 |
| Rights of Way | | 2 | 221 |
| Water Rights | | 1 | 59 |
| Surface Leases | | 111 | 4615 |
| Applications for Sale | | 3 | 170 |
| Sales | | 100 | 1382 |
| Tax Histories | | 0 | 702 |
| Legal Opinions | | 0 | 195 |

The following comments cover the various documents, etc. that were placed on the Department records during 1937:

MINING LEASES

These are leases for mining purposes either to or from the Company. There were no leases made during 1938.

MISCELLANEOUS DOCUMENTS

This classification covers all documents of every nature involving transfer of rights affecting mineral lands. Nineteen of these documents had to do with the acquisition and exchange of lands in the City of Negaunee. The other two involved the Mesaba Range.

EASEMENTS

These documents cover transmission line rights of way acquired by the Cliffs Power & Light Company. The four entered on the records concern the lease of the line in Newton Township from the Wisconsin-Michigan Power Company.

RIGHTS OF WAY

This file covers railroad and highway rights of way across mineral lands. The two received during the year concerned highways in Marquette County.

WATER RIGHTS

These are permits granting rights for mine water discharge, etc. across lands adjacent to mines. This additional right was in connection with the Spies-Virgil Mine water discharge.

SURFACE LEASES

The surface leases cover all sorts of permits for the use of Company lands for residence, gardens, farms, camps, etc., and all originate in the Land Department.

APPLICATIONS FOR SALE

These also originate in the Land Department and are the preliminary report covering the area to be sold and are for the most part, issued for farm lands off the mineral formation.

SALES

This classification covers sales of all kinds. Most of these sales originate in the Land Department and are sent to the Mining Department for approval. There were 14 rights of way for highways, sewers, etc. and the balance covered the sale of lands in various counties.

TAX HISTORIES

There were no Tax Histories received during the year. These are usually secured when lands are being purchased to make sure that all taxes have been paid.

LEGAL OPINIONS

This file is for ready reference of legal opinions as to the title of lands. None were received during the year.

ABSTRACTS

Very little work was done during the year on the abstracts of the mineral lands for the Cliffs Power & Light Company. Only such documents were added as passed through the office. All of our records are sadly in arrears and will require a tremendous amount of work to bring them up to date.

D. THE FORCE

The personnel of the Engineering Department was reduced during the year owing to the curtailment of mining operations. Two of the men were transferred to other departments and one left the employ of the Company.

The following table shows the personnel of the Department during the year, their position and the period employed during 1938:

| Name | Position | Entered | Left | 1938 Employment |
|---|---|---|---|---|
| C. Brewer | Chief Mining Engineer | | | 12 months |
| J. Trosvig | Engineer | | | 12 " |
| F. J. Haller | " | | | 12 " |
| O. Marjama | " | | | 12 " |
| W. R. Atkins | " | | | 12 " |
| W. A. Richards | " | | | 12 " |
| A. Minnear | Draftsman | | June 10th | 5½ " |
| A. Koski | Helper | | | 12 " |
| R. J. Devine | " | | June 15th | 5½ " |
| F. Brown, Jr. | " | | June 15th | 5½ " |
| A. H. Tillson | Draftsman | June 27th | | 6 " |
| D. W. Carlson | Stenographer | | | 12 " |

The next table shows the length of service of the men now employed in the Engineering Department:

| Name | Date Entered | Years of Service | |
|---|---|---|---|
| C. Brewer | August, 1906 | 20 years, 3 months. | |
| J. Trosvig | June, 1911 | 21 " 10 " | (1) |
| F. J. Haller | June, 1930 | 4 " 7 " | (2) |
| O. Marjama | September, 1936 | 2 " 3½ " | |
| W. R. Atkins | November, 1936 | 2 " 1½ " | |
| W. A. Richards | March, 1937 | 1 " 10 " | |
| A. Koski | January, 1936 | 3 " | |
| A. H. Tillson | June, 1938 | 6 " | |
| D. W. Carlson | August, 1936 | 2 " 4½ " | |

(1) Not employed by Company from October 15, 1914 to December 1, 1915, also from June 1, 1932 to November 9, 1936.

(2) Not employed by Company from February 1, 1932 to January 6, 1936.

The above "Years of Service" only covers the period that the men were employed in the Engineering Department and does not necessarily cover the entire length of service with the Company. Several of the men have been in other departments either before or at intervals since first entering this department.

The following table shows the total days worked, days overtime, sick and absent for the year:

| Name | Days Worked | Days Overtime | Days Sick | Days Absent |
|---|---|---|---|---|
| C. Brewer | 213½ | - | 20½ | 21 |
| J. Trosvig | 239½ | 4 | 9½ | 10 |
| F. J. Haller | 248½ | 3½ | 1½ | 8½ |
| O. Marjama | 239½ | 2 | 10 | 7½ |
| W. R. Atkins | 248 | 1 | - | 8 |
| W. A. Richards | 241 | 1 | - | 15 |
| A. Minnear | 148 | - | 2 | 2½ |
| A. Koski | 252 | 5 | - | 8 |
| R. J. Devine | 119½ | - | 2 | - |
| F. Brown, Jr. | 113½ | - | - | 23 |
| A. H. Tillson | 117½ | - | - | 10 |
| D. W. Carlson | 243 | ½ | 1½ | 11 |

The next table shows the distribution of the days spent underground, in the field and in the office during 1938. This table includes overtime:

| Name | Underground | Field | Office | Total |
|---|---|---|---|---|
| C. Brewer | 5½ | 19 | 189 | 213½ |
| J. Trosvig | 39 | 17 | 183½ | 239½ |
| F. J. Haller | 43½ | 60½ | 144½ | 248½ |
| O. Marjama | 88 | 12 | 139½ | 239½ |
| W. R. Atkins | 83½ | 18½ | 146 | 248 |
| W. A. Richards | 72 | 51½ | 117½ | 241 |
| A. Koski | 74 | 46 | 132 | 252 |
| A. Minnear | 10 | 30 | 108 | 148 |
| R. J. Devine | 52½ | 7 | 60 | 119½ |
| F. Brown, Jr. | 27 | 20½ | 66 | 113½ |
| A. H. Tillson | - | - | 117½ | 117½ |
| D. W. Carlson | 2 | 1 | 240 | 243 |
| TOTAL | 497 | 283 | 1643½ | 2423½ |
| % | 20.5 | 11.7 | 67.8 | 100.0 |

The following is a brief summary of the work done by each person in the Department during the year:

CARL BREWER, Chief Mining Engineer, had charge of the Department and exercised general supervision over all the work. He entered on the records, all documents that were received by the Mining Department and made such reports on them as were necessary. He compiled the annual report books, estimates of ore reserves, maps for the Michigan State Tax Commission, stockpile estimates, etc. The maps he was preparing for the Cleveland office, showing the ownerships of

surface and mineral rights in Negaunee have been almost completed. The question of title to a small area has been referred to the Legal Department. When this matter is settled the maps will be forwarded to the Cleveland office. The maps in connection with the report on the surface rights on lands in which the Arctic Iron Company has a mineral interest are also completed but owing to press of other work the report has not been completed. He spent considerable time studying the surface water condition for the Maas-Negaunee Mines in connection with the drilling done in that locality. He also made a study of the No. 1 and No. 2 shaft pillars at the Negaunee Mine in connection with the exploratory work now being done in that territory. Throughout the year he has been collecting miscellaneous data regarding shaft design from various companies. This information is being compiled for use when a new shaft for the Company is required.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| General Engineering | 1 | 7½ | 186 | 194½ | 91.1 |
| Negaunee Mine | 2 | 1 | 2 | 5 | 2.3 |
| Spies-Virgil Mine | 1 | | | 1 | .5 |
| Mackinaw Mine | | 2½ | | 2½ | 1.2 |
| Lloyd Mine | | 4½ | | 4½ | 2.1 |
| Athens Mine | | 2 | | 2 | .9 |
| C. P. & L. Co. | | 1 | | 1 | .5 |
| Maas Mine | 1½ | ½ | 1 | 3 | 1.4 |
| TOTAL | 5½ | 19 | 189 | 213½ | 100.0 |
| % | 2.5 | 9.0 | 88.5 | | 100.0 |

JOHN TROSVIG, Engineer, has taken care of the engineering work at the Cliffs-Shaft Mine during the entire year. He made the quarterly map reports and did considerable surveying for the location of diamond drill holes, development raises, etc. He also took care of the engineering work on the Jackson Lease at the Cambria Mine. This involved the monthly underground inspections and map reports similar to those of our property. This mine has been closed since the end of May but he has continued to make monthly visits and made reports on what was going on. During May, he spent ten days in Cleveland making an estimate of the ore in stock at the plant of the Otis Steel Company.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Cliffs-Shaft Mine | 35 | 10½ | 143½ | 189 | 78.9 |
| Cambria Mine | 4 | | 10 | 14 | 5.8 |
| General Engineering | | | 24 | 24 | 10.0 |
| Lloyd Mine | | ½ | 2 | 2½ | 1.1 |
| Otis Steel Company | | 6 | 4 | 10 | 4.2 |
| TOTAL | 39 | 17 | 183½ | 239½ | |
| % | 16.3 | 7.2 | 76.5 | | 100.0 |

F. JOSEPH HALLER, Engineer, has taken care of the engineering work at the Maas and Tilden Mines throughout the year. He made weekly inspections of the underground workings at the Maas and prepared the monthly map reports. He also did considerable surveying underground throughout the year in connection with the development of new cross-cuts on the main levels and opening up of new sub-levels. On surface he staked out the stocking trestles and the foundations for the new rock trestle to the Northeast of the shaft and gave grade stakes, etc. for the grading for the new stocking area South of the East steel trestle. The Tilden Mine required about 36% of his time, much of which was in supervision in connection with the stripping, approach grading, etc. for opening the lower bench of the West Pit. He has made an extensive investigation of the various types of haulage equipment, tractors, trucks, etc. for transportation of ore from the lower bench to the crusher. This required many consultations with the various manufacturer's representatives, etc.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Maas Mine | 42½ | 20 | 89 | 151½ | 61.0 |
| Tilden Mine | | 39 | 51 | 90 | 36.2 |
| General Engineering | | | 4 | 4 | 1.6 |
| Negaunee Mine | 1 | | | 1 | .4 |
| Spies-Virgil Mine | | 1½ | ½ | 2 | .8 |
| TOTAL | 43½ | 60½ | 144½ | 248½ | |
| % | 17.5 | 24.4 | 58.1 | | 100.0 |

ONNI MARJAMA, Engineer, has been engaged throughout the year with the engineering work at both the Athens and Negaunee Mines. This has kept him very busy because the large amount of development work has required constant attention. At the Negaunee Mine, he ran frequent surveys into the territory above the 9th Level and spent some time planning for the 13th and 14th Level development. At the Athens Mine, the development from the 7th Level required frequent surveys. On surface, he made plans and supervised the construction of the new coal dock.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Negaunee Mine | 48 | 4 | 71½ | 123½ | 51.6 |
| Athens Mine | 40 | 8 | 68 | 116 | 48.4 |
| TOTAL | 88 | 12 | 139½ | 239½ | |
| % | 36.8 | 5.0 | 58.2 | | 100.0 |

W. R. ATKINS, Engineer, has taken care of the engineering work at the Gardner-Mackinaw and Spies-Virgil Mines throughout the year and at the Lloyd Mine since June. At the Gardner-Mackinaw Mine he ran surveys on the 6th to 10th Levels, inclusive, for the development work to the Northwest and made frequent studies with the Geological Department of this territory. The mine was closed down on May 31st and since then he has watched the underground water situation so that it could be kept under control. The development on the 8th Level and above at the Spies-Virgil Mine required most of his time both for surveys underground and office study. At the Lloyd Mine, the principal new work was the development of the 6th Level. On surface, he staked out and supervised the grading of the new stocking ground Northeast of the Lloyd shaft. He spent some time with the Marquette County Road Commission engineers on a proposed sewer for the North Lake location. At Gwinn, he gave grades, etc. for the new sidewalks being laid on Pine Street. He also planned with the Mechanical Department for the proposed Princeton location water tank. This latter project was not completed.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Spies-Virgil Mine | 32½ | 2 | 42½ | 77 | 31.0 |
| Lloyd Mine | 24½ | 9½ | 49½ | 83½ | 33.7 |
| Mackinaw Mine | 26½ | 3 | 51 | 80½ | 32.5 |
| General Engineering | | | 3 | 3 | 1.2 |
| Hard Ore | | ½ | | ½ | .2 |
| Gwinn District | | 3 | | 3 | 1.2 |
| Negaunee Mine | | ½ | | ½ | .2 |
| TOTAL | 83½ | 18½ | 146 | 248 | |
| % | 33.7 | 7.5 | 58.8 | | 100.0 |

WILLIAM A. RICHARDS, Engineer, had charge of the Lloyd Mine during the first six months of 1938. Since June he has been assisting the other engineers at the various properties and has done most of the surface surveying in the laying out of drill holes for the Geological Department. He has also done whatever other survey work has been required during the year.

The following is the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Lloyd Mine | 31½ | 9½ | 45 | 86 | 35.7 |
| Maas Mine | 11½ | 11 | 25½ | 48 | 19.9 |
| Spies-Virgil Mine | 2 | 1 | 4½ | 7½ | 3.2 |
| Negaunee Mine | 11½ | 8 | 17 | 36½ | 15.1 |
| General Engineering | | 5½ | 12½ | 18 | 7.6 |
| Geological Department | | 2½ | ½ | 3 | 1.2 |
| Athens Mine | 2 | 4 | 5 | 11 | 4.6 |
| Tilden Mine | | 3½ | 2½ | 6 | 2.4 |
| Mackinaw Mine | 13 | 2½ | 4 | 19½ | 8.1 |
| Cliffs-Shaft Mine | ½ | 4 | 1 | 5½ | 2.2 |
| TOTAL | 72 | 51½ | 117½ | 241 | |
| % | 29.8 | 21.5 | 48.7 | | 100.0 |

ARCHIBALD MINNEAR, Draftsman, was in the Department until June 13th. Most of his time was spent in the office making maps and tracings. He assisted in various surveys on surface and underground. He was transferred to the Cliffs Power & Light Company to do drafting. During September and October he assisted the Department in the field surveys of the stockpile estimates.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| General Engineering | | 1 | 15½ | 16½ | 11.1 |
| Cliffs-Shaft Mine | 1 | 3½ | 10½ | 15 | 10.1 |
| Maas Mine | 2½ | 7½ | 34½ | 44½ | 30.0 |
| Lloyd Mine | ½ | 5 | 5 | 10½ | 7.1 |
| Negaunee Mine | 2 | 4½ | 15½ | 22 | 14.9 |
| Tilden Mine | | | 10 | 10 | 6.9 |
| Spies-Virgil Mine | | 1 | 4½ | 5½ | 3.8 |
| Athens Mine | 4 | 4 | 3½ | 11½ | 7.7 |
| Mackinaw Mine | | 3 | 7½ | 10½ | 7.1 |
| Jackson Lease | | | ½ | ½ | .3 |
| Hard Ore | | ½ | 1 | 1½ | 1.0 |
| TOTAL | 10 | 30 | 108 | 148 | |
| % | 6.8 | 20.2 | 73.0 | | 100.0 |

ALFRED KOSKI, Helper, has assisted in most of the underground and surface surveys throughout the year. In the office he has done most of the blueprinting and has assisted in making tracings and in other work.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| General Engineering | | 3 | 108½ | 111½ | 44.3 |
| Cliffs-Shaft Mine | 39 | 6½ | 4 | 49½ | 19.7 |
| Maas Mine | 6 | 12½ | 1 | 19½ | 7.7 |
| Lloyd Mine | 2 | 4 | 1 | 7 | 2.8 |
| Negaunee Mine | 10½ | 4 | 3½ | 18 | 7.1 |
| Tilden Mine | | 2½ | | 2½ | .9 |
| Spies-Virgil Mine | 4 | 1 | 4½ | 9½ | 3.8 |
| Athens Mine | 4 | 2 | 2½ | 8½ | 3.4 |
| Mackinaw Mine | 6 | 2½ | 1½ | 10 | 3.9 |
| Jackson Lease | 2½ | | 1 | 3½ | 1.4 |
| Geological Dept. | | 2 | 0 | 2 | .8 |
| Otis Steel Company | | 6 | 4½ | 10½ | 4.2 |
| TOTAL | 74 | 46 | 132 | 252 | |
| % | 29.4 | 18.3 | 52.3 | | 100.0 |

ROLAND J. DEVINE, helper, was in the Department until June 15th when he left the Company. He assisted in the underground and surface surveys and made tracings, blue-prints, etc. in the office.

The Following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Negaunee Mine | 4 | 1½ | 10 | 15½ | 13.1 |
| Lloyd Mine | 5 | 1 | 4 | 10 | 8.4 |
| Jackson Lease | 1 | | | 1 | .8 |
| Mackinaw Mine | 18 | | 6 | 24 | 20.1 |
| Maas Mine | 6 | 1 | 7 | 14 | 11.7 |
| Cliffs-Shaft Mine | 12½ | | 2½ | 15 | 12.2 |
| Tilden Mine | | 2 | ½ | 2½ | 2.1 |
| Spies-Virgil Mine | 3 | | 3 | 6 | 5.1 |
| Athens Mine | 3 | ½ | 1 | 4½ | 3.8 |
| General Engineering | | ½ | 24 | 24½ | 20.6 |
| Geological Dept. | | ½ | | ½ | .4 |
| C. P. & L. Co. | | | 2 | 2 | 1.7 |
| TOTAL | 52½ | 7 | 60 | 119½ | |
| % | 43.9 | 5.9 | 50.2 | | 100.0 |

FAYETTE BROWN, JR., helper, was in the Department until June 15th when he was transferred to the General Storehouse. He assisted in the underground and surface surveys and in the office helped in the general office work.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Maas Mine | 6½ | 5½ | 12½ | 24½ | 21.6 |
| Tilden Mine | | 1½ | ½ | 2 | 1.8 |
| Mackinaw Mine | 2 | | 2½ | 4½ | 4.0 |
| Negaunee Mine | 2½ | 4 | 7 | 13½ | 11.9 |
| Spies-Virgil Mine | 2 | 1 | 1 | 4 | 3.5 |
| Athens Mine | 2½ | | 1 | 3½ | 3.1 |
| General Engineering | | ½ | 29 | 29½ | 26.0 |
| Lloyd Mine | 2½ | 3 | 1½ | 7 | 6.2 |
| Geological Dept. | | 1 | | 1 | .9 |
| C. P. & L. Co. | | | 10½ | 10½ | 9.2 |
| Cliffs-Shaft Mine | 9 | 4 | | 13 | 11.4 |
| Hard Ore | | | ½ | ½ | .4 |
| TOTAL | 27 | 20½ | 66 | 113½ | |
| % | 23.8 | 18.1 | 58.1 | | 100.0 |

A. H. TILLSON, draftsman, was transferred from the Timber Department on June 27th. For three months he was engaged in preparing the ownership maps for the City of Negaunee and for the report on the surface holdings on the Arctic Iron Company's land. The rest of the year he assisted in survey calculations, and in making tracings, etc.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| General Engineering | | | 64½ | 64½ | 54.9 |
| Negaunee Mine | | | 14 | 14 | 11.9 |
| Lloyd Mine | | | 2½ | 2½ | 2.1 |
| Spies-Virgil Mine | | | 7 | 7 | 6.0 |
| Maas Mine | | | 4 | 4 | 3.4 |
| Athens Mine | | | 3 | 3 | 2.5 |
| Cliffs-Shaft Mine | | | 22½ | 22½ | 19.2 |
| TOTAL | | | 117½ | 117½ | |
| % | | | 100.0 | | 100.0 |

DONALD W. CARLSON, Stenographer, has been in the Department for the entire year. He has done work for both the Engineering and Geological Departments and has helped on some of the underground and surface surveys.

The following table shows the distribution of his time for the year:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| Stenography | | | 240 | 240 | 98.8 |
| Athens Mine | 1½ | | | 1½ | .6 |
| Lloyd Mine | ½ | ½ | | 1 | .4 |
| Cliffs-Shaft Mine | | ½ | | ½ | .2 |
| TOTAL | 2 | 1 | 240 | 243 | |
| % | .8 | .4 | 98.8 | | 100.0 |

## E. DISTRIBUTION OF TIME

There has been very little engineering work done in the Department outside of that connected with the various operating mines. Although the working time of the mines was curtailed during the year, this did not appreciably affect the calls upon the Engineering Department. The weekly inspections had to be continued and the same reports, etc. made as usual. Furthermore, there was an unusual amount of development in all of the mines which called for additional attention. A large amount of development work required preliminary study and then was carefully followed up, giving lines, etc. All work in connection with the mines has been charged to that property, while all other work such as miscellaneous reports, blueprints and other work not strictly chargeable to the various mines has been classified under General Engineering.

The following table shows the distribution of time of the entire Department that was spent underground, in the field or in the office for the various mines and departments:

| Property | Underground | Field | Office | Total | % |
|---|---|---|---|---|---|
| General Engineering | 1 | 18 | 471 | 490 | 20.2 |
| Athens Mine | 57 | 20½ | 84 | 161½ | 6.7 |
| Cliffs-Shaft Mine | 97 | 29 | 184 | 310 | 12.8 |
| Gardner-Mackinaw Mine | 65½ | 13½ | 72½ | 151½ | 6.3 |
| Lloyd Mine | 66½ | 37½ | 110½ | 214½ | 8.8 |
| Maas Mine | 76½ | 58 | 174½ | 309 | 12.7 |
| Negaunee Mine | 81½ | 27½ | 140½ | 249½ | 10.3 |
| Spies-Virgil Mine | 44½ | 7½ | 67½ | 119½ | 4.9 |
| Tilden Mine | | 48½ | 64½ | 113 | 4.7 |
| Jackson Lease | 7½ | | 11½ | 19 | .8 |
| C. P. & L. Co. | | 1 | 12½ | 13½ | .5 |
| Geological Department | | 6 | ½ | 6½ | .3 |
| Hard Ore | | 1 | 1½ | 2½ | .1 |
| Otis Steel Company | | 12 | 8½ | 20½ | .8 |
| Gwinn District | | 3 | | 3 | .1 |
| Stenography | | | 240 | 240 | 10.0 |
| TOTAL | 497 | 283 | 1643½ | 2,423½ | |
| % | 20.5 | 11.7 | 67.8 | | 100.0 |

## F. COSTS

The next table shows a comparison of costs for the Engineering Department for the last three years:

| | 1936 | 1937 | 1938 |
|---|---|---|---|
| Salaries | $13,675.58 | $17,469.54 | $16,107.77 |
| Auto Expense | 253.60 | 575.69 | 460.07 |
| Furniture and Fixtures | 28.07 | 22.18 | |
| Heat, Light and Power | 189.24 | 175.59 | 224.23 |
| Insurance | 142.25 | 171.53 | 99.54 |
| Postage | 18.00 | 18.33 | 24.05 |
| Repairs | 280.07 | 1,449.93 | 134.98 |
| Stationery and Printing | 75.72 | 115.59 | 58.14 |
| Supplies | 1,017.43 | 1,812.10 | 1,254.51 |
| Taxes | 44.49 | 44.67 | 47.52 |
| Traveling and Entertainment | 79.44 | 88.40 | 119.52 |
| Personal Injury Expense | 279.62 | 368.93 | 326.45 |
| Telephone and Telegraph | 102.33 | 103.80 | 94.66 |
| Papers and Publications | 7.00 | 2.25 | 1.30 |
| Janitor and Cleaning | | 204.79 | |
| Unemployment Insurance Tax | 139.81 | 368.93 | 536.40 |
| General - Unclassified | 96.83 | 38.06 | 59.69 |
| Old Age Benefit Tax | | 176.36 | 155.24 |
| Depreciation Mine Rescue Equipt. | | | |
| TOTAL | $16,429.48 | $23,206.67 | $19,704.07 |

## H. AUTOMOBILES

The Ford Station Wagon and Chevrolet Coupe have been operated steadily throughout the year. Both cars have given good service.

The following table shows the mileage travelled by these cars in 1938, the total mileage and the date purchased:

| Car | Miles | | Date Purchased |
|---|---|---|---|
| | 1938 | Total | |
| Ford Station Wagon | 2,510 | 31,576 | November 10, 1930 |
| Chevrolet Coupe | 7,869 | 14,118 | July 1, 1937 |

## I. MINES

The following summary covers the work done in the Department in connection with the various mines, that has not been mentioned previously:

### GENERAL

Weekly inspections of soft ore mines were made throughout the year by the engineer doing the engineering work at that property. These inspections were made in company with the Mining Captain of a shift boss and have proved very satisfactory in planning development work as well as mapping. All the information acquired during the inspections was posted at the end of the month when the regular monthly map reports were made. The engineer assisted the mine superintendents in writing the underground portion of the monthly and annual reports.

### ATHENS MINE

The new coal dock was planned, staked out in the field and its construction supervised by the engineer. The development above the 7th Level had previously been planned so that during 1938 there was no special work except watching that the plans were carried out. Surveys were run to some of the new sub-levels being opened up.

On July 26th, the 12th annual inspection of experimental treated timber was made by Mr. F. S. Crawford of the U. S. Bureau of Mines and Mr. R. M. Wirka of the U. S. Forest Laboratory, Madison, Wisconsin. These timbers were placed in the mine in 1926 and have been inspected annually ever since. The summary of the report on this inspection is as follows:

| Preservative | Number of Timbers Placed. | Good | Condition Partly Decayed | Badly Decayed | Removed | | Eliminated |
|---|---|---|---|---|---|---|---|
| | | | | | Decay | Crushed | |
| Borax | 12 | - | 1 | 4 | 5 | 3 | 3 |
| Sodium Fluoride | 27 | - | - | - | 21 | 6 | - |
| Zinc Chloride | 13 | 6 | - | - | 3 | 4 | 2 |
| Untreated | 12 | - | - | - | 12 | - | 3 |

The average life of the untreated timber was 3.8 years.

### CAMBRIA MINE - JACKSON LEASE

Weekly inspections of the operations on that part of the mine covered by the Jackson Lease were made by Mr. Trosvig and a regular monthly map report was made for Mr. Jackson. This mine was closed down on May 28th and remained closed for the remainder of the year with the exception of sinking of the shaft and development on the 7th Level. Mr. Trosvig thereafter made monthly visits and continued his monthly reports on the progress of shaft sinking and other work.

CLIFFS-SHAFT MINE

The diamond drill holes underground were surveyed as necessary during the year. Lines were also given for raises and development work was carefully planned. Considerable study was made for the development of the ore in Section 9 where the 10th Level drift from "B" shaft had encountered ore.

GARDNER-MACKINAW MINE

The extensions of the 6th and 7th Levels to the Northwest were planned and surveys run as the work advanced. Before the mine was closed on May 31st, all the openings were carefully surveyed and the maps posted with all the information available as to the ore possibilities in that locality. After the mine was closed, the water situation was carefully watched.

LLOYD MINE

The new stocking ground Northeast of the shaft was planned, the estimates of excavation made and the construction supervised. The progress of the 6th Level was carefully watched and lines given for cross-cuts and advance as necessary. Surveys were run to some of the new sub-levels above the 5th Level as this territory was opened up for stoping.

MAAS MINE

The considerable amount of construction on surface required much attention during the summer. The grading for the new stocking area South of the East steel trestle was carefully watched. Grade stakes were placed for the fill which was done by steam shovel loading into trucks from the old rock pile at the East end of the steel trestle. The new rock trestle to the Northeast of the shaft was planned and the concrete piers staked out. Lines and grades were given for this trestle as required. The crusher foundations were staked out in the early spring. Lines and grades for the new road from the shaft to the Cherry Street extension were also staked out. Surveys were run to the drill holes as they were put down testing for surface pumping. Underground, surveys were run as necessary above the 3rd Level as new territory was opened up. On the 4th Level, the footwall drift required lines from time to time.

NEGAUNEE MINE

Surveys were run to the drill holes that were put down at the East end testing for water and for the extension of the No. 1 and 2 shaft pillars. Underground, the development above the 9th Level was carefully watched and frequent surveys were run to sub-levels being opened up in that territory. During July the development work encountered the old big stope Southeast of No. 1 Shaft and a complete survey with elevations was run over the entire opening. Samples were taken and studies made to see whether or not there was any ore available around the sides. Lines were given on the 12th and 13th Levels for the cross-cuts being driven thereon. Surveys were also run for the drill holes on the 13th Level. Between April and October the Negaunee shaft was deepened for the 14th Level from +100 to -18. A small plat was cut out at the 14th Level at +67'. At the bottom of the shaft a skip pit drift was driven and the small raise put up under the 14th Level from which the pocket is to be excavated was completed about the end of the year. Prior to the cutting out of the 14th Level

a careful study of the ore body to be made available by the new level was made so that the new level would be at the proper elevation to mine the remaining ore below the 13th Level.

SPIES-VIRGIL MINE

The development of the ore body above the 8th Level on the Southwest part of the property was planned and lines given and surveys run as required. The ventilation raise from the 6th to the 4th Level was also planned and surveyed from time to time.

TILDEN MINE

Plans for the opening up of the lower bench of the West Pit took a large amount of the time of the engineer throughout the year. The stripping and grading for the approach was carefully watched and grades were given as often as needed. The location of drill holes for blasting in the lower bench as well as in the East and West Pits were surveyed and carefully watched so that the right depth of holes would be secured. The engineer also spent a large amount of time studying up the best type of equipment for handling the ore from the lower bench to the crushing plant. This involved interviews with tractor and truck representatives and he made a trip to Duluth in connection with this study.

J. MISCELLANEOUS

SHAFT RUNNERS

The shaft runners at the various mines were gauged during June and July and the results reported to the various superintendents.

VENTILATION

In February and August the volume and direction of air currents in the various operating mines were checked and the ventilation maps in the engineering and mine offices were posted up to date.

STOCKPILES

The engineer's estimates of ore in stock at the various mines in Michigan were made during September and October and were reported as of November 1st, 1938. The following table shows the adjusted engineers estimate, book figures and overruns as of November 1st for both 1937 and 1938:

| Date Reported | Nov. 1st, 1937 | Nov. 1st, 1938 | Difference |
|---|---|---|---|
| Adjusted Engineers' Estimate | 684,929 | 2,046,403 | +1,361,474 |
| Book Figures | 460,900 | 1,773,431 | +1,312,531 |
| Overrun | 224,029 | 272,972 | +68,943 |

Messrs. Trosvig and Koski made an estimate of the ore in stock at the Otis Steel Company's plant in Cleveland during May and reported direct to the Cleveland office.

## MISCELLANEOUS SURVEYS

The route of U. S. 41 North of Ishpeming was mapped during June and the maps posted. Surveys were run for the drilling in Section 2.

## TAXES

The tax lists of the Mining Department lands and the Cliffs Power & Light Company lands were prepared during October. Twenty different tax receipts were printed covering the hydro-electric system of the Cliffs Power & Light Company and the descriptions for several of the operating mines. All of the printed descriptions are those that have been unchanged for several years and will continue in the same form for some time in the future. This printing not only saves the annual typing of both lists and tax receipts but insures accuracy in listing the various descriptions of land.

Prior to the sale of lands by the State for delinquent taxes in May, Mr. Brewer spent a long time checking over not only the Mining Department lands but those of the Cliffs Power & Light Company. Reports were made as to the lands listed for sale. On the advice of Berg & Clancey, delinquent taxes on many parts of the Cliffs Power & Light Company's hydro-electric lands were paid. Inasmuch as this was the first sale since 1931, there were a large number of lands delinquent and required a great deal of work to see that the Company's property was protected.

## GWINN DISTRICT

The construction of sidewalks on Pine Street in the Village of Gwinn with W.P.A. labor required frequent attention. Mr. Atkins gave all the grades for the walks and estimate the amount of material donated by the Company for the sidewalks in front of its property.

Plans were drawn for the installation of a water tank in the Princeton location but construction was postponed until some future date.

## OFFICE HOURS

The office hours during the year were as follows:

| | A. M. | P. M. | Saturday |
|---|---|---|---|
| From January 1st to April 20th | 8:30-12:00 | 1:15-5:00 | 8:30-12:15 |
| From April 20th to December 31st | 8:30-12:00 | 1:15-5:00 | - |

HOLIDAYS

The following holidays were granted during the year:

| | |
|---|---|
| January 1st | New Years Day |
| February 22nd | Washington's Birthday |
| April 4th | Election Day |
| April 15th | Good Friday |
| May 30th | Memorial Day |
| June 24th | Midsummer Day |
| July 4th | Independence Day |
| September 5th | Labor Day |
| September 13th | Primary Election Day |
| November 8th | Election Day |
| November 11th | Armistice Day |
| November 24th | Thanksgiving Day |
| December 26th and 27th | Christmas Holidays. |

Carl Drewer

Chief Mining Engineer

CB:DWC
1-7-39

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CLIFFS SHAFT MINE:

In February the flange connection between the valve pots and the water cylinder on the #2 Prescott Pump developed a crack. A mild steel ring was shrunk on the flange, closing the crack, and no further trouble has developed. This pump is now in good condition.

A new pinion was installed in the #8 McCully Crusher in June to replace a pinion that was very badly worn. A new mantle was also installed in October to replace one that was cracked and worn out.

The safety catches on the "B" Shaft cage were cleaned, adjusted and repaired in July and are now in first class condition.

The doors and safety catches on the "A" Shaft cage were cleaned, adjusted and repaired in August, and they are now in good condition.

All mechanical equipment at this mine is in good condition, and its operation was very satisfactory during the year.

Some minor trouble has occured in haulage generators due to general obsolescence and a gradual increase in load.

It will be necessary to install a new and larger motor-generator set and to double the cable capacity of the mine feeders next year.

In general the electrical equipment has given good and reliable service. Replacement of one set of locomotive batteries was necessary, but the old set had given longer service than had been expected under the purchase guarantee. This change abandoned the Edison type cells and replaced them with Exide lead cells. This change was made on account of lower maintenance costs.

TILDEN MINE:

A little trouble developed in the speed reducer on the belt conveyor in June. This reducer was repaired and put in good condition.

The shipper shaft on the #31 Shovel broke in October. A new shaft has been installed.

The shovels are being repaired at the present time for next season's operations. New concaves are being installed in the two 10" Crushers as the old conceves are completely worn out. The large Traylor crusher has been inspected and found to be in good condition.

All mechanical equipment operated satisfactorily during the year.

Since the change of substations giving service at this mine, electrical service has been decidedly improved. No trouble other than routine maintenance has occured.

The shovel feeder circuit was changed to the West Pit during the year. No further changes of moment are contemplated.

ATHENS MINE:

On February 14th. one of the girder supports broke on the steel stocking trestle. Repairs were made at once so that stocking of ore could be continued. On a close inspection of the rest of the trestle we thought it advisable to reenforce the connections at each pier. This repair work was completed in April and the trestle is now in good condition.

The Ingersoll-Rand compressor valves were cleaned and repaired in July.

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ATHENS MINE: (CONT'D.)

The new skip dumps were installed on September 24th. and September 30th, and the new spherical bottom skips were put in operation on the same dates. Both the skips and dumps are operating very satisfactorily.

All mechanical equipment operated satisfactorily during the year.

Electrical apparatus caused little trouble and the service has been continuously reliable and satisfactory.

The induction signal on the cage seems to give the expected service.

MAAS MINE:

We had some trouble with a special fitting the the 3rd. level pump house. This fitting was repaired several times but failed each time. In September it was replaced by a new fitting that is re-inforced, and it is now in good condition, and we should have no more trouble at this point.

The 800 G.P;M. Alberger Centrifugal pump on the 3rd. level is at the present time in the Herd Ore Shop being fitted with new thrust bearings, which will eliminate a lot of trouble that we formerly had with the old type bearings. This change will be completed and the pump put in operation about January 15th.

The intercooler on the #2 Air Compressor gave us some trouble on account of leaking tubes. Repairs were made and it is now in good condition.

The crosshead guide on the center plunger of the Aldirch Quintuplex pump broke in September. Repairs were made at once and pump put in operation. The gear and pinion on this pump is badly worn and will have to be replaced in a short time. The Purchasing Department are getting prices on gears for this pump at the present time.

A burn-out occured in the Skip Hoist motor, probably being due to overload and vibration. This was repaired and is thought to be in as good condition as before.

Several pump motors required rewinding due to age and exposure.

The new Allis-Chalmers 250 K.W. motor-generator set was put in service in January, giving ample power for haulage and slushers.

The new Larry Cars were put in operation, having a new type of control from single collector using the 3rd. rail. The minor detail troubles have been corrected and we are now sure that this type is good and will be very satisfactory.

NEGAUNEE MINE:

On November 18th. we put a 9" extension on the skip hoist drum to take care of the new 14th. level which was sunk 121 feet.

The mechanical equipment at this mine is in good condition and operated satisfactorily during the year.

Electrical installation as a whole has been operating satisfactorily and meets all requirements.

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LLOYD MINE:

The #6 Cursher was given a general overhaulling in April and it is in good condition.

The skip hoist idler stands were equipped with rubber lined sheaves in May to try to reduce the wear on the hoisting ropes.

In November we put additional conterweight on the cage hoist, this in the form of 15 ft. and 6 inches of 11" Shafting, which weighs 3747 pounds, the weight of the cage being 8750 pounds.

All mechanical equipment operated satisfactorily during the year.

Electrically service has met the requirements. The haulage sets are somewhat small but appear adequate for the present time.

MACKINAW MINE:

Operations were discontinued at this mine on May 31st.

SPIES-VIRGIL MINE:

The heating boiler was in very poor condition at this mine. A boiler from the Helmer Mine that was not in service was shipped to the Spies and installed in November. The condensation from all the heaters is returned to the boiler, which should show a considerable saving in fuel and boiler repairs. The Shaft House is now heated with steam instead of stoves, which was a great fire hazard.

All mechanical equipment operated satisfactorily during the year.

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## THE CLIFFS POWER & LIGHT CO.:

The year of 1938 has been a very unusual one in the operation of the Cliffs Power & Light Company system. In the month of January we had the worst snow storm in the history of the institution, accompanied by a very high wind. It was only by our utmost efforts and a certain amount of luck that we were able to maintain service. The storm was so severe that all roads were blocked and telephone communication destroyed to practically every vital point.

In June we had a very severe wind storm which caused sectional interruptions caused by trees blowing over the lines. Another similar storm occured in the month of September. In October we had a freak snow storm during which period the lines were covered by a very heavy, wet snow, causing numerous interruptions which could not be avoided. In the similar storm which occured in November we had several serious interruptions. In December we had a sleet storm which broke down our lines, the wires being loaded with a heavy sleet and it was only under very great difficulty that we were able to maintain service. In July a stroke of lightning caused the failure of bushings and destroyed the switch house at the Cliffs Shaft substation. This caused an appreciable delay but was not serious.

It is very fortunate that we have so many well trained men who have been in our employ for many years, and because of their experience are able to give intelligent and effective cooperation in times of distress. Our entire maintenance and operating crews are entitled to a great deal of credit for this record.

The low pressure end of the McClure Plant pipe line which is of wood stave construction has deteriorated badly, and some repairs were necessary. It was decided to repair this by enclosing it in reinforced concrete similar to what was done on the Carp River pipe line. This is a more formidable job, as the pipe line is seven feet in diameter, while the Carp is five feet.

Thirteen hundred and forty seven feet (1347') of this line was covered during the past year. The worst part was about 400' from the surge tank to the crossing of the L.S. & I.R.R. The remainder was on the high fill between the surge tank and the dam. This part was in bad condition and a serious leak here might wash out this fill and allow the pipe to fail. The entire portion on this fill is now completed, about 950'.

It will be advisable to continue this work during the coming summer when about 2000 fet. should be covered. This method not only rppairs the line but makes what would seem to be a permanent job.

The break-up last Spring occured earlier than the average, the gates being closed on the last day of March. Due to the heavy snow storm and unusual precipitation we probably had the greatest run-off in any year since the hydro plants started. Precipitation was sustained until the close of the year and we entered the winter season with all of the storage basins filled.

On account of the excessive water available at various times we sold an appreciable amount of excess current to the Wisconsin Michigan Power Company at a very low rate.

More expenditures were made for rural extensions than in any year in the history of the company. We added approximately 100 rural customers, and extended about 35 miles of rural circuit. Due to a lock of cooperative help byt the State Utilities Commission we were held up for quite some time on one of these projects, but things were finally adjusted to their satisfaction and we were allowed to proceed.

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THE CLIFFS POWER& LIGHT CO.: (Cont'd.)

In carrying on this extension program we utilized very largely men who had been released by the mines which were closed down or at which production had been limited due to the recession. While this class of labor were not particularly effecient on the electrical construction, in general it was considered a very satisfactory arrangement in every respect.

Some five transmission towers lying about a mile east of Negaunee were moved to the north of the L.S.&I.R.R. tracks, eliminating four right angle turns and reducing the number of insulators and supports to a very considerable extent. This is a very decided improvement in one of our main transmission lines.

The Republic Steel Company's Hartford Mine completed the electrification of their property in Negaunee, which necessitated the construction of a larger substation for their service. We anticipitate that they will make a very excellent customer in the coming years.

Our output and revenue decreased somewhat during the year on account of business conditions. Output was on the order of 12% less and income perhaps slightly less as compared to last year. Sales to outside customers not directly affiliated with the Cleveland-Cliffs Iron Co. showed a greater proportion of service use than our own operations and affiliates, some months the outside sales reaching as high as 55% of the total output.

Due to the Federal and State Utilities Commissions requirements we have been introducing standardization in our accounting and property valuations. This is a tremendous task and required the necessity of additional help and considerable time. The Stone & Webster engineers have assisted in the latter part of the year and they have required a considerable amount of time in the securing of necessary data and history. Upon the basis of experience of other companies we must expect that the cost of this work in total will be on the order of 1% of the total value of the plant, and that after the system has been established we will be confronted with the necessity of continued additional expenditure for the maintenance of the records and reports, in common with other business institutions. The multitude of detail required by the numerous governmental reports has become an expensive burden.

# MECHANICAL DEPARTMENT
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## THE CLIFFS POWER & LIGHT CO.

### Statistical Data - 1938

| Month | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Precipitation - | 4.54 | 1.35 | 2.00 | 3.37 | 3.04 | 3.70 | 3.80 | 4.43 | 2.17 | 3.18 | 1.88 | 1.86 |

Total Precipitation at Ishpeming during 1938 - 35.32" (2.943")
Average " " Marquette - 32.8 " (46 year record)

### CARP RIVER PLANT:

| | |
|---|---|
| Drainage area above Intake Dam, | 66.66 sq. miles |
| Cubic feet precipitation in 1938, | 5,469,195,100 |
| Kilowatt hours generated in 1938, | 16,587,800 |
| Cubic feet water utilized (90 cu. ft. - 1 KWH) | 1,492,902,000 |
| " " " in Carp Storage Basin Jan. 1,1938, | 328,756,580 |
| " " " " " " " Dec.31, 1938, | 361,658,600 |
| " " " stored in 1938, | 32,902,020 |
| " " " wasted over Intake Dam, | 1,272,584,000 |
| Total run-off for year 1938, (Cubic Feet) | 2,798,338,020 |
| Run-off per square mile of drainage area, | 41,980,000 |
| Second-feet of run-off, | 1.33 |

| | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Precipitation | 30.11 | 26.53 | 38.40 | 36.83 | 25.46 | 31.05 | 29.50 | 27.40 | 30.38 | 33.67 |
| Sec.ft. per sq. mile run-off | 1.03 | 0.67 | 0093 | 1.29 | 0.70 | 0.79 | 0.83 | 0.73 | 0.68 | 0.06 |

| | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Precipitation | 21.90 | 22.95 | 20.71 | 35.69 | 29.86 | 36.06 | 32.28 | 23.14 | 36.70 | 31.20 |
| Sec.ft.per sq. mile runoff | 0.59 | 0.50 | 0.25 | 0.85 | 0.98 | 1.11 | 0.67 | 1.10 | 0.83 | 1.13 |

| | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 |
|---|---|---|---|---|---|---|
| Total Precipitation | 32.72 | 32.87 | 27.10 | 30.23 | 30.10 | 35.32 |
| Sec.ft.per sq. mile run-off | 1.14 | 1.00 | 0.79 | 0.89 | 0.86 | 1.33 |

### McCLURE PLANT:

| | |
|---|---|
| Drainage area above Intake Dam, | 140.52 Sq. Miles |
| Cu. ft. precipitation in 1938, (Hoist Plant - 40.93") | 13,358,582,100 |
| Kilowatt Hours generated at McClure Plant in 1938, | 35,308,700 |
| Cubic feet water utilized, (125 cu.ft.- 1 KWH), | 4,413,587,500 |
| " " " wasted over Intake Dam in 1938, | 2,812,032,000 |
| " " " in Hoist Storage Basin 1/1/38, | 1,496,246,500 |
| " " " " " " " 12/31/38, | 2,086,683,900 |
| " " " stored in Hoist Basin in 1938, | 590,437,400 |
| " " " in Silver Lake Jan.1, 1938, | 639,045,000 |
| " " " " " " Dec.31,1938, | 588,181,300 |
| " " " used from Silver Lake in 1938, | 50,863,700 |
| Total runoff for year 1938, (cubic feet) | 7,765,193,200 |
| Run-off per square mile of drainage area, | 55,260,400 |
| Second-feet of run-off | 1.75 |

| | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Precipitation, | *27.40 | 35.10 | 42.03 | 26.60 | 30.49 | 24.06 | 43.85 | 35.51 | 43.80 | 38.75 |
| Sec.fet.per sq.mi. run-off | 1.22 | 1.02 | 1.54 | 0.85 | 0.92 | 0.52 | 1.52 | 1.80 | 2.22 | 1.36 |

| | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 |
|---|---|---|---|---|---|---|---|---|---|
| Total Precipitation, | 30.81 | 37.02 | 32.54 | 35.07 | 35.02 | 29.96 | 32.16 | 38.18 | 40.93 |
| Sec.ft.per sq. mi. run-off | 1.45 | 1.10 | 1.23 | 1.30 | 1.16 | 0.90 | 1.05 | 1.19 | 1.75 |

* - 1920 Precipitation figure is total precipitation at Ishpeming.

## THE CLIFFS POWER & LIGHT CO.

## STATISTICAL DATA ----- 1938

| | KILOWATT HOURS GENERATED & PURCHASED | | | | | | | | Used by Auxiliaries | Delivered to Line | KWH SOLD | TRANSMISSION LOSSES | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | McCLURE | CARP | HOIST | AUTRAIN | REPUBLIC | ESCANABA | PURCHASED | TOTAL | | | | K.W.H. | % |
| Jan. | 3,089,600 | 1,411,900 | 1,137,000 | 396,120 | 90,500 | 248,000 | 61,000 | 6,434,120 | 20,583 | 6,413,537 | 5,652,192 | 761,345 | 11.87 |
| Feb. | 3 580 200 | 1 393 200 | 1 299 000 | 438 220 | 84 300 | 239 000 | 36 000 | 7 039 920 | 21 722 | 7 048 198 | 6 063 892 | 984 306 | 13.96 |
| Mar. | 3 678 300 | 1 443 400 | 1 276 000 | 523 250 | 85 700 | 273 000 | 4 000 | 7 283 650 | 20 426 | 7 263 224 | 6 324 822 | 938 402 | 12.91 |
| Apr. | 3 071 600 | 1 751 400 | 824 000 | 521 650 | 106 800 | 254 000 | 23 000 | 6 552 450 | 18 481 | 6 533 969 | 5 763 481 | 770 488 | 11.79 |
| May | 2 799 100 | 1 888 000 | 216 000 | 516 150 | 104 200 | 299 000 | 0 | 5 822 450 | 15 644 | 5 806 806 | 5 098 719 | 708 087 | 12.19 |
| June | 2 567 000 | 1 525 500 | 411 000 | 508 340 | 102 100 | 303 000 | 16 000 | 5 432 940 | 14 409 | 5 418 531 | 4 577 662 | 840 869 | 15.51 |
| July | 2 714 300 | 986 800 | 702 000 | 449 210 | 100 200 | 257 000 | 28 000 | 5 237 510 | 15 940 | 5 221 570 | 4 479 067 | 742 503 | 14.22 |
| Aug. | 2 520 400 | 939 700 | 1 029 000 | 509 020 | 104 400 | 294 000 | 0 | 5 396 520 | 19 237 | 5 377 283 | 4 763 294 | 613 989 | 11.41 |
| Sept. | 2 640 600 | 879 700 | 1 087 000 | 322 400 | 89 000 | 285 000 | 159 000 | 5 462 700 | 19 838 | 5 442 862 | 4 771 002 | 671 860 | 12.34 |
| Oct. | 3 324 700 | 911 600 | 1 228 000 | 219 500 | 89 200 | 311 000 | 92 000 | 6 176 000 | 20 684 | 6 155 316 | 5 293 733 | 861 583 | 13.99 |
| Nov. | 2 674 000 | 1 971 400 | 1 004 000 | 237 200 | 104 800 | 263 000 | 60 000 | 6 314 400 | 19 343 | 6 295 057 | 5 441 393 | 853 664 | 13.56 |
| Dec. | 2 648 900 | 1 485 200 | 985 000 | 177 500 | 105 700 | 267 000 | 0 | 5 669 300 | 19 995 | 5 649 305 | 4 881 089 | 768 216 | 13.59 |
| TOTAL | 35,308,700 | 16,587,800 | 11,198,000 | 4,818 560 | 1,166 900 | 3,293,000 | 479,000 | 72,851,960 | 226,302 | 72,625,658 | 63,110,346 | 9,515,312 | 13.10 |

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

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1938 TOTALS |
|---|---|---|---|---|
| CLIFFS POWER & LIGHT COMPANY: | | | | |
| 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 | | | |
| Drill | 1 | | | 88 |
| MAAS TURBINE AUXILIARIES: | | | | |
| Circulating Pump | 40 | | | |
| Injection " | 25 | | | |
| Exciter " | 35 | | | 100 |
| CENTRAL POWER PLANT - TURBINE AUXILIARIES: | | | | |
| Circulating Pump | 50 | | | |
| Injection " | 40 | | | |
| Exciter " | 33 | | | |
| Boiler Room Fan (To Tilden) | 50 | | 50 | |
| Coal Handling Machinery | 10 | | | |
| " " " | 5 | | | 138 |
| CARP PLANT: | | | | |
| Auxiliaries - 2 - 15 H.P. Pump Motors | 30 | | | |
| Water Supply Pump | 1 | | | |
| Air Compressor | 5 | | | 36 |
| HOIST PLANT: | | | | |
| Exciter Motor-Generator Set | 20 | | | |
| Oil Pump | 3 | | | |
| Air Compressor | 5 | | | |
| Small Supply Hoist Motor - Incline Hoist | 3 | | | 31 |
| McCLURE PLANT: | | | | |
| Water Supply Pump | 2 | | | |
| Exciter Motor-Generator Set | 17-1/2 | | | |
| Air Compressor | 5 | | | 24-1/2 |
| ESCANABA PLANT: | | | | |
| Air Compressor | 5 | | | |
| Oil Pump | 5 | | | |
| Valve Operating Motor | 1 | | | 11 |
| TOTAL CLIFFS POWER & LIGHT CO. | 478-1/2 | 0 | 50 | 428-1/2 |

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

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| CLIFFS SHAFT MINE: | | | | |
| Shop | 25 | | | |
| No. 8 Crusher | 125 | | | |
| Screens | 15 | | | |
| Top Tram | 125 | | | |
| Hoist for "A" Shaft | 750 | | | |
| Underground Plunger Pump #1 | 180 | | | |
| " Centrifugal Pump | 250 | | | |
| Allis-Chalmers Compressor | 175 | | | |
| Hoist for "B" Shaft | 750 | | | |
| Underground Plunger Pump #2 | 200 | | | |
| Laboratory Crusher | 5 | | | |
| Cooling Water Pump for Compressors | 10 | | | |
| Ingersoll-Rand Compressor #1 | 400 | | | |
| " " " #2 | 400 | | | |
| Lower Tram #2 | 50 | | | |
| Heating Plant Condensing Water Pump | 5 | | | |
| Underground Haulage Set #2 | 215 | | | |
| Jaw Crusher - New Crushing Plant | 75 | | | |
| Underground Scrapers - 75 - 25 H.P. motors | 1,825 | 50 | | |
| Lower Tram #3 | 30 | | | |
| Battery Chraging Set. 2nd. Level "A" Shaft | 7-1/2 | | | |
| Grinder in Drill Sharpening Shop | 7-1/2 | | | |
| Boiler Feed Pump at Central Office | 3/4 | | | |
| Undg. Haulage Set #1 (From Gen. Storehouse) | 150 | | | |
| Carpenter Shop | 25 | | | |
| Return Water Pump-Central Office | 1 | | | |
| Stoker at " " | 3/4 | | | |
| Rock Tram | 50 | | | |
| Laboratory Stoker | 3/4 | | | |
| Rock Picking Belt | 5 | | | |
| Machine Shop Stoker | 1 | | | |
| Bit Grinders - 4 - 2 H.P. | 8 | | | |
| Laboratory Compressor | 5 | | | |
| No. 4 Compressor (From Morris Mine) | 500 | | | |
| Bit Grinder | | 5 | | 6,427-1/4 |
| HARD ORE SHOPS: | | | | |
| Machine Shops | 25 | | | |
| Carpenter Shop | 25 | | | |
| Blacksmith Shop Punch | 3 | | | |
| Armature Bending Machine | 2 | | | |
| " " " | 1/2 | | | |
| " " " | 1/8 | | | |
| Lathe Grinder | 1 | | | |
| Portable Drill - Small (Stanley) | 1/4 | | | |
| " " - Large | 1/4 | | | |
| Commutator Slotter | 1/8 | | | |
| Lathe | 7-1/2 | | | |
| Blacksmith Shop Blower | 1/4 | | | |
| Hacksaw | 1/2 | | | |
| Small Grinder | 1/4 | | | |
| fwd. | 6,372-1/4 | 55 | 0 | 6,427-1/4 |

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Alternating current motor record: (Cont'd.)

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED TO JAN. 1,1938 TOTALS |
|---|---|---|---|---|
| brt. fwd. | 6,372-1/4 | 55 | 0 | 6,427-1/4 |
| HARD ORE SHOPS: (Cont'd.) | | | | |
| Portable Drill - (Stanley) | 1 | | | |
| Carpenter Shop Saw | 25 | | | |
| Water Pump (S.R.Elliott) | 2 | | | |
| Motor-Generator Set | 15 | | | |
| Air Compressor | 60 | | | |
| Hard Ore Office Stoker | 1/4 | | | |
| Bandsaw | 5 | | | |
| Crane | 2 | | | |
| Shop Stoker | 1 | | | |
| Welder | 35 | | | |
| Punch Press | 10 | | | |
| Portable Welder | 20 | | | |
| Drill Press | 5 | | | |
| Drill Threader | 1/2 | | | |
| Small Lathe | 1 | | | |
| #7 Grinder | 1/2 | | | |
| Small Grinder | 1/4 | | | |
| Titan Grinder | 1/2 | | | |
| K. C. Drill | 1/4 | | | |
| Ventilating Fan | 1/4 | | | 250-1/2 |
| ISHPEMING HOSPITAL: | | | | |
| Passenger Elevator | 7-1/2 | | | |
| Dumb Waiter | 3 | | | |
| Large Washer | 2 | | | |
| Small Washer | 1 | | | |
| Extractor | 2 | | | |
| Vacuum Cleaner | 3 | | | |
| Water Supply Pump | 1 | | | |
| X-Ray Machine | 1/4 | | | |
| Hot Water Circulating Pump | 1/2 | | | |
| " " Return - High Pressure | 5 | | | |
| " " " - Low " | 1-1/2 | | | |
| Vacuum Pump | 3 | | | |
| Refrigerator | 1-1/2 | | | 31-1/4 |
| TILDEN MINE: | | | | |
| Compressor | 150 | | | |
| Centrifugal Pump | 275 | | | |
| Scraper on Coal Dock | 15 | | | |
| #29 Shovel - Motor-Generator Set | 110 | | | |
| " " - Air Compressor | 4-1/2 | | | |
| " " - Oil Pump | 1/4 | | | |
| " " - Trip Motor | 2 | | | |
| " " - Exciter Motor | 10 | | | |
| Cyclone Drill | 10 | | | |
| " " - 4- 15 H.P. | 60 | | | |
| Car Dumper | 30 | | | |
| Large Crusher | 250 | | | |
| Car Puller | 10 | | | |
| Sample Crusher | 3 | | | |
| Belt Conveyor | 50 | | | |
| Secondary Crushers - 2 - 100 H.P. | 200 | | | |
| fwd. | 6,654 | 55 | 0 | 6,709 |

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Alternating current motor record: (Cont'd.)

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1, 1938 TOTALS |
|---|---|---|---|---|
| Brt. fwd. | 6,654 | 55 | 0 | 6,709 |
| TILDEN MINE: (Cont'd.) | | | | |
| Small Hoist over Crusher | 3 | | | |
| #31 Shovel - Motor-Generator Set | 110 | | | |
| " " - Exciter Motor | 7-1/2 | | | |
| " " - Trip Motor | 1-1/4 | | | |
| " " - Air Compressor | 5-3/4 | | | |
| Drill Sharpener | 15 | | 15 | |
| Pump for Drills | 10 | | | |
| Synchronous Condenser from P.C.P. Plant | 625 | | | |
| Shop Motor | 5 | | | |
| " " #2 | 3 | | | |
| Armstrong Drill | 15 | | | |
| Blower Fan | 1/2 | | | |
| Fan in Crusher Bldg. | 1/2 | | | |
| Centrifugal Pump in Compressor Pit | 2 | | | |
| Booster Pump | 125 | | | |
| Pump for Summit Pit | 50 | | | |
| Emery Wheel | 1/4 | | | |
| Marion Shovel - M.G. Set | 85 | | | |
| Drill Sharpener - 9" (Correction) | 15 | 5 | | |
| Armstrong Drill - 8" | 20 | | | |
| Blower | 1-1/2 | | | |
| Armstrong Drill | 20 | | | |
| Scraper | 50 | | | |
| Dust Fan (From P.C.P. Plant) | | 50 | | 2,390 |
| ATHENS MINE: | | | | |
| Cage Hoist | 400 | | | |
| Nordberg Compressor | 325 | | | |
| Compressor Cooling Water Pump | 3 | | | |
| Auxiliary Compressor for Hoist Brakes | 5 | | | |
| Skip Hoist Set | 850 | | | |
| " " " Oil Pump | 1 | | | |
| Shop | 10 | | | |
| Underground Haulage Converter | 150 | | | |
| Skip Pit Pump | 2 | | | |
| Underground Plunger Pumps - 2-400 H.P. | 800 | | | |
| Ore Tram 2- 50 H.P. | 100 | | | |
| Carpenter Shop | 20 | | | |
| Ore Crusher | 25 | | | |
| Underground Ventilating Fan #2 | 50 | | | |
| Ingersoll-Rand Compressor | 450 | | | |
| Rock Tram | 50 | | | |
| Underground Haulage Converter #2 | 150 | | | |
| Saw Gumming Machine | 1/4 | | | |
| Nordberg Compressor Oil Pump | 1/2 | | | |
| Breitung Shaft Pump | 25 | | | |
| Battery Charging M.G. Set | | 30 | | 3,416-3/4 |
| Fwd. | 12,420-3/4 | 140 | 15 | 12,545-3/4 |

Alternating current motor record: (Cont'd.)

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1, 1939 TOTALS |
|---|---|---|---|---|
| Brt. fwd. | 12,420-3/4 | 140 | 15 | 12,545-3/4 |
| NEGAUNEE MINE: | | | | |
| Underground Haulage Set #1 | 300 | | | |
| "Ilgner" Hoist Set | 450 | | | |
| Ore Tram 2 - 50 H.P. | 100 | | | |
| Carpenter Shop in Lab. Bldg. (From Athens) | 5 | | | |
| Auxiliary Compressor for Hoist Brakes | 3 | | | |
| 10th. Level Plunger Pumps - 2-300 H.P. | 600 | | | |
| " " Centrifugal Pump | 350 | | | |
| " " Suction Pumps - 2-15 H.P. | 30 | | | |
| Compressor Cooling Water Pump | 3 | | | |
| Nordberg Air Compressor | 325 | | | |
| Shop | 15 | | | |
| Ore Crusher | 25 | | | |
| Ingersoll-Rand Compressor | 400 | | | |
| 13th. Level Plunger Pump | 15 | | | |
| 11th. " " Pumps - 2 - 75 H.P. | 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 | 5 | | | |
| Underground Haulage Set #2 | 220 | | | |
| Pump - Skip Pit | 35 | | | |
| New Flywheel Set for Hoists | 800 | | | |
| Oil Pump on #2 Flywheel Set | 1 | | | |
| " " " " " " | 1 | | | |
| " " " " Nordberg Compressor | 1 | | | |
| Hot Well Pump | 2 | | | |
| | | | | 4,081-1/2 |
| MAAS CRUSHING PLANT: | | | | |
| Jaw Crusher | 100 | | | |
| Belt Crusher | 50 | | | |
| Pan Conveyor Motor-Generator Set | 50 | | | |
| | | | | 200 |
| LLOYD MINE: | | | | |
| Skip Hoist (From Republic) | 500 | | | |
| Cage " | 400 | | | |
| Top Tram | 50 | | | |
| Ore Crusher | 25 | | | |
| Water Supply Pump Installed Underground | 50 | | | |
| Concrete Mixer | 5 | | | |
| Top Tram | 50 | | | |
| Compressor (Correction) | 100 | 50 | | |
| " | 225 | | | |
| Underground Haulage Converter | 120 | | | |
| Timber Yard Saw | 7-1/2 | | | |
| Underground Haulage Converter (From Wade) | 150 | | | |
| Compressor Cooling Water Pump | 3 | | | |
| | | | | 1,685-1/2 |
| Fwd. | 18,387-3/4 | 140 | 15 | 18,512-3/4 |
| | | Plus 50 | | |
| | 18,387-3/4 | 190 | 15 | 18,562-3/4 |

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Alternating current motor record:

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED TO JAN. 1, 1939 TOTALS |
|---|---|---|---|---|
| MAAS MINE: | | | | |
| Underground Haulage Set | 215 | | | |
| Shop | 10 | | | |
| 3rd. Level Centrifugal Pump | 350 | | | |
| " " Plunger Pump #1 | 500 | | | |
| Ore Tram - 2 50 H.P. motors | 100 | | | |
| Coal Crushing Plant | 15 | | | |
| 3rd. Level Plunger Pump #2 | 250 | | | |
| Ingersoll-Rand Compressor - 2 400 H.P. | 800 | | | |
| Skip Hoist | 700 | | | |
| Cage " | 400 | | | |
| Skip Hoist Rheostat Pump | 3 | | | |
| Carpenter Shop Saw | 15 | | | |
| Auxiliary Compressor for Hoist Brakes | 7-1/2 | | | |
| Cooling Water Pump | 5 | | | |
| Saw Gumming Outfit in Carpenter Shop | 2 | | | |
| Underground Haulage Set #2 (From Neg. Mine) | 215 | | | |
| 5th. Level Aldrich Pump ( " Boing " ) | 100 | | | |
| 3rd. " Centrifugal Pump | 400 | | | |
| " " " " - Primer | 50 | | | |
| 5th. " Prescott Plunger Pump (From Lake) | 75 | | | |
| " " Centrifugal Pump (From Princeton) | 125 | | | |
| New Underground Haulage Set | 365 | | | |
| Surface Well Pump | 40 | | | |
| Crusher | 35 | | | |
| | 4,777-1/2 | 0 | 0 | 4,777-1/2 |

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Alternating current motor record: (Cont'd.)

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | INSTALLED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| Brt. Fwd. | 18,387-3/4 | 190 | 15 | 18,562-3/4 |
| SECTION 6 SHAFT: | | | | |
| Hoist | 200 | | | 200 |
| GWINN CRUSHING PLANT: | | | | |
| Crusher | 85 | | | |
| Pan Conveyor | 50 | | | |
| Belt " | 50 | | | |
| Compressor | 15 | | | |
| Compressor Cooling Water Pump | 3 | | | 203 |
| GARDNER MINE: | | | | |
| Hoist | 400 | | | |
| Top Tram | 50 | | | |
| Laboratory Crusher | 3 | | | 453 |
| MACKINAW MINE: | | | | |
| Hoist | 400 | | | |
| Shop | 7-1/2 | | | |
| Ore Tram | 50 | | | |
| Underground Haulage Set | 150 | | | |
| Air Compressor | 325 | | | |
| Compressor Cooling Water Pump | 7-1/2 | | | |
| 4th. Level Quintuplex Pump | 350 | | | |
| 5th. " Pump - Automatic #1 | 30 | | | |
| Winze Hoist | 200 | | | |
| 4th. Level Centrifugal Pump | 400 | | | |
| 5th. " " " - Automatic #2 | 20 | | | |
| Grinder in Shop | 3 | | | |
| Loader Used by Railo & Rytkonen | 25 | | | |
| 10th. Level Pump (Stored) | 7-1/2 | | 7-1/2 | 1,968 |
| PRINCETON MINE #2: | | | | |
| Hoist | 200 | | | 200 |
| PRINCETON MINE #3: | | | | |
| Hoist | 75 | | | 75 |
| PRINCETON CENTRAL SHOPS: | | | | |
| Shop Motor | 25 | | | 25 |
| NEW PUMP STATION AT KIDDER SHAFT: | | | | |
| Layne & Bowler Pump | 75 | | | |
| Automatic Pump | 30 | | | |
| Booster Pump at Austin | 10 | | | 115 |
| TOTAL MINING DEPARTMENT | 21,634-1/4 | 190 | 22-1/2 | 21,801-3/4 |
| PLUS MAAS MINE (Omitted) | 4,777-1/2 | 0 | 0 | 4,777-1/2 |
| TOTAL MINING DEPARTMENT | 26,411-3/4 | 190 | 22-1/2 | 26,579-1/4 |

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Alternating current motor record: (Cont'd.)

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| TOTAL MINING DEPARTMENT | 26-411-3/4 | 190 | 22-1/2 | 26,579-1/4 |
| CLIFFS POWER & LIGHT CO. | 478-1/2 | 0 | 50 | 428-1/2 |
| CLIFFS DOW CHEMICAL CO.: | | | | |
| Chemical Plant & Sawmill | 1,195 | | | 1,195 |
| L. S. & I. R.R. CO.: | | | | |
| Shops, Sawmill, Ore Dock & Pumps | 800 | | | 800 |
| LAND DEPARTMENT: | | | | |
| Grand Island 3 motors | 15-1/2 | 4-1/2 | | 20 |
| LUMBERING DEPARTMENT: | | | | |
| Location Water Supply Pump | 5 | | | |
| Tie Mill Saw | 75 | | | |
| " " Conveyor | 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 CO.: | | | | |
| Pumps at Angeline & Sec. 16 Mines | 525 | | | |
| Holmes Mine | 2,552-1/2 | | | 3,077-1/2 |
| CITY OF ISHPEMING: | | | | |
| Booster Pump at Brownstone | 15 | | | |
| Air Compressor for Tank | 10 | | | 25 |
| CITY OF NEGAUNEE: | 435 | | | 435 |
| C. P. & L. CO. RETAIL: | 150 Est. | | | 150 |
| PALMER MINING COMPANY: | | | | |
| Volunteer Mine, Palmer | 800 | | | 800 |
| PIQUA MUNISING WOOD PRODUCTS CO., MUNISING | 695 | | | 695 |
| NORTH RANGE MINING CO.: | | | | |
| Blueberry Mine | 1,165 | | | 1,165 |
| INLAND STEEL CO.: | | | | |
| Greenwood Mine | 450 | | | |
| Morris Mine | 3,360 | | | 3,810 |
| INLAND LIME & STONE CO.: | | | | |
| Quarry & Dock | 4,000 | | | 4,000 |
| MICHIGAN GOLD MINE: | 150 | | | 150 |
| ROPES GOLD MINE: | 350 | | | 350 |
| REPUBLIC STEEL CORPORATION: | | | | |
| Hartford Mine | 625 | | | 625 |
| TOTAL OUTSIDE LOAD | 19,990 | 4-1/2 | 0 | 19,994-1/2 |
| GRAND TOTAL CONNECTED LOAD | 46,880-1/4 | 194-1/2 | 72-1/2 | 47,002-1/4 |

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The following motors are not connected to our Power System.

| MESABA RANGE: | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| CANISTEO MINE: | | | | |
| Priming Pump | 3 | | 3 | |
| Shop Line Shaft | 10 | | | |
| Washing Plant Compressor | 50 | | | |
| Belt Conveyors 2 - 5 H.P. motors | 10 | | | |
| Jaw Crusher | 100 | | | |
| Centrifugal Pumps 125 H.P. " | 250 | | 125 | |
| Symons Crushers 2 -100 " " | 200 | | | |
| Belt Conveyor | 75 | | | |
| Centrifugal Pump | 25 | | 25 | |
| Portable Drill | 1/2 | | | |
| Hacksaw | 1/2 | | | |
| Wood Planer | 3 | | | |
| Band Saw | 5 | | | |
| Circular Saw | 5 | | | |
| Shaper | 3 | | | |
| Portable Drill | 1/8 | | | |
| Clear Water Pumps 1 - 3 H.P. motor | 3 | | | |
| Motor-Generator Set on Shovel No's. 32 & 35 | 750 | | | |
| Exciter Set " " " " " | 40 | | | |
| Dipper Trips " " " " " | 4 | | | |
| Fan | 6 | | | |
| Heater Motors 5 - 1/2 H.P. motors | 2-1/2 | | | |
| " Motor | 1/4 | | | |
| " Motors 8 - 1/8 " " | 1 | | | |
| Bolt & Pipe Machine | 5 | | | |
| Machine Shop Planer | 10 | | | |
| Boring Machine | 15 | | | |
| Pressure Pump in Boiler House | 30 | | | |
| Shop Air Compressor | 50 | | | |
| Portable Grinder | 1 | | | |
| Bench Grinders 2 - 1/2 H.P. motors | 1 | | | |
| Blacksmith Shop Forge | | 1/4 | | |
| Electric Welder | 15 | | | |
| Punch & Shear Machine | 5 | | | |
| Small Pump | 3 | | | |
| Portable Saw | 7-1/2 | | | |
| Blacksmith Shop Bit Sharpener | 10 | | | |
| Roll Motor in Laboratory | 5 | | | |
| Pulverizer " " | 1 | | | |
| Fan " " | 1/8 | | | |
| Fan " " | 1/8 | | | |
| Centrifgual Pump | 125 | | | |
| Motor-Generator Set - Washing Plant | 225 | | | |
| Battery Charger | 3 | | | |
| Allis-Chalmers Screen | 5 | | | |
| Electric Welder (To Hill Trumbull) | 0 | | | |
| Priming Pump | 3 | | | |
| Armstrong Drill | 15 | | | |
| Ro-Tap in Laboratory | 1/2 | | | |
| Centrifugal Pump (From Holman) | 125 | | | |
| Battery Charger (To Hill Trumbull) | 3 | | 3 | |
| fwd. | 2,210-1/8 | 1/4 | 156 | 2,054-3/8 |

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| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| CANISTEO MINE: (Cont'd.) brt. fwd. | 2,210-1/8 | 1/4 | 156 | 2,054-3/8 |
| Portable Drill | 1/2 | | | |
| Dorr Classifiers - From Holman - 2-10H.P. | 20 | | | |
| Picking Belts - " " - 2- 5 " | 10 | | | |
| Armstrong Drill - " " | 15 | | | |
| Portable Grinder - " " | 1 | | | |
| Shop Heater - " " | 1/4 | | | |
| Shop Door Hoist - " " | 1/2 | | | |
| Air Comp. in Lab.- " " | 1-1/2 | | | |
| Exhause Fan | 1/2 | | | |
| Blacksmith Forge Fan | 1/2 | | | |
| Pit Pump | 20 | | 20 | |
| " " | 125 | | 125 | |
| 4' x 6' Screen | 5 | | | |
| Lake Feed Pump | 10 | | | |
| Clear Water Pump | 7-1/2 | | 7-1/2 | |
| 5' x 14' Screen | 10 | | | |
| Drive Under Cutting Tool | 1/4 | | | |
| Arc Welder | 15 | | 15 | |
| Pit Conveyor | 20 | | 20 | |
| Laboratory Fan | 1/8 | | | |
| Clear Water Pump | 3 | | | |
| Pit Conveyor - (Stored at Hill-Trumbull) | 25 | | 25 | |
| " " | 60 | | 60 | |
| Tank Water Supply (Stored at Holman) | 20 | | 20 | |
| Pump for Pit | 85 | | 85 | |
| Clear Water Pump | | 3 | | 2,135-1/2 |
| HOLMAN CLIFFS MINE: | | | | |
| Bench Grinder | 1/4 | | | |
| Belt Conveyor | 75 | | | |
| Symons Crushers 2 - 100 H.P. Motors | 200 | | | |
| Jaw Crusher | 100 | | | |
| Air Compressor | 50 | | | |
| Screen | 25 | | | |
| Machine Shop | 30 | | | |
| Centrifugal Pump | 275 | | | |
| Motor-Generator Set | 225 | | | |
| Clear Water Pump - Washing Plant | 3 | | 3 | |
| Bench Grinder | 1/4 | | | |
| Shop Heater | 1-1/4 | | | |
| " Heaters 10 - 1/8 H.P. motors | 1-1/4 | | | |
| Roll Motoer in Laboratory | 3 | | | |
| Pulverizer " " | 1 | | | 987 |
| HILL-TRUMBULL MINE: | | | | |
| Belt Conveyors 4 - 5 H.P. motors | 20 | | | |
| Crusher | 100 | | | |
| Sample Crusher | 10 | | | |
| Prescott Plunger Pump | 125 | | | |
| Centrifugal Pump | 150 | | | |
| Shops | 30 | | | |
| Punch & Shear Machine in Shop | 5 | | | |
| Band Saw in Carpenter Shop | 5 | | | |
| Compressor in Shop | 50 | | | |
| Screen | 20 | | | |
| FWD. | 3,655-3/4 | 3-1/4 | 536-1/2 | 3,122-1/2 |

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| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| brt. fwd. | 3,655-3/4 | 3-1/4 | 536-1/2 | 3,122-1/2 |
| HILL-TRUMBULL MINE: " " | 515 | | | |
| Conveyor | 100 | | | |
| Planer in Shop | 2 | | | |
| Variety Saw in Shop | 5 | | | |
| Electric Drill | 1/4 | | | |
| Motor-Generator Set | 65 | | | |
| Blacksmith Shop Fan | 1/4 | | | |
| Drill | 1/4 | | | |
| Washing Plant Laboratory Rolls | 3 | | | |
| Picking Belt | 5 | | | |
| Car Puller | 7-1/2 | | | |
| Portable Grinder | 1 | | | |
| North Pit Pump | 30 | | | |
| Air Compressor at Washing Plant | 25 | | | |
| Churn Drill | 10 | | | |
| Boiler Feed Pump | 5 | | | |
| Layne & Bowler Pump | 125 | | | |
| Tool Post Grinder | 1/4 | | | |
| Armstrong Drill (From Drew Mine) | 15 | | | |
| Rock Drives on Classifiers (2 - 10 H.P. motors) | 20 | | | |
| Pulverizer in Laboratory | 1 | | | |
| Fan " " | 1/8 | | | |
| Symons Crushers 2 - 100 H.P. motors | 200 | | | |
| Bench Grinder | 1/2 | | | |
| Motor-Generator Set on Shovel #34 | 250 | | | |
| Exciter " " " | 20 | | | |
| Dipper Trip " " " | 2 | | | |
| Fan " " " | 3 | | | |
| Fan for Blacksmith Shop | 5 | | | |
| Clear Water Pump | 3 | | | |
| Flue Machine | 5 | | | |
| Bench Grinder at Washing Plant | 1/2 | | | |
| Pit Pump | 30 | | 30 | |
| Shop Door Hoist | 2 | | | |
| Cross Conveyor | 10 | | | |
| Screen Conveyors 2 - 5 H.P. motors | 10 | | | |
| Transfer & Boom Conveyors 2 - 30 H.P. motors | 60 | | | |
| Motor-Generator for Logs | 150 | | | |
| Pump for Pit | 2 | | 2 | |
| Drill Water Supply Pump | 25 | | 25 | |
| Arc Welder | 15 | | | |
| South Log Screen | 5 | | | |
| North " " | 5 | | | |
| Bit Sharpener in Shop (From Tilden) | 15 | | | |
| Motor-Generator Set - Marion Shovel #47 | 100 | | | |
| Electric Welder | | 15 | | |
| Battery Charger | | 3 | | |
| | | | | 1,814-5/8 |
| TOTAL MESABA RANGE | 5,509-3/8 | 21-1/4 | 593-1/2 | 4,937-1/8 |

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The following motors are not connected to our Power System.

| | INSTALLED TO JAN. 1 1938 | INSTALLED IN 1938 | TAKEN OUT IN 1938 | CONNECTED JAN. 1,1939 TOTALS |
|---|---|---|---|---|
| SPIES-VIRGIL MINE: | | | | |
| Underground Triplex Pump | 50 | | | |
| Crusher | 50 | | | |
| Air Compressor | 403 | | | |
| Compressor Cooling Water Pump | 3 | | | |
| Hoist | 400 | | | |
| Boiler Feed Pump | 2 | | | |
| Circular Saw in Carpenter Shop | 25 | | | |
| Shop | 5 | | | |
| Compressor Cooling Water Pump | 3 | | | |
| 8th. Level Prescott Plung.Pumps - 2-150 H.P. | 300 | | | |
| Underground Haulage Converter | 150 | | | |
| Sump Pump | 2 | | | |
| Auxiliary Compressor for Hoist Brakes | 5 | | | |
| Fan | 15 | | | |
| " (From Athens) | 15 | | | |
| " | 5 | | | |
| Grinder | 2 | | | |
| TOTAL | | | | 1,435 |

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The following A.C. motors are on hand, (Dec. 31, 1938) but are not installed:

| | | |
|---|---|---|
| CLIFFS SHAFT MINE: | | |
| Top Tram (Stator only) | 50 H.P. | |
| Spare Top Tram | 50 | |
| Small Conveyor Motor | 2 | |
| Scraper Motors 2 - 25 H.P. | 50 | |
| Scraper Motor | 15 | |
| Top Tram Motor from Republic | 50 | |
| Magnetic Separator | 3 | |
| Screen | 10 | |
| | | 230 H.P. |
| GENERAL STOREHOUSE & BARN: | | |
| Spare from Republic Concrete Mixer (Needs repairs) | 5 | |
| " General Electric pump | 50 | |
| " for Centrifugal pump used at North Lake | 200 | |
| " motor (Needs repairs) | 40 | |
| Pump Motor from Republic Mine (Needs repairs) | 10 | |
| 2 - 500 H.P. hoist motors from Cliffs Shaft Mine | 1,000 | |
| Hoist stator only " " " " | 500 | |
| Feeder Belt " " " " | 5 | |
| Conveyor Belt " " " " | 20 | |
| Concrete Mixer from AuTrain | 7-1/2 | |
| Leach concrete mixer | 10 | |
| Carpenter Shop from Republic Mine | 20 | |
| Undg. Hoist " " " | 50 | |
| " " " Maas " | 50 | |
| Cyclone Drill " Tilden " | 10 | |
| Pump " AuTrain Dam | 100 | |
| " " Republic Mine (Needs repairs) | 50 | |
| " " " " | 7-1/2 | |
| Screen #9 Shaft " " " scrap | 25 | |
| Crusher " " " | 100 | |
| Coal Tram " " " | 7-1/2 | |
| Pump from 3rd. Level " " | 50 | |
| Screen from Crusher " " | 10 | |
| Pump from " " | 35 | |
| Pump from Mackinaw Mine | 20 | |
| Spare for small compressors | 5 | |
| Pump motor from Cliffs Shaft change house | 2 | |
| Prescott pump motor from Maas Mine | 325 | |
| Pump motor from Morris Mine | 50 | |
| " " " " " | 50 | |
| Gwinn crushing plant conveyor motor | 40 | |
| Top Tram from Wade Mine | 50 | |
| Sump Pump " " " | 7-1/2 | |
| Blacksmith Shop fan " " | 3 | |
| Air compressor " " " | 150 | |
| Clear water pump " " | 15 | |
| Triplex pump from " " | 50 | |
| Pump motor " " " | 100 | |
| Undg. Haulage Set from Morris Mine | 150 | |
| Cooling water pump " Wade " | 2 | |
| Sump Pump from Negaunee Mine (Needs repairs) | 5 | |
| Allis-Chalmers 3-K-2164.1 from Armour Mine | 5 | |
| Hoist | 150 | |
| fwd. | 3,532 | |
| " | | 230 H.P. |

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A. C. motors on hand but not installed: (Cont'd.)

| | | | |
|---|---|---|---|
| | Brt. fwd. | | 230 H.P. |
| GENERAL STOREHOUSE & BARN: (Cont'd.) | " " | 3,532 | |
| Hoist from Armour Mine | | 250 | |
| Centrifugal pump " " " | | 150 | |
| " " " " " | | 200 | |
| Blacksmith Shop blower (C.S. Lab.) | | 1/2 | |
| Centrifugal pump from Armour Mine | | 35 | |
| Centrifugal pump | | 5 | |
| Skip hoist motor from Lloyd Mine | | 400 | |
| " " " " Barnes-Hecker Mine | | 400 | |
| Compressor motor | | 50 | |
| " " from Shop | | 10 | |
| Top Tram from Lloyd Mine | | 40 | |
| Top Tram | | 50 | |
| Cliffs Shaft Tram | | 100 | |
| Lloyd Tram | | 40 | |
| Sump Pump | | 2 | |
| " " | | 2 | |
| Top Tram for Lloyd Mine | | 50 | |
| Hoist Motor from Angeline Mine | | 250 | |
| | | | 5,566-1/2 |
| ISHPEMING HOSPITAL: | | | |
| Spare for dumb waiter | | 3 | |
| " " hot water return | | 5 | |
| | | | 8 |
| ATHENS MINE: | | | |
| Pump Motor | | 50 | |
| Spare for Breitung Pump | | 25 | |
| | | | 75 |
| MAAS MINE: | | | |
| Winze Pump | | 15 | |
| Rheostat Pump | | 2 | |
| Cooling Water Pump | | 5 | |
| Return " " | | 2 | |
| Sump Pump (New) | | 5 | |
| | | | 29 |
| NEGAUNEE MINE & BARN: | | | |
| Flywheel hoist set motor | | 350 | |
| Top Tram | | 50 | |
| Hoist from South Jackson | | 75 | |
| Pump from Maas Mine | | 50 | |
| Pump " Morris Mine | | 50 | |
| Hoist motor from Stephenson Mine | | 75 | |
| | | | 650 |
| GWINN DISTRICT: | | | |
| Underground Pump | | 150 | |
| Hoist motor from Spies Mine | | 200 | |
| Hoist Motor | | 400 | |
| Top Tram from Gardner Mine | | 25 | |
| Stephenson 5th. level plunger pump | | 250 | |
| " " " " " | | 250 | |
| " 8th. " " " | | 50 | |
| Spare for Pumping Station | | 30 | |
| | | | 1,355 |
| | fwd. | | 7,913-1/2 H.P. |

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ANNUAL REPORT
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A. C. motors on hand but not installed: (Cont'd.)

| | | |
|---|---|---|
| Brt. fwd. | | 7,913-1/2 H.P. |
| TILDEN MINE: | | |
| Conveyor Belt | 50 | |
| Trip motor for shovels | 1-1/4 | |
| | | 51-1/4 |
| TOTAL | | 7,964-3/4 H.P. |
| Spare motors at Spies-Virgil Mine: | | |
| Underground haulage set | 150 | |
| TOTAL | | 150 |
| Spare motor on Mesaba Range: | | |
| HILL-TRUMBULL MINE & SHOPS: | | |
| Screen from Crosby Mine | 20 | |
| Picking Belt " " " | 3 | |
| Chip Screen " " " | 3 | |
| #2 Turbo " " " | 20 | |
| Planer " " " | 3 | |
| Chip screen | 2 | |
| Conveyor belt 2 Drew " | 15 | |
| Feeder " " " | 10 | |
| Helmer hoist | 200 | |
| Log Washer | 50 | |
| " " | 40 | |
| Pit Conveyor | 25 | |
| Centrifgual Pump | 85 | |
| Pump for Pit | 2 | |
| Drill water supply pump | 25 | |
| | | 503 |
| CANISTEO MINE: | | |
| Centrifugal Pump | 600 | |
| " " | 600 | |
| Dipper trip | 2 | |
| H-T table motor | 20 | |
| H-Y picking belt | 5 | |
| Spare heaters on #35 shovel | 1/8 | |
| Dorr washers 2 - 75 H.P. | 150 | |
| Priming Pump | 3 | |
| Centrifugal Pump | 125 | |
| " " | 25 | |
| Heater | 1/8 | |
| Pit Pump | 20 | |
| " " | 125 | |
| Clear Water Pump | 7-1/2 | |
| Arc Welder | 15 | |
| Pit Conveyor | 20 | |
| " " | 60 | |
| Pump for Pit | 85 | |
| | | 1,862-3/4 |
| HOLMAN-CLIFFS MINE: | | |
| Shaft Pump | 150 | |
| Sump pump | 5 | |
| Air compressor from Pontiac Mine | 100 | |
| Chip Screen | 2 | |
| Blacksmith shop fan | 1/4 | |
| Hydrotator | 15 | |
| Tank Water Supply | 20 | |
| | | 292-1/4 |
| TOTAL | | 2,658 H.P. |