The greatest value of the table lies in a comparison of various types used at the same mine.

TABLE 6—LIFE OF ROPES.

Mine.	Type of Rope Used.	Tons per ft. of Rope.	Remarks.
A.	⅜-in. 6 x 19 Seale construction. I. wire center	9	Soft and lumpy ore. Use about 5,000 ft. per mo.
	½-in. 6 x 19 Seale construction with I. wire center	15.5	Larger head sheaves. Use about 2,000 ft. per mo.
B.	⅜-in. 6 x 19 cast steel, hemp center (prefer this to plough steel)	15	Soft ore. Av. of about a year. Long Pulls. Large head sheaves.
C.	⅜-in. 6 x 19 Truelay plough steel, I. wire center	15	Hard, lumpy ore. Used 2,000 ft.
D.	⅜-in. 8 x 19 plough steel, hemp center	25	Soft ore. Tried about 3 mo.
	⅜-in. 8 x 19 plough steel, flattened strand, hemp center	20	Rope found too stiff.
	⅜-in 6 x 37 plough steel, hemp center	..	Was not satisfactory.
	⅜-in. 8 x 19 plough steel, hemp center	..	Preferred.
E.	⅜-in. 6 x 19 plough steel, hemp center	Pull rope lasted 4 weeks. Tail rope lasted 6 weeks.	Have no tonnages for ropes.
	⅜-in. 6 x 19 plough steel, I. wire center	Pull rope lasted 8 weeks. Tail rope lasted 16 weeks.	Comparative value shown under like conditions.
	⅜-in. 6 x 19 plough steel, Truelay I. wire center	Pull rope lasted 16 weeks.	

ROPE ATTACHMENTS.

The method of attaching the rope to either end of scrapers depends on the size of the rope, and on what importance is placed at each mine on devices that should be designed for the purpose. For smaller-size ropes a knot around a ring or device is deemed sufficient. This makes a speedy arrangement to repair, but causes trouble in the rear connection in that it pounds the sheave wheel on the back pull. This is true especially in loading operations where a number of jerks back and forth take place, pounding the edges off the sheave. A simple device shown in Fig. 40-D relieves this trouble, for, if the scraper is pulled back with a bang the flat edge of this device will hit the rim of the sheave. It also saves time at the forward end of the scraper. In case the rope breaks here there is no knot to untie off the device. Simply pull out the broken end and thread new rope thru hole and tie a knot in it.

Another time-saving device is the "pig-tail" connection, with which most blacksmiths are familiar. A knot is unnecessary with it. The rope is pulled through the loop, a twist made in it so that when the pull is applied it is gripped by friction of parts against themselves. Because of stiffness on rope it does not become loose when the load is released.

When using large-diameter ropes U-bolts with rope looped around it and clamped with ½-round iron clamps are used.

ROPE GUARDS.

The rope guard is a safety factor protecting the operator from lashing of rope and from revolving of drum.

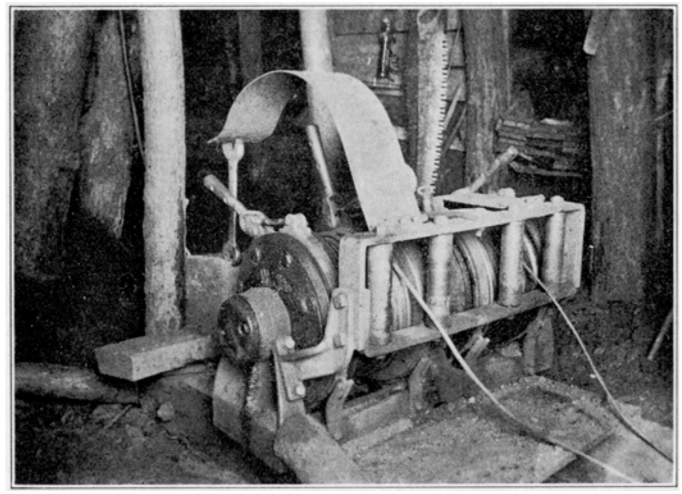

FIG. 30—AN ELECTRIC 6½-H.P. DOUBLE-DRUM HOIST, MOUNTED ON TURN-TABLE.

Two types of guards are shown in Figs. 30 and 31. The former is the most common type in use although the detail of mounting it on the hoist may vary. The type shown in the picture is hinged on the top. Similar guards are sometimes hinged at the bottom, as in Fig. 40-B. In some cases hinges are placed near the middle of the guard to facilitate handling when the rope on drum needs attention. Fig. 31 illustrates a type which is not common, but which makes an excellent guard.

Vertical Rollers for Ropes—A vertical roller on a scraper hoist performs the function of guiding the ropes to the limits of the width of the drums. Fig. 30 shows the most common method of mounting such a roller. Those illustrated are short as compared to the type in Fig. 31. In several mines, besides the type discussed, a roller was placed horizontally opposite each drum across the top of the frame. This in a way eliminates the necessity of a rope guard in respect to lashing. When a considerable amount of angle scraping is done, the rollers receive a great deal of wear. A recent method of repairing such worn-out rollers is that of applying "stellite" (mentioned in connection with scrapers). In Fig. 30 please note such a correction to the lower ¼ of the second roller from the left.

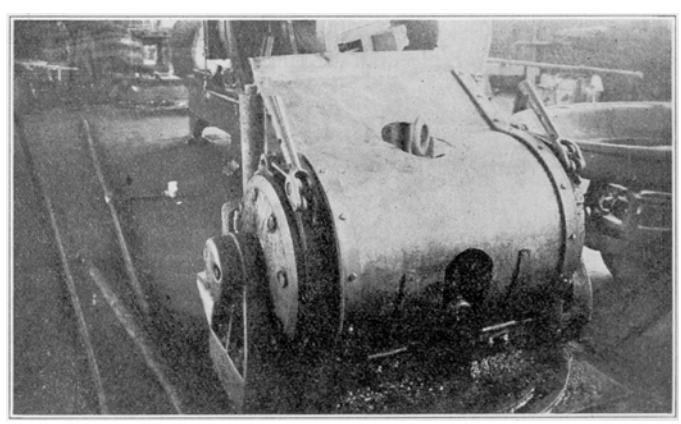

FIG. 31—AN ELECTRIC 6½-H.P. DOUBLE-DRUM HOIST WITH SINGLE PIECE ROPE GUARD.

Little attention has been paid in the majority of the mines to makings any refinements in the construction of rope rollers. Any kind of bolt with a revolving envelope, such as a piece of pipe or a loose fitting roller, would do; no attempt being made to keep them greased. As a result, rapid wear took place, causing frequent renewal of the worn parts. In Fig. 40-C is shown a lubricated rope guide designed and used at one mine. The graphite is placed between pin and roller and lasts the life-time of the piece without refilling. Such a roller in use has lasted over a year and is still on the hoist.

CHAPTER V.

SCRAPER HOISTS.

In the iron ranges of the Upper Peninsula there are in constant use approximately 400 double-drum electric hoists and 150 air hoists, representing about $460,000 worth of power equipment used in the scraping of iron ore. This paper does not attempt a discussion of the entire held of scraper hoists; rather it is limited to some of the most pertinent facts observed in connection with the ore scraping problem. For a comprehensive discussion of the details of the construction of hoists there is no better reference than the trade catalogues of the manufacturer.

Types in Use—Hoists can he divided into two classes on the basis of size and h.p.: Class 1, small, and Class 2, large. The latter includes those hoists that are rated from 15 h.p. to 25 h.p. and the former those rated from 6 h.p. to 10 h.p.

Class 1—Hoists of the first-class are light and compact and are readily handled thru raises. They are mainly used in sub-levels although a few are working very well on scraper loaders in drifts. They are designed to handle a maximum rope pull of 4,000 lbs. at present rope speeds. The fact that beyond this pull the motor will stall is for the best since a greater pull may yank out the posts on which the scraper is likely to be caught. A low motor torque is desirable also when the operator's view of the scraper at the breast is obstructed either by timber or by a curve in the slice. Although the hoists of this class have a horsepower varying between 6 and 10 by far the greater majority of them are 6½ h.p. double-drum hoists; about 270 from a total of 350 Class 1 hoists. In the mines visited there were only 16 hoists which rated between 10 and 15 h.p., eleven of them being 10½ h.p.

Class 2—Hoists of the second class are almost entirely either 25 or 27½ h.p. The writer has noted 54 such hoists in use. One type of this class is illustrated in Fig. 32. A hoist of this capacity and rating is necessarily quite large and is used where the amount of shifting required is small, as in long hauls from stopes, storage scraping drifts, and large rooms. With the rope speeds obtainable with these large hoists they are capable of exerting a rope pull of about 6,500 lbs. before stalling; however, the rating for one of these types is 3 tons vertical lift at 150 ft. per minute as compared to a 6']/2 h.p. electric hoist rated 1 ton vertical lift at 150 ft. per minute.

APPLYING OF POWER TO HOISTS.

The method of applying power to the drums varies with the conditions of installation and with closeness of quarters. Air hoists are very compact and the method of applying power makes little difference to the outside dimensions of the hoist. In all cases electrically operated small hoists at the present time have D.C. motors. These motors may be inside the drum or may be mounted as a separate unit behind the drum driving-it with a worm gear. The former arrangement is most compact. The larger hoists use the following methods: When the opening is liable to be narrow, the drums, motor and control boxes are in tandem, the motor driving the drum either by gears or by a chain. At the Cliffs Shaft hard ore mine, where the scraper hauls are long and heavy lumpy ore is handled, the common type of clutches gave a great deal of trouble. Lucien Eaton designed a planetary type of drum which has worked well under the difficulties. A new hoist of this type is so designed that it can be handled through an opening 24 x 29 in. (See Fig. 32).

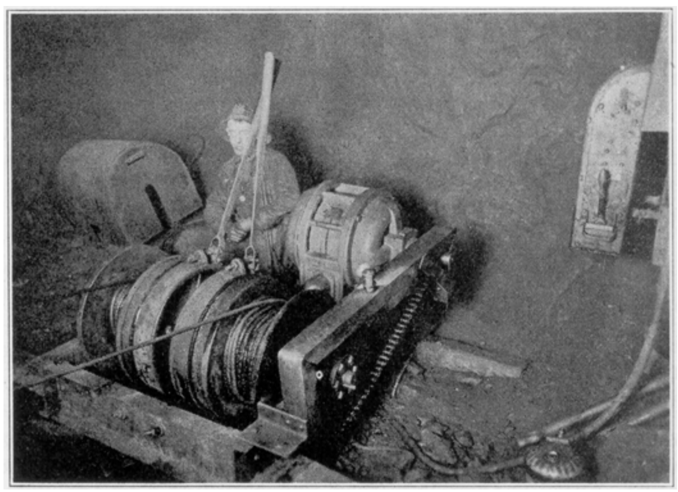

FIG. 32—25-H.P. DOUBLE-DRUM PLANETARY TYPE CHAIN-DRIVE, ELECTRIC HOIST.

AIR HOISTS.

The first types of air hoists used 225 C.F.M. at 80 lbs. and were rated 6 h.p. Later types used 190 C.F.M. at 80 lbs. pressure and developed 12 h.p. by using the air expansively. These were all piston machines. The turbine types of machines use 155 C.F.M. when new and after two years of service about 200 C.F.M. The piston type of machines had a life of about 125,000 tons and the turbine type about 175,000 tons to the hoist. The latter type is made by two manufacturers of hoists, and preference of one make over the other is largely a mailer of circumstances under which the hoists are to work. One is considered faster but has been known to freeze in the turbine due to exhaust of air when the surrounding-temperatures are low. The exhaust port in the other make is larger but as a consequence more air is used. The upkeep of both kinds of machines will run about $5 per month. This figure was obtained from keeping a record of 37 such hoists. At one of the large mines where air hoists only are used, the efficiency engineer reported the cost per ton of air hoist to be $.00028-$.0003.

There is no danger of injuring parts of an air hoist in case of overloads. The bearings of air hoists need not be as accurate as those of electric hoists, and therefore roller bearings can be used to advantage. The breaks on air hoists are more positive than those on electrical hoists. The latter type needs frequent adjusting to prevent locking, and tension is necessary in them at all times. An air hoist is faster and more flexible in handling than are electrically operated hoists; however, recent improvements eradicating this advantage are claimed for a new electrical hoist. It has a 2-speed locomotive control and is capable of operating at a slow speed when filling the scraper and of being shifted to a higher one when pulling in the load.

Table 7 is offered for the reader's consideration. It was compiled at one of the soft ore mines operating by the top slicing method and is fairly representative of similar methods elsewhere. When comparisons are being made about the costs of maintenance, the difference in tonnage handled by each type of hoist should be considered. The most striking fact presented by this table is the power cost.

TABLE 7—COMPARATIVE COSTS OF OPERATING AND MAINTAINING ALL AIR AND ELECTRIC TUGGERS, IN TERMS OF COST PER TON SCRAPED AND COST PER HOUR OF SERVICE.

	Air Tuggers.	Electric Tuggers.	Total.
Tons slushed	604,005	91,124	695,129
Hours of service	45,609	6,632	52,241
Tons per hour of service	13,243	13,740	13,306
1. Maintenance Cost—			
A. Lubrication	$ 494.40	$ 92.68	$ 587.08
Cost per ton	.000819	.001017	.000845
Cost per hour	.01084	.01397	.01124
B. Repair (labor and material)	756.17	166.64	922.81
Cost per ton	.001252	.001829	.001327
Cost per hour	.01658	.02513	.01766
C. Total (lubrication and repairs)	1,250.57	259.32	1,509.89
Cost per ton	.002071	.002846	.002172
Cost per hour	.02742	.03910	.02890
2. Power Cost—			
Cost per ton	.034634	.004165	.030640
Cost per hour	.45866	.057229	.407701

ELECTRIC HOISTS.

In the course of the discussion on electric hoists the form of electrical power will be D.C. unless specifically stated as A.C. Mention has already been made of the prevalence of electrical hoists in; this district. A brief discussion of some of the features of electric hoists follows:

Rope Speeds—Rated rope speed run from 150 to 180 ft. per minute for a full load, but the writer seldom found that rate attained, although he made numerous time studies in stopes and drifts. Some of the most pertinent instances recorded are shown in Table 8. This table was compiled from observations of the scraper as it made round trips to the pile of dirt. Five to fifteen such round trips formed the average extent of observations. The time lost due to delays is not figured into rope speed except in the case of Mine G.

A typical section from a graphic watt-meter chart is given in Fig. 33. The data was obtained under conditions which were: as severe a strain on hoists of this size as can be found anywhere. The average pulling-in speed was 200 ft. per minute and the return trip speed was 210 ft. per minute. It was found that hoist motors are worked harder, from a heating standpoint, with soft ore than with chunky ore.

Bearings—At the present time roller and ball bearings are most common. The later hoists, rated from 10- 25-h.p., are equipped with Timken bearings. The objection to hall bearings underground is that, since their clearance is only about 10 thousandths of an inch, small pieces of grit which may enter with the lubricant will cause the balls to break. Replacement of this type of bearing with rollers is common practice, in one mine where this trouble was encountered "Hoffman" roller bearings, the dimensions of which are standard with ball bearings, were used at $3.50 each. During the six months since the installation, only one roller bearing has been lost. In another mine where the ore though similar in texture was dry, hoists with ball bearings were used for 3 years with no repairs. Stress here was laid on the use of Gurney (bronze) ball bearing retainers.

Lubrication—It is difficult to keep a scraper hoist lubricated because it is hard to make any one person responsible and because it is hard to find a proper lubricant. When left up to the miners the responsibility becomes too widely distributed. At the majority of the mines one or two men travel through the mine attending to this work only. In other mines the timber boss looks after it.

Superla grease No. 42 is probably the most common lubricant although Arco liquid grease is widely used. At one mine difficulty was experienced in keeping the bearing between drums lubricated. One machine taken to the surface after a service of several months had the original grease still in place. Too heavy a lubricant had been used upon it. Most machines should be greased once a month and oil should be applied each, day at the beginning of the shift.

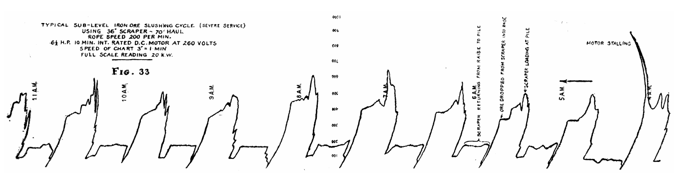

TABLE 8—RESULTS OF TIME STUDIES OF SCRAPER HOISTS.

Mine.	Type of Hoist.	Size of Load. cu. ft.	Length of Haul. ft.	Average rope speed. Load.	Average rope speed. Empty.	Kind of Scraper.	Kind of Place.	Rate of Filling Car
A.	25-h.p. electric	14	50	118	150	Sauerman	Storage drift.	1-40 cu. ft. car in 1′-40″
	25-h.p. electric	9	75	120	146	42″ box-type.	Storage drift.	1-2½ ton car 3′-24″
B.	6½-h.p. electric	6	20	(rated cap.)	180	36″ box-type.	Osana loader drifting. (ore chunky)	1-3 ton car 9′-15 sec.
C.	6½-h.p. electric	6	60	82.5	100	36″ box-type.	In slice along dike.	
D.	6½-h.p. electric	3¼	70	140	rd. trip average.	30″ Hoe-type.	In sub.	
	6½-h.p. air	3¼	25	200	per min. round trip.	30″ Hoe-type.	In sub.	1-2.2 ton car in 5′-48″
E.	25-h.p. electric	14	110	192	204	60″ Hoe-type.	Storage sub-drift.	
	6½-h.p. air	3¼	20	130	per min. round trip.	30″ Hoe-type.	Subs.	
F.	6-h.p. air	6	60	112	per min. round trip.	36″ box-type.	Subs.	
G.	6-h.p. air	6	60	100	189.5	36″ box-type.	Sub-level.	Average of 77 trips.
H.	6-h.p. air (using 90 lbs. air)	6	75	140	225	36″ box-type.	Sub-level.	Note great difference between full and empty rope speeds.

Repairs and Manitenance—The weak point in the light hoists seems to be the armatures. When the ore is lumpy and somewhat sticky the armatures frequently become troublesome. When the scraper is caught, the miners operating such hoists are not likely to be careful about overloading, and in many cases they have been known to short circuit the 30-ampere safety fuses provided for such an emergency. When the core is burned the only remedy is to buy a new one at about $80. Under such conditions the miner's preference is for a more rugged type of hoist. Another reason given for the burning of armatures is the resulting vibration when parts, such as bearings, wear.

At a mine where the ore is soft but sticky and wet, forty small hoists are in use. The repair parts per month total to $200 or $5 per machine. The labor spent on repairs on each machine is 20 man hrs. per month.

The following figures were obtained at a soft ore mine which is worked by the Top-Slicing Method. Small hoists are used.

Repair cost per operating hr., 2½c on electrical hoists for 90,000 tons.

Repair cost per operating hr., 1.7c on air hoists for 600,000 tons.

Cost per ton of ore moved = .00183 electric hoists.

Cost per ton of ore moved = .00125 air hoists. The last two cost figures include labor and material.

The following methods of maintenance are practiced:

Mine A—Every motor is brought to the shop every 6-8 months for inspection whether it seems to need repairs or not. Further precaution is taken by having the electrician inspect each unit every day underground.

Mine B—Electric hoists are inspected weekly. Air hoists are inspected once a month.

Mine C—The mechanic inspects every hoist once every 2 weeks.

Mine D—Each machine is inspected thoroughly once a month.

The method of inspection depends, of course, on the number of hoists used, upon liability of breakage, etc., but, in most mines where scrapers are used in sub-levels, there are more hoists in use than there are drilling machines. A considerable amount of money is represented by this sort of equipment and a hoist, unlike a drilling machine, will not stand the racket to which the former is subjected. In view of these facts it would seem that more mines should follow the example set by Mine A.

In places where scraping is done at an angle from the hoist such as in radial slicing, less wear is entailed on the hoist if turn tables are used. The additional cost for such equipment on light hoists is $35.

CHAPTER VI.

POWER.

Some mention has already been made of the kinds of power used by hoists and of the relative advantages of air and electricity. It has also been stated that the smaller types of hoists use D.C. entirely, while the larger hoists under favorable conditions use A.C.

A.C. and D.C. Compared—Because it is a comparatively recent innovation underground, scraping has had to adjust itself to the conditions which existed before. Formerly the principal underground users of electricity were haulage motors, fans, and lights; of these the haulage motors were the most important. They were designed with D.C. on account of the peculiarities of the service to which they were subjected, and as a result all other equipment had to be adapted to that type of power. This situation has led to the prevalence of D.C. over A.C. in scraping. For small scrapers an A.C. not only is feasible but in many ways has advantages over D.C. One of the mines visited had just installed haulage locomotives with A.C. motors—the first to be used on that range. The plan there was to change entirely from D.C. to A.C. motors. In a mine on another range some A.C. motor locomotives have been used for five years. During that time three of the A.C. motors needed repair, and the average cost of repairs on each machine did not exceed $5 per month.

Some of the advantages of A.C. are as follows:

1.—The armatures of an A.C. motor are practically indestructable. When overloaded they do not burn; consequently there is less handling and less repair work. They do not have a brush or commutator.

2—D.C. motors require generator sets underground; A.C. motors use the more flexible "step-up" or "step-down" transformers. Also the latter type uses smaller wiring for purposes of transmission.

3—The cost of maintenance of D.C. underground fan motors is excessive because the motors burn out when the fluctuating voltage rises too high; the power required varies approximately as the cube of the voltage. An A.C. motor with proper connections does not burn.

4—When 110-volt lamps are used with A.C. the lamp cost is reduced 65 per cent compared to the cost with 250- 270-volt D.C. lighting. Filaments in 110-volt A.C. lamps stand more vibration than do those in the 250 and 270-volt D.C. lamps.

5—The D.C. motor costs about twice as much as an A.C. motor of the same capacity. The latter has lower transmission and lower maintenance costs.

6—Probably the most important advantages offered by A.C, is the smaller line losses. Less copper is also required for conductance. With a power factor of unity, A.C. for three-phase mine circuits requires 75 per cent of the copper needed by D.C. of same voltage. This percentage varies inversely as the square of the power factor.

D.C. power offers important advantages in the scraping problem.

1—Most scrapers get power from the trolley lines already installed. No special transmission lines are necessary.

2—D.C. motors have an easier and more efficient speed control and a better starting torque. The present type of A.C. wound-rotor induction motors has a range of control which is good enough for this problem without the use of a resistance either at starting the motor or during the operation. At the start clutches can be used. The aforementioned advantages need not be of damning importance against A.C. motors.

3—With a light load the speed characteristics of a D.C. motor are better than those of an A.C. This fact is important in scraping ore, since in the process of scraping some loads are not filled and the speeding of the load saves time. The return trip with an empty scraper is another instance where this factor offers an advantage. An A.C. motor is practically constant speed regardless of load.

4—A drop in voltage due to line losses, poor wiring, etc., does not stall a D.C. motor as easily as it does an A.C; nor is a drop in voltage a very serious drawback in starting a D.C. motor. This stalling of an A.C. motor may be a point in favor of the D.C. motor; however, if the A.C. were used it would be absolutely necessary to keep the transmission lines in first class order, eliminating losses due to short circuits, before the hoist could be operated at all.

The sizes and weights of both types of installations would not vary greatly; if anything, the D.C. motor weighs more than an A.C. of the same rated h.p. Because of the advantages offered by an A.C. motor, if a new mine were to be opened, the recommendation of anyone familiar with the problem would be to operate all electrical equipment with the A.C. form of power.

Air and Electricity—Although the ratio of air hoists in use to electrical hoists is about 1 to 3, air as a power medium has good points in its favor. Some mines which have a big fire hazard, because they use large amounts of timber, are using air power for scraper hoists. Although ventilation in such places is poor it is improved by the escaping air from the hoists. At one of the mines 19 air hoists were placed in a section where electric hoists had been used. The revolution per mo. of the compressor dropped because less air was used in blowing on the men in the slices. All power was generated at the mine. The air cost was 4½c per 1,000 cu. ft. and electrical power cost was about 2½c per k.w. hour making the ratio 6-1. (See Table 7). Roughly, the cost of the ventilation of this place amounted to five times the cost of the electrical power, which would have been used during the scraping-period or about $.70 per man per day. This estimate is based upon the assumption that every unit was working at least 3 hours a day and that the difference in cost of the two forms of power was paying for the ventilation. An interesting piece of research work along these lines has been recently carried on by one of the largest mining companies in the Upper Peninsula. It was definitely determined that at least 50 per cent of the air made at the central compressor plant was used for blowing at the working faces to effect a better condition of air. One of the large mines makes too million cu. ft. of air per month. At 4½c per 1,000 cu. ft. of air, the total cost of air for ventilation would be $2,250 per month which is rather expensive.

No matter how excessive the demands of power may be at certain periods of the day, electrical equipment can supply it. When air is used drilling machines lower the pressure and make the operation of air hoists difficult because they are a great drain on available air supply during those hours when scraping is being done. Another factor to be considered is the noise which the hoist makes when running. When the operator is some distance from the breast, it is difficult for him to hear signals from the assistant if the hoist is noisy. There is also increased danger to the man at the breast because the excessive noise of the hoist prevents him from hearing any sound which might indicate danger. Electrical hoists operate much more quietly than do air hoists.

The strongest argument for the use of electrical power for scraping ore is the relative cost of this type of power as compared to air power. Roughly it can be said that under the same underground conditions, electrical power costs 1/6 as much as does air power. With the possible future development of water power plants in the Upper Peninsula, it appears that electrical power will in time entirely replace air for this purpose.

On the basis of efficiency electrical power is also cheaper. The efficiency of electric hoists is about 65 per cent and that of air hoists about 15 per cent. The cost of maintenance of electrical equipment is much less than that of air.

For transmission of air the following arrangement is common: One 6-in. line in the shaft, and sometimes two for emergencies; 3-in. or 4-in. pipes along main levels, drifts, and crosscuts; and a 1½ to 2-in. pipe up to the subs.

Transmission of Electrical Power—In most mines where D.C. is used the power for scraper hoists is taken off the trolley lines. One exception to this was noted: Excessive-demands were being made by large scraping equipment. Separate lines had to be used. An insulated wire was tried but failed because of the burning of insulation with a 250-volt pressure. A 400,000 C.M. bare cable was substituted.

At two of the mines using A.C. a No. 4,- 3-conductor Tirex cable is used down the shaft at 2,250 volts. At one mine it is stepped down to 440 volts; at the other 220 volts. In the former case No. 4 Tirex branch cables are used in the drifts with No. 6 cables for distributing to the scrapers. Three scrapers can operate off one No. 6 cable. The plan for the future in this mine is to use plugs at intervals of 300 ft. to facilitate the handling of equipment. Two men can comfortably carry such a length of No. 6 wire on a pole. Three and four-way plugs for this purpose are illustrated in Figs. 34 and 35; the wire cable shown above the plug is used to support the heavy conductor by means of easily attachable clips.

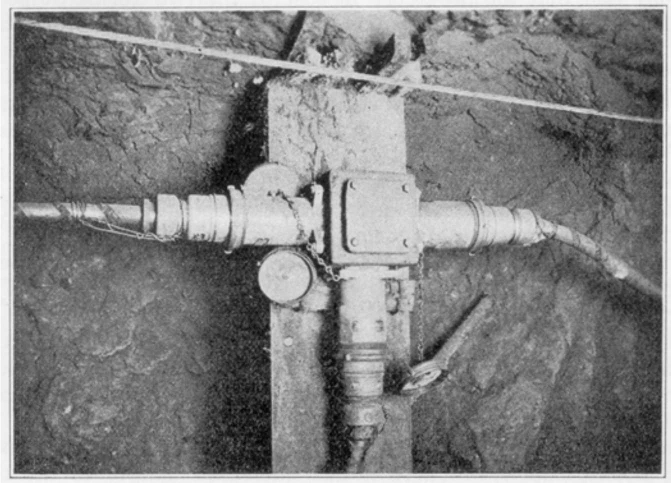

FIG. 34—A 3-WAY PLUG BOX FOR 440 VOLT—A.C.

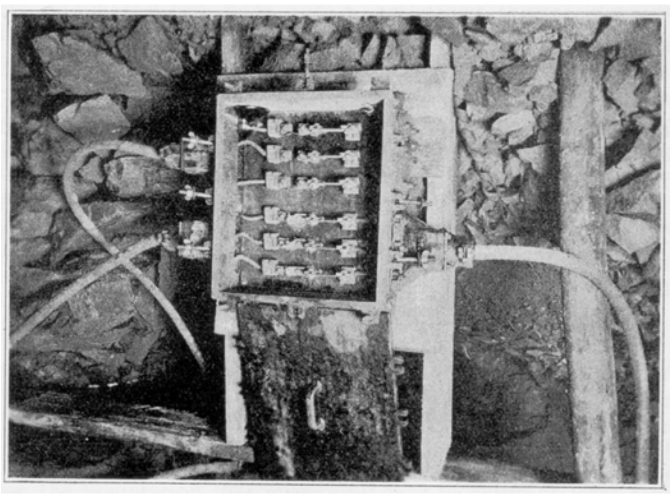

FIG. 35.—A 4-WAY PLUG BOX FOR 440 VOLT—A.C.

With D.C. the common practice is to have either a direct connection between the cables going up the raises and the trolley line, or a main level cable connected at frequent intervals to the trolley, with a connection to this cable at the foot of the raise. A No. 6 Tirex double-braid wire is commonly used up the raise; Duplex No. 8 is also used for this purpose. The distributing wires in the subs run from No. 8 to No. n; No. 11 is more flexible, more heavily insulated, and easier to splice than the others. Two types of cable can be furnished for D.C. current in all these sizes-—concentric and double braid. The former prevents leakages and grounding since the negative wire is the outer circle, but this type is difficult to splice. Regardless of the good insulating qualities of these cables, they should be kept away from all pipe lines. In going through ladderways with cables and pipe lines in them, the writer often experienced quite severe shocks due to grounding of these cables.

When a trolley line is used as a transmission medium for scraper power, and when the locomotives are overloaded, delays are frequent because current breakers shut off the power. As a result all the scrapers in the locality supplied by the cut-off circuit are without power. It is a question now in some mines whether an individual wire along the drift from the generator to the scraping area might not be cheaper.

CHAPTER VII.

OPERATING DATA.

The facts presented in the following discussion do not pertain to any one method of mining, but are quite general. If an attempt were made to list all qualifying factors, the resulting article would be an encyclopedic description of mining methods. No such complete treatise is intended.

Organization—The ideal organization of mine labor, as well as of labor in any other enterprise, is found when each man has a special kind of work to perform. This ideal is hard to approach underground where the cycle of work is not variable, and is limited by time, where distances between operations are great and access to them is inconvenient. Shaft sinking crews and drift gangs have more or less specialized labor; however, even there the space and nature of the work does not permit it to be entirely specialized. In stopes or slices where timbering has to be done soon after an excavation is made, waiting for a special timbering crew delays the start of a new cut, and makes it necessary that the miners do the timbering. Concentrating a number of gangs into a smaller area has proved beneficial. This admits of specializing in some phases of the work. One or two men are employed whose duty it is to assist in timbering and running of scraper hoists. Where ventilating fans and tubes have been installed, blasting at any time of the day is possible. This breaks the phase in cycles of work between different working places and admits of specialized gangs of men doing the same kind of work in a number of places, which are near each other. The use of scrapers has equalized the three principal items of a cycle of work in a slice.

In the soft ore mines these items with approximate time of performing them are: drilling, 1½ to 2½ hours, depending on hardness, etc.; scraping and cleaning, 1½ to 2½ hours: timbering, ½ to 2 hours. From the above, it can be readily seen that as far as time interval is concerned three places could be worked with more or less specialized labor. In mines where the ore is very soft, drilling time is still small compared to that involved in the handling of the ore with scrapers. Shorter hauls with large capacity scrapers have helped this situation at one such mine; a sketch and further discussion of this condition is given later.

Examples of various methods of organization are given as follows:

Two men per gang is the most common arrangement, and it is expected that they will complete at least one cycyle of work in one cut.

Under ordinary conditions, and when the chance is good they can complete two cycles of work except for the timbering. In one mine a gang of three men was used, one operating the scraper hoist, and two working at the breast. Usually one man only is employed at the breast, but this mine used two as a safety measure. The advance was one cut a shift, a distance of 4 feet. In another mine experience proved that one gang in one place was more efficient than two gangs in the same place on opposite shifts. The production by the former method was 23 tons per man, and by the latter 18 tons. A spirit of rivalry was encouraged there by having two gangs on opposite sides of the drift. These gangs also help each other in erecting timber sets. Two working places for one gang has also been tried and has been found to be efficient when there is a lack of men. (See Fig. 41-D). Under this plan one man performs the scraping while the other man drills the cut in another slice. A three-man gang would be more effiicent under such circumstances than a two-man gang. A saving in hoist equipment is effected at one mine where the same hoist scrapes from opposite sides of the raise. The hoist is located between two openings to the same raise. Two scrapers are needed; one in each slice.

An advantageous method for varying the cycle of work is illustrated in Fig. 41-D. Untimbered 5 ft. by 7 ft. dog-drifts are driven at 60-ft. intervals to the foot and hanging walls. Slices are then carried radially from these dog-drifts. The slices are timbered with 10-ft. legs and 8-ft. caps and reach to within 2 ft. of the gob above. It is planned to work two places with one gang of two men. One man will run the scraper while the other drills a cut in another slice.

Results—A listing of the results obtained in various places is of doubtful value, without a complete explanation of the existing conditions; however, the following facts are given for what they may be worth.

A Scraping Record in a Good Place—Method used, sub-caving; a 7 by 9 slice advancing; dirt fine but sticky; a turbinair hoist used with a 30-in. box scraper, capacity, 3T4 cu. ft.; length of haul, 30 ft.

22 trips, 22 full scrapers, time	9′-90″
Picking dirt into scraper trough	2′-30″
11 trips, 11 full scrapers	5′-00″
1/3 of total pile from one cut handled in	17′-00″

In a similar place a record was kept of the average size of the load which a scraper will handle. Five hundred observations were made, and the conclusion was reached that the average load was only 80 per cent of the rated capacity of the scraper.

The fallowing record which is unusual for the quick handling of a large volume of ore, is an instance of conditions favorable for an air hoist. The dirt was fine and dry without much lump, and the temperature at the hoist was about 100 deg. F. The unusual amount of ore handled was due to the sub-caving method and to the fact that the place was so situated that several thicknesses of slice could be caved.

The equipment used was a 6½-h.p. air hoist and a 30-in. box-type scraper. In an 8-hour day a total of 118 3.5-ton cars of ore were scraped into a raise 40 ft. distant from the source of supply. In other words one car was filled every 4 min. and 22 sec, in spite of all delays, giving an average rope speed for the 8 hrs. of 266 ft. per minute. This rate is higher than average which is about 230 ft. per min. under normal conditions.

The performance of a 6-h.p. air hoist with a 30-in. box-type scraper in soft, friable, fine ore after a blast in a sub-slice is given as follows:

The length of haul was 60 ft. and the total number of trips was 102. The average rope speed was 112 ft. per min. including all delays. The total time for the 102 trips was 2 hrs. 36 min. Of this time 48 min. and 5 sec. were used in items other than scraping, and are accounted for as follows:

Nearby blasting	3′-10″
No air	10′-15″
Pipe man	1′-00″
Rope caught	1′-00″
Rope caught	0′-40″
Rope caught	1′-14″
Picking breast	6′-50″
Blasting	7′-00″
Picking	4′-40″
Shovelling side dirt to scraper trough	9′-45″
Handling timber	3′-10″
Miscellaneous	9′-21″
Total delay	48′-05″

The average time in the last 77 trips for items listed below is:

Return trip	18′- 8″	Av. per min.........189.5′
Loading	6′- 2″	
Hauling	36. 0″	Av. per min.........100′
Dumping	2.28″	
	Av. round trip, 144.7′ per min.	

It is well to note that although none of the delays amount to very much individually, the total is 30 per cent of the scraping time.

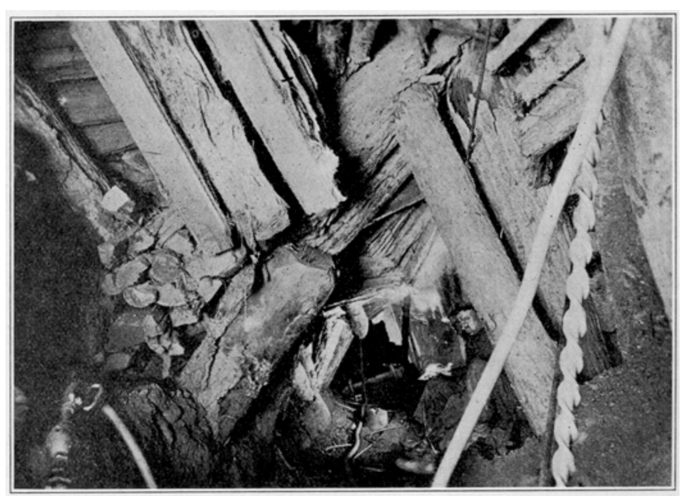

FIG. 36—DIFFICULT CONDITIONS FOR SCRAPING.

Openings for Scrapers—In the soft ore mines no striking changes in shape, size of timbering sub-level drifts, crosscuts, or slices have been effected for adapting them to scrapers. The retention of the old style of drifts is not needed for scrapers, but because they can be used satisfactorily under the new method they have not been changed. Scrapers do not need the rectangular shape of X-section of the opening in which they are to perform. Rectangular shapes of openings were necessary when small cars or buggies were used. Although the question arises as to what shape of opening can be most economically supported it does not need to be the same for all mines, since conditions vary from mine to mine, depending upon the characteristics of the ore. The method of mining used may require openings of a certain shape, but it is possible that the shape may influence the details of the method. It may also be quite possible that cheaper methods of supporting drifts, better adapted to the use of scrapers, can be developed. The question arises as to what size of drift can be carried most economically; however, the use of smaller openings need not be condemned. The order of spacing of the smaller openings, the caving of ore into them, the rapidity with which they can be carried and their economical use of timber may offset an increase in cost per foot of development. An example of conditions under which a scraper can still function, with a good factor of safety, is illustrated in Fig. 36. Car or buggy haulage would be quite difficult under the circumstances and would necessitate frequent retimbering. The shape of the opening, thru which scraping is still effected, may suggest a shape of opening and a style of timbering which would be suitable for a sub-caving method of mining.

In mines where excavations stand open well, the openings may be made quite large and different arrangements of scraping machinery can be used; the costs may then be reduced thru the more speedy handling of larger quantities of broken ore and more efficient cycles of work may be introduced. Slicing with 8-ft. legs and 8-ft. caps is practiced now in one of our mines where the characteristics of the ore are similar to those given above.

SCRAPER LOADERS.

The problem of loading ore or rock in drifts and crosscuts brings up the question as to whether shovel loaders are more economical than scraper loaders. The latter method is more common in the iron mines of the Upper Peninsula. The writer visited 18 mines where this type of work was being performed and found three in which shovel loaders were used.

The size of the entry being carried bears an important influence on the economical use of shovel loaders. Small sized openings adapt themselves to the use of scraper loaders better than to shovel loaders. Most scrapers are operated by electrical power, and hence the introduction of a few shovel loaders, necessarily operating' by air, is not economical. The air consumption of a shovel loader is four times as much as that of a scraper loader hoist doing the same work. Since the hoists and scrapers which are used in the stopes will also serve on a scraper loader, flexibility in the use of such equipment is an argument against buying the much more expensive shovel loader, especially where development work is more or less intermittent.

Before proceeding with the discussion on scraper loaders, an instance in which the mining captain had a decided preference for the other type of loader will be cited. It is the writer's opinion, however, that in this case close supervision and excellent organization of work had more to do with the good results obtained than the loader itself.

The entry carried was an 11 x 11 drift through jasper. Two eight hours shifts per day with three miners on each shift and three men on the shovel, one runner and two helpers, carried the drift 381 feet in 7½ actual working days. During the last three days the advance was 72 ft. A scraper which was claimed to handle dirt only one-half as fast as did the shovel loader was tried; neither the length of the trial nor the means used to insure the best possible performance were given. Some of the facts claimed for the loader were that it filled a 2-ton car in 1½ minutes; that in loading 11 cars it had to move three times, and that the total time consumed was 22 minutes. Further the loader could be moved to new positions in 30 seconds, and it could he overhauled thoroughly in 2 days after it had been nine months underground without major repairs. For each step of advance about fifteen holes were drilled, four in the top row, three in the row below, and four each in the two lower rows. After the blasting, the pile of broken rock at the breast was such that it was possible by means of short posts to set up two drilling machines on this dirt. The four upper holes could then be drilled and sometimes the three below them, before enough dirt would be removed to disturb the support of the machines. This arrangement is not often practiced with scrapers because the head sheave interferes with the drillers; however, the writer did see one instance of its use in a rock drift 7 by 9 in dimension. The blasting was done in such a manner that enough dirt was thrown far enough away from the breast to make it worth while to use two set-ups of the bar which holds the head sheave. This bar, usually a long machine post, was placed across the drift about 6 feet from the face. It was possible to set up short posts on the pile of broken rock and to drill two rows of upper holes before the head sheave had to be moved.

At another mine a 9 by 14 crosscut was carried through quartzite and iron formation. A shovel loader was used there, and with it the advance was about 100 ft. a week. A change was made to scraper loading and the advance was doubled. The following notes may save reference to the more lengthy articles recently published about this record advance.

Crosscut advanced 771 ft. in 29 days; 20 ft. ore, 470 ft. quartzite slate, 140 ft. massive quartzite and 141 ft. iron formation.

Organization—One general foreman, 1 foreman each shift, 6 drills each shift, 3 machines each shift, 1 laborer day shift, trackman, electrician and pipeman intermittently.

Routine of Work—Six drillers start at 7 a. m., blast at 10 a. m.; muckers come to work at 10 a. m. and clean up about 12 a. m.; 6 drillers return at 12 a. m., blast at 3 p. m.; the drillers are through at 3:00 p. m. and the muckers clean up and finish work at 6 p. m. New shift, 4 rounds in 24 hours.

Details of Mucking—In mucking a 6½-h.p. double-drum hoist mounted on an Osana Loader was used. (See Fig. 37). It had a 36-in. arrowhead box-type scraper. The head sheave was mounted on a horizontal cross bar which had to be tightened five or six times during the mucking. It handled about 55 cu. ft.—15 cars in 1 hour and 10 minutes to 2 hours and 45 minutes. Two drillers cleaned the back and mounted the bar in 15 to 25 minutes. In the meanwhile two muckers cleaned up the fly-dirt to the side of track and the motorman brought in a car and loader. No attempt was made in this cycle of work to drill upper holes off the top of the dirt pile.

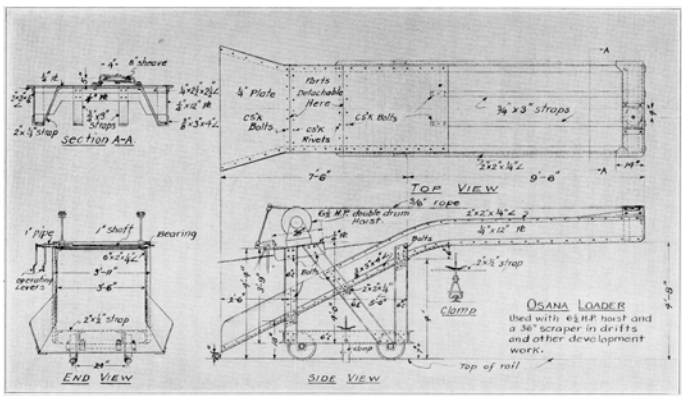

FIG. 37.

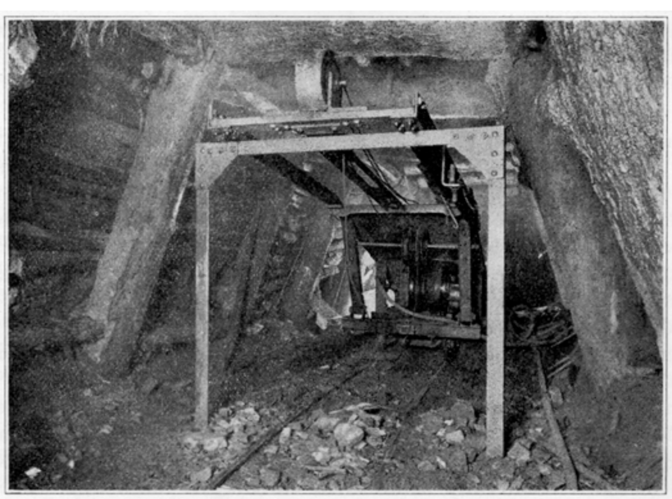

FIG. 38—SCRAPER SLIDE, MOTOR AND HOIST UNDER SLIDE.

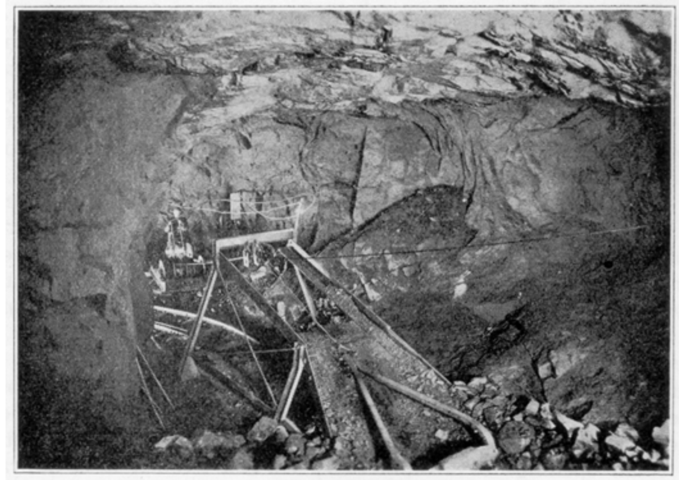

FIG. 39—SCRAPER SLIDE, HOIST SEPARATE FROM SLIDE.

Three types of scraper loaders were shown in Figs. 37, 38 and 39. The only point in which they differ materially is that of method of mounting the hoist. In the Osana Loader the hoist is mounted on an inclined table above the slide. The fact that the table is inclined should be noted, for horizontal supports were tried and found to be less satisfactory. The method of attaching head sheave in an inclined position to give clearance in low places should also be noted. In Fig. 38 the hoist is located below the slide; the main and tail ropes clear the car with the aid of two deflecting pulleys, and are protected from dirt by a channel iron leading up to the head pulley. Fig. 37 shows a loader with the hoist separate from the loading slide and platform. This type of loader is used with hard heavy ore where both scraper and hoist are heavy. The advantage offered is that in wide stopes the slide can be shifted laterally without the shifting of the heavy hoist.

SCRAPING AROUND CORNERS.

No satisfactory method has yet been devised for scraping without a snatch block around corners of over 45 deg. There are bound to be many occasions when such flexibility would be desirable and when a new arrangement of work, requiring fewer raises and resulting in lower development costs, would be possible. A continuous haul method illustrated in Fig. 40-A was tried at one of the mines, but it has been discontinued. It may suggest more improved devices, which may be practical. In the use of a snatch block, the time consumed in taking out a cut is about 3½ hours; while in straight scraping the same work can be done in ⅔ of an hour. This great difference in time does not permit angle scraping except in special cases.

Numerous methods are used in taking care of the slight bends in a slice. The most common practice is to have a number of holes both front and back connections at both sides of the center line of the scraper, to which the pull and tail ropes can be easily switched. An off center pull will guide the scraper around small curves. Another scheme is to nail a plank to the posts near the floor on the curve side of the drift. This arrangement does not permit very sharp curves, for, although the scraper may get around the curves the ropes are abraided or cut the timber. The scheme shown in Fig. 42 is an interesting one, even if it is not practical in small openings or around sharp curves. When it is desirable to swing the scraper around the pillar, the operator at the hoist by tightening up on the tail rope causes the deflection pulley to move with the tail rope away from the pillar and thus to move the scraper. It might he possible to adapt this device to more confined spaces such as are found in slicing. A deflection pulley might ride a separate rope or trolley up to the point of curve, and then at that point the connection of the deflection pulley to the rear of the scraper might be broken.

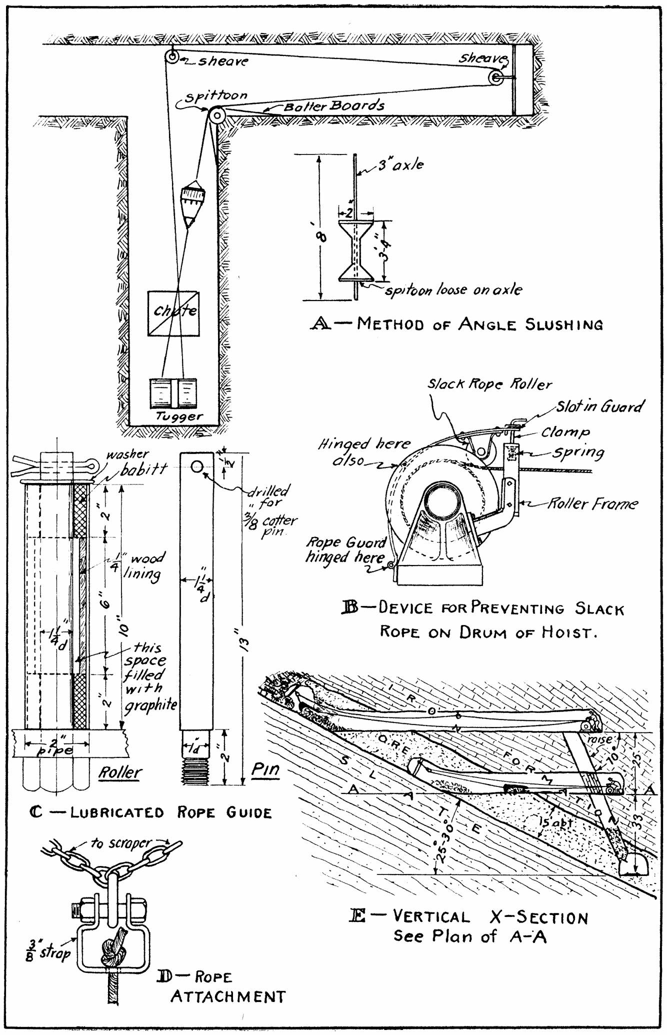

Fig. 40.

Scraper Slides—It is a common practice to use something on the floor of a slice for the purpose of making the load slide more easily—1 to 1½-in. green hardwood being almost universally used for the lighter scrapers in wet ore. When the ore is fine and dry the packing of ore beneath the scraper and load provides a good runway. In the use of hardwood planks several layers are obtained by overlapping ½ of each length; where the ore is sticky and the load is heavy, ⅔ of each length is overlapped giving thickness of 3 planks.

Rails spaced 6 to 8-in. apart with a plank set between the webs, are used for the larger scrapers. These rails are usually 15 lbs. per yard, but in one instance noted 30 lb. rails were used. With some large scrapers it is necessary to use a slide on slopes as low as 5 to 10 deg.

At one of the mines a slide in a main level scraping drift was made of three parallel rails set about 2 ft. apart and fastened to ties which were spaced about 3 feet apart. It made an excellent bottom for the heavy scrapers which were used.

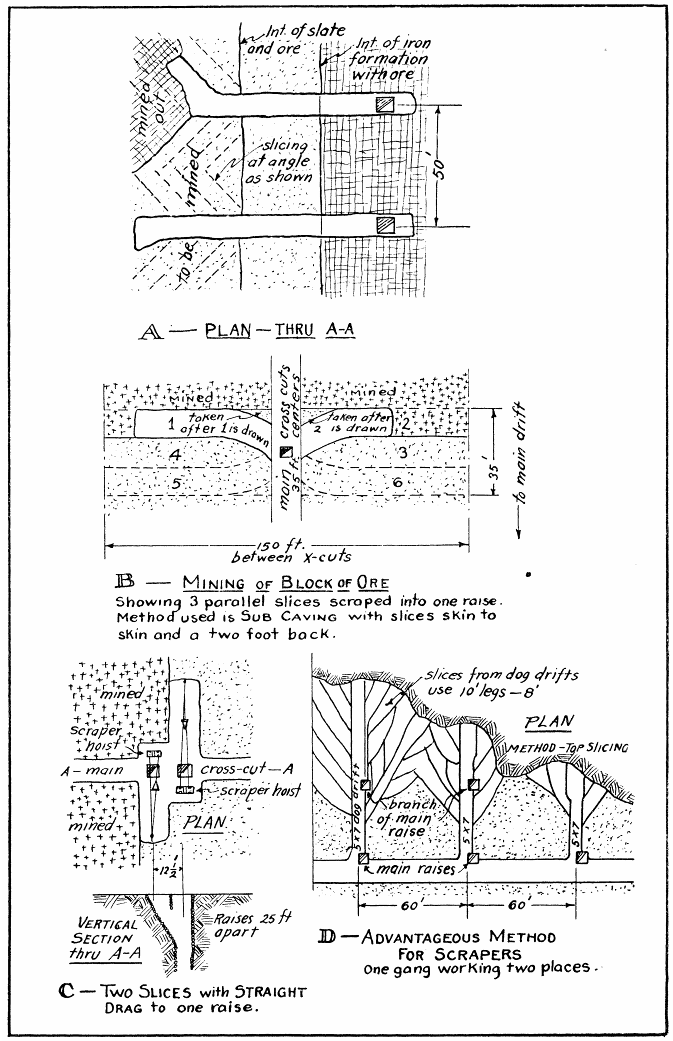

Fig. 41.

CHAPTER VIII.

Scraping and Methods of Mining.

The scraping of broken ore has reduced not only the mining costs of handling ore hut other costs as well, especially that of timber used. It will not be necessary to show figures to prove this, for it can readily be understood that faster removal of ore results in less replacement of timber. In one of the mines parts of a slice had to be timbered at least three times before all of the ore was obtained from it. Under present methods of quick handling of ore very little retimbering is done there.

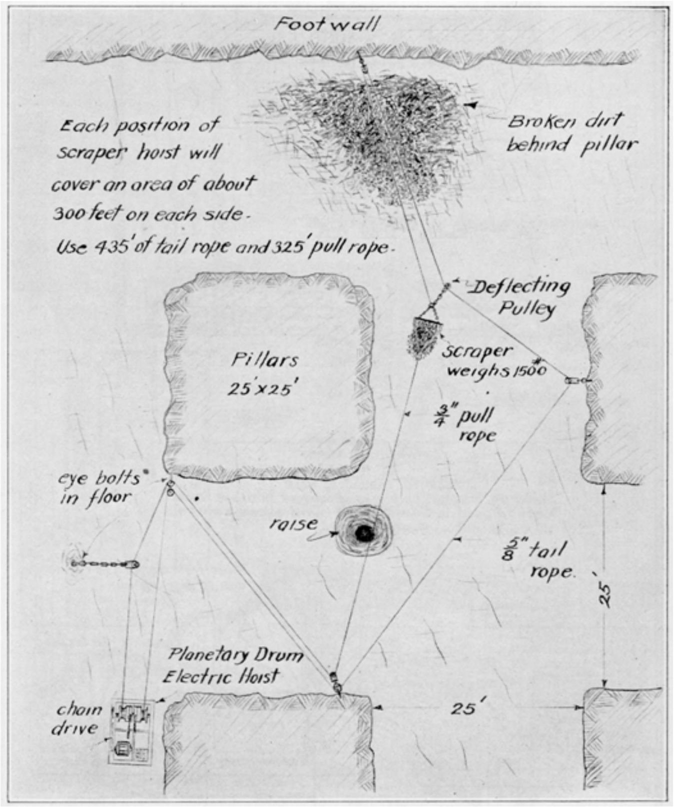

FIG. 42—DIAGRAM OF SCRAPER LAYOUT IN A HARD ORE MINE—ROOM AND PILLAR METHOD OF MINING.

A description of applications of scraping to Methods of Mining would cover more territory than is intended by this paper. Only those methods which differ materially from the more common ones will be treated.

When scraping was first introduced it was natural to try to adapt it to schemes of development existing at that time. Raises were then spaced and branched so that they occurred at the corners of rectangular blocks on the working sub. In trying to use scrapers to suit the location of such raises, "Radial Slicing" was developed. No attempt will be made to describe this method, since it has been frequently written up in mining publications. Every square foot of area must be timbered at least once and often three or four times in "Radial Slicing." It is still quite common where top slicing methods of mining are used, since the amount of timber required for both methods does not differ materially; however, it is being rapidly replaced by straight slicing in the Top Slicing mines.

Development—The present trend of development work is to have as few raises as possible with more lateral movement of ore by scrapers in parallel slices. Some of these methods will be discussed later in detail.

To make straight hauls possible in the scraping ore, it is necessary to have raises or openings into them, located opposite each slice. (See Fig. 41-C). Because such an arrangement introduces expensive raise work, one mine is trying the scheme of spacing raises opposite every third slice. (See Fig. 41-B). The slices are still parallel except for a slight curve in every second slice.

Economy of Short Hauls—The most economical length of scraper haul in slicing is a question difficult to decide. The width of the ore body, angle of slope of hanging footwall, kind of equipment available are some influencing factors in deciding how long the haul of the scrapers shall be. Experience has proven, however, that when the block of ore to be mined is large and uniform enough to systematic spacing of raises, drifts, and crosscuts, short hauls are most efficient. In one mine it has been demonstrated that in using small scrapers with 30-foot hauls, a block of ore can be mined 25 per cent faster than a similar block laid out for 40-50 ft. hauls.

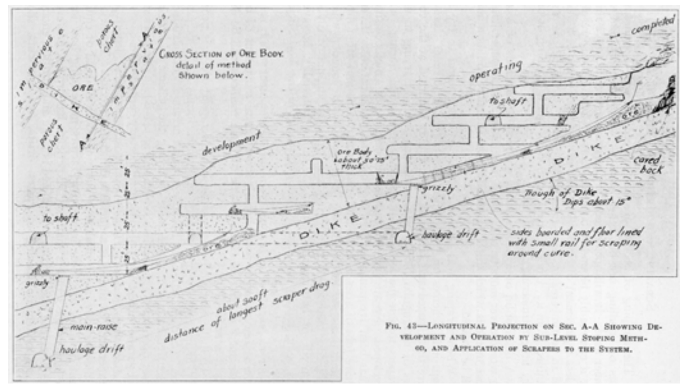

FIG. 43—LONGITUDINAL PROJECTION ON SEC. A-A SHOWING DEVELOPMENT AND OPERATION BY SUB-LEVEL STOPING METHOD, AND APPLICATION OF SCRAPERS TO THE SYSTEM.

Tabular Deposits and Long Scraper Hauls—Perhaps the greatest benefit derived from the use of scrapers goes to the tabular deposits of ore dipping at small angles. Narrow and flat fringes of a massive deposit lying on footwalls and dikes with a dip of from 5 to 30 deg. can be most economically handled with scrapers. These types of deposits would require a great deal of rock development if the broken ore had to be handled into raises at frequent intervals. This was necessary with the use of buggies. Scrapers can be utilized to haul down the slopes as well as on the horizontal, and as a result some of the hauls are about 300 ft. long.

Figs. 40-E and 41-A illustrate an ore body 15 ft. long and dipping about 25 to 30 deg, from the horizontal. Although considerable rock development is shown, the vertical cross-section and the plan Fig. 41-A show that raises are 50 ft. apart. The lineal rock development is about 120 ft. for approximately 8.000 tons of ore. The 50-ft. spacing of raises is made possible by using angle slicing. The dip of the footwall is of material help in getting the scrapers and its load around the slight curves.

A detailed description of the method represented on Fig. 43 is not necessary, since a paper about it has already been published. It will be sufficient to say that the ore body mined is considerably thicker than that discussed in the previous method, and that because of greater distances of haulage much heavier equipment is used. The hoists are 25-h.p. and the scrapers of the 60-in. box-type, 14 cu. ft. capacity.

Storage Drifts and Trenches—The most recent and perhaps the greatest improvement in underground ore-handling methods at the soft ore mines is the use of either storage drifts or trenches. An entirely different cycle of main level ore handling operations is possible. With the old method a peak in production is reached about the middle of the forenoon and again in the middle of the afternoon. The number of locomotives, motormen, and trammers depends upon the peak production. These men are working a total of 6 hours only; but during that time they are going at high speed. When it is possible to have a place of storage to even up the supply of ore to the chutes and cars, less tramming equipment and fewer men will be needed. Expensive storage pockets at the shaft would not be required, since an even flow from the stopes would be possible.

At the present time there are three separate ways of applying storage space to the method of mining. All of these three were applicable to either sub-caving or top-slicing methods.

First Method—Storage scraping drifts on main haulage levels.

Second Method-—Storage scraping drifts on sub-levels.

Third Method—Storage scraping trenches one set below the working sub.

The methods have been listed in the order in which they were introduced into the iron mines of the Lake Superior district. They are all of too recent date to be compared as to relative merits under different conditions of ore; however, they have been a decided improvement on the former installations at their places of use. A brief discussion of each method will follow, although the illustrations are quite explanatory.

Main Level Storage (See Fig. 44)—One of the differences of this method from the other two is that no chutes are used. The ore is allowed to drop directly on the floor of the main level drift. The broken ore in this mine packs when it is allowed to drop into a chute at the bottom of a raise. For this reason it was not practicable to use the raises for purposes of storage. The result was that scraping of ore in the sub-levels was delayed until such raises were opened and cleaned. This also caused delays in loading cars on the main level. When the new scheme was installed the tons-per-man in handling ore was about tripled and the tramming expense cut in two.

The scraping equipment in the subs consists of 6½-h.p. double-drum hoist and 30-in. box-type scrapers. Three parallel slices are scraped into one raise. Note drawing for spacing of all development work. In the main level storage drifts 25-h.p. double-drum hoists are used with 42-in. box-type scrapers. The floor of the main level scraping drift has 3 parallel rails, 2 ft. apart to form a good scraper runway. Wooden loading platforms are constructed and spaced as shown.

With this arrangement two men can handle 48 2-ton cars in 3½ hours. This includes the trips to the shaft, the average time of each trip being about seven minutes; however, this time is utilized by the hoist operator in scraping a pile of dirt to the slide ready for quick filling of cars on their return.

Sub-Level Storage (See Fig. 45)—The method of storage scraping drifts in sub-levels, together with the spacing of development work as shown in Fig. 45, is designed to do two things. First, to facilitate tramming by having storage space to cut out the peak-production period, and second, to concentrate operating areas in the sub-levels.

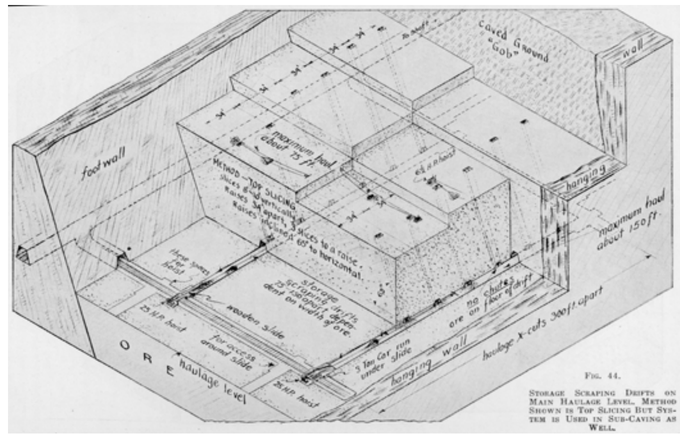

Fig. 44.

Storage Scraping Drifts on Main Haulage Level. Method Shown is Top Slicing But System is Used in Sub-Caving as Well.

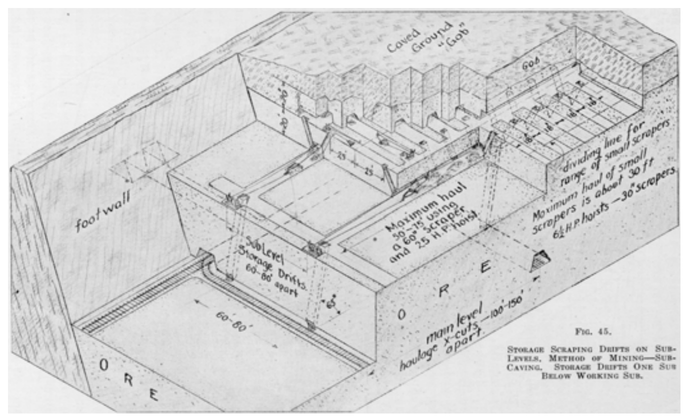

Fig. 45.

Storage Scraping Drifts on Sub-Levels, Method of Mining—Sub-Caving. Storage Drifts One Sub Below Working Sub.

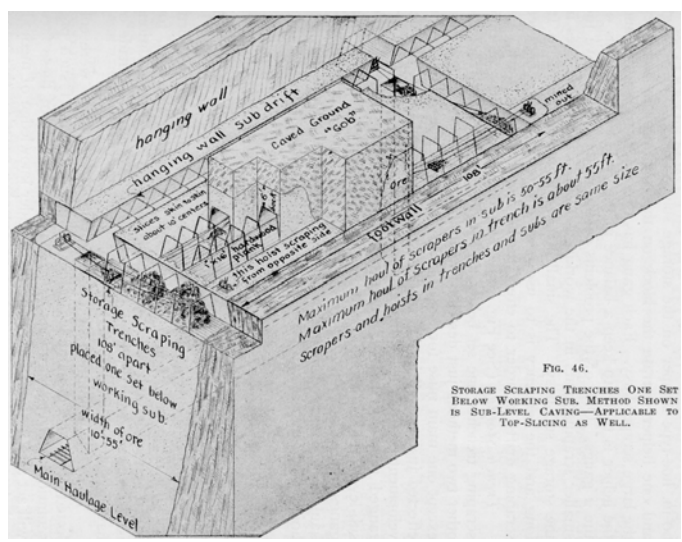

Fig. 46.

Storage Scraping Trenches One Set Below Working Sub. Method Shown is Sub-Level Caving—Applicable to Top-Slicing as Well.

An important difference between this method and the main level storage drift plan is that fewer high raises are required to be developed from the haulage level and therefore less immediate outlay of capital for this purpose and less expense for maintenance. Raises are used; but they are short, are developed only when actually needed, and have a short period of life.

Each block is served by one 25-h.p. double-drum hoist with a 60-in. hoe-type scraper on the storage sub. Two two-men gangs and one helper operate the block on the working sub and keep the large scraper busy. Each gang has two places to work in and the helper is there to keep a balance in the cycle of operations of the 2 gangs. One of the problems of the method is to have the smaller scraping units in the working sub keep the larger ones in the storage sub busy. The small scraper hauls are about 30 ft. long and the tendency is to use even shorter distances between scraping drifts in order to effect further concentration work.

Trench Storage (See Fig. 46)—The method of having storage scraping trenches one set below the working sub differs from the other two methods just described mainly in that no raises are used except one main raise for each block. The function of storage is effected just as well in this method as in the other two. The development of main level drifts, crosscuts, and raises can be so arranged that any desired concentration of working areas in the sub-levels can be done. Each block is worked by two two-men gangs pulling ore into the trench from both sides. The length of hauls is so arranged in the trench and sub that the same sizes of hoists and scrapers can be used in both kinds of places.

CONCLUSION.

Further conclusions or suggestions other than have already been presented under the foregoing topics will not be made. It is hoped that such opinions and suggestions as have been set forth will not be looked upon as a reflection on existing practices, for it can be readily understood that a specific knowledge of conditions is necessary before criticism is warranted. No claim is made of having that specific knowledge.

The facts submitted for consideration in this paper were collected from the most active mines of the district. If such presentations and classifications which have been made of these facts will act as a medium for furthering a wider knowledge of methods and details in the many phases of scraping practice, this paper will have served its purpose.

NOTES ON SOME OF THE IRON MINES OF RUSSIA.

BY LUCIEN EATON, ISHPEMING, MICH.*

During the winter and early spring of 1928 I had the opportunity to spend three months in Russia on engineering work for Stuart, James & Cooke, of New York, consulting engineers of the "Southern Ore Trust," which operates iron mines in the Krivoi Rog District in the Republic of Ukrainia. As comparatively little in regard to these mines has been written in the English language and as the mines are of great economic importance, some of the information that I gathered on my trip may be of interest to the members of the Lake Superior Mining Institute.

The known iron ore deposits of Russia are widely separated and vary greatly in richness. In the Ural Mountains there are scattered deposits of magnetite and hematite, the largest being at Alapaievsk, Perm and Viatka. The deposits at Perm and Viatka are low-grade siderite carrying only 22 per cent iron, but the other deposits average 45 to 65 per cent iron. In central Russia there are large deposits at Vladimir and Lipetsk carrying 40 to 52 per cent iron, and at Kertch in the Crimea there are very large deposits of low-grade ore carrying 40 to 42 per cent iron. These deposits are close to tide-water and are mined by steam-shovel. There is very little stripping. The high-grade ores are found in the Krivoi Rog District in Ukrainia, formerly South Russia, and at Daschkiessan in the Caucasus, but the latter is not commercially developed. The Krivoi Rog District is the only one that I visited, and I obtained the other information from hearsay and from Mr. Olin R. Kuhn's article on the "World's Iron Ore Resources," Engineering and Mining Journal, Vo. 122, No. 3, p. 87, July 17th, 1926, and from Eckels' "Iron Ores."

The Krivoi Rog District is situated in southern Ukrainia about 100 miles north of the Black Sea, at approximately 48 deg. N., Lat. 33 deg. E. Long. The formation occurs as a relatively narrow belt of iron-bearing rocks extending nearly north and south for a distance of some 70 miles. The active mines, however, are confined to a length of sixteen miles. The country is a rolling, treeless plain, 200 to 300 feet above sea-level, much like our western prairies, which is cut in rather deep gorges by the Saksagan River and its tributaries. It was in these gorges that the ore was discovered many years ago, but its existence was not generally known until about forty years ago, when exploration began. The mines were opened by foreign capital, mostly Belgian and French.

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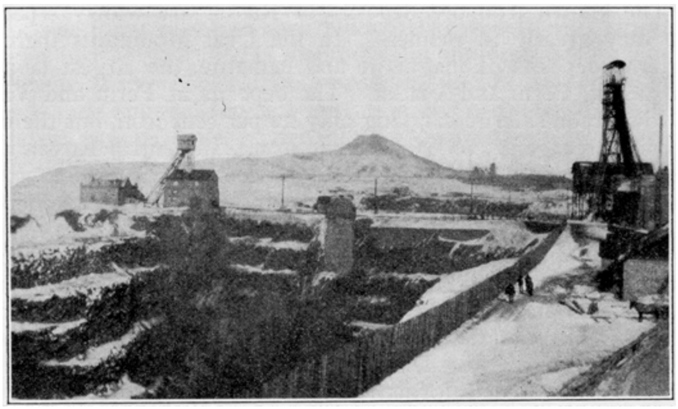
The strata in the central part of the district strike approximately N. 25 deg. E., and dip 45 to 55 deg. to the northwest. There are three ore-bearing formations, as follows:

1. The most eastern ore-bearing stratum is called the "First Saksagan Layer." It is of minor importance, but carries some ore bodies of commercial value, which are, however, not particularly high grade.

2. The next ore-bearing stratum is the "Second Saksagan Layer," and is approximately 825 feet west of the First Saksagan Layer and nearly parallel with it. In this layer the principal ore bodies occur as lenticular masses in jaspilite (locally called iron-quartzite). Some of the ore bodies are of large size.

3. The third iron-bearing stratum lies about 3,000 feet west of the Second Saksagan Layer. It is narrow, but contains commercial ore bodies which are being explored at the present time. It is called the "Gleyevatski Layer."



DOOBOVAYA BALKA MINE—"OCTOBER REVOLUTION" MINE IN DISTANCE

An attempt has been made to account for the three ore-bearing strata as the result of folding of one bed, but my observations did not lead me to believe that this hypothesis is correct.

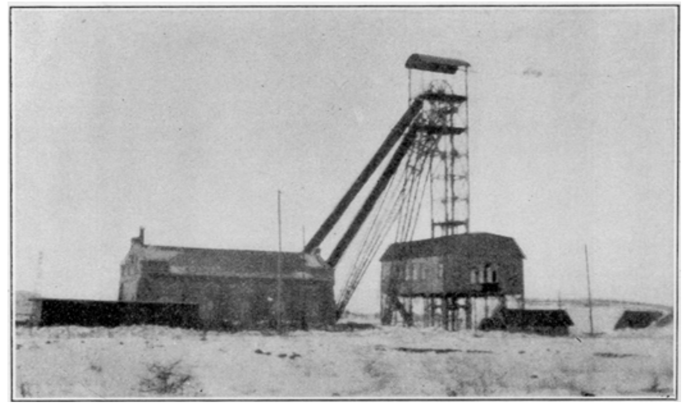
The ore is a high grade hematite, associated with small amounts of martite and magnetite, and varies in hardness from a dense specular ore to a soft, granular ore that breaks into dry small grains, when mined. The ore as mined has an analysis of 60 to 65 per cent iron, .010 to .040 per cent phosphorus dried, .060 per cent sulphur, and contains 3.5 to 5.3 per cent moisture in its natural state.

Underlying the jaspilite of the First Saksagan Layer are chlorite and talc slates, which are badly shattered and disintegrate quickly when exposed to the air.

Between the First and Second Saksagan Layers are aspic slates and unaltered jaspilites of medium hardness, which stand well when exposed to the air in small areas.

Between the Second Saksagan Layer and the Gleyevatski Layer are alternate strata of unaltered jaspilite, slate and paint-rock of varying thickness and various degrees of hardness.

The ore bodies show little change in character at the depth to which they have been mined, and the total area of the ore on successive levels remains practically constant. The width of the ore varies from a few feet up to 250 feet, and averages about 100 feet.



SOLAKRUN SHAFT

The mines were all originally opened as quarries or pits, which in some instances have been carried down to a depth of 350 feet. Some of the quarries are still working, but the amount of rock that has to be mined from the hanging-wall in many instances exceeds the amount of ore mined, and it will be only a short time before practically all the ore will be mined underground. Most of the mines are shallow, i.e., under 500 feet in depth, but one, the Doobovaya Balka mine, has followed the ore to a depth of over 1,000 feet without appreciable diminution in the size of the ore bodies or change in the quality of the ore.

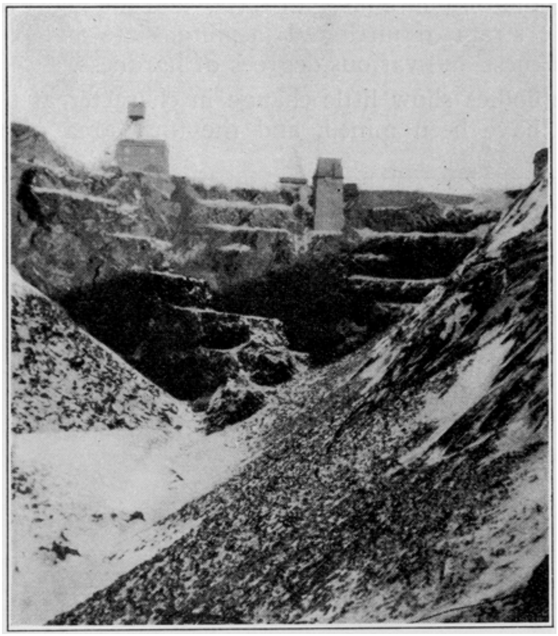
The only exploration in depth is a vertical diamond-drill hole put down in the hanging-wall. This hole passed through the usual hanging-wall strata in their proper sequence, and between 1,500 and 1,700 feet in depth cut two veins of ore, showing ore of the same size and character as on the upper levels. If the same conditions exist in depth in other parts of the district, the reserves of high-grade ore must be very large indeed.

As there is no timber in the vicinity of the mines, the mining methods most commonly used are variations of the room and pillar system with filling. The rooms are in most cases mined by horizontal cut and fill, but this is being changed to shrinkage stopes, where the ground will stand well enough. After the ore is removed the shrinkage stopes are filled with clay It is only recently that any serious attempts have been made to recover the pillars, using sub-level caving, and the difficulties of the work have not been entirely overcome as yet.

In the open pits the ore is hoisted in one-ton rocker-dump cars on inclined cages balanced by counter-weights. In the deeper mines the shafts are usually concrete lined, and are circular or oval in cross-section. The ore is hoisted on cages here also, except at the Karl Liebknecht mine, where there are two 2-ton skips. All tramming is done by hand or with horses.

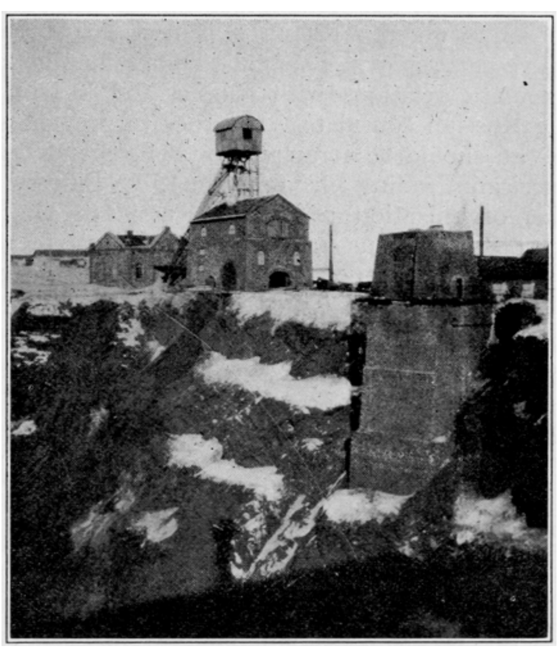
Electric power is used everywhere. It is generated at present at a central steam-plant at Vichernikoot, which will soon be replaced by a much larger steam-plant at

Ness, where 30,000 k.w. will be generated. Colonel Cooper is now building for the government a large dam at Duieperstroi on the Duieper River near Alexandrovsk, which will eventually furnish power for all the industries of southern Ukrainia.



SOUTH QUARRY—DOOBOVAYA BALKA MINE

Labor is comparatively cheap, and when properly trained and led, should become efficient. The working hours are short, seven hours, "collar to collar." In the underground mines production is less than one ton per man per day, but the government is trying to increase production by the introduction of modern machinery and mining methods, and with this thought in mind has employed American engineers as consultants and has sent delegations to this country to study our methods.



CENTRAL SHAFT—DOOBOVAYA BALKA MINE

All the mines belong to the government, and are operated vicariously by so-called "Trusts." The Krivoi Rog mines are operated by the Southern Ore Trust, or 'Yurt," as it is called, and by the Steel Trust, or "Yugostahl." In each trust and at each group of mines there is a manager, who is a member of the Communist party and is responsible to the central committee at Moscow. The technical staff work under his direction. A good deal of welfare work is done among the workmen, and at each property there is a representative of the Union, who has a voice in all matters pertaining to labor.

Most of the ore is smelted at the steel-works at Mariupol on the Sea of Azov, but some of the high-grade lump ore is shipped by rail to Poland and even to Germany.

On account of the enormous distances and the high cost of transportation it is unlikely that any of the Russian ores will ever come into competition with ore in this country. Indeed most of the Russian iron ores, except those of the highest grade, will be of value only to Russia for her own manufacture and consumption.

Some notes on travel in European Russia may be of interest. In order to go into Russia it is necessary to have a Russian visa on your passport. This must be obtained in some country having diplomatic relations with Russia, and is best obtained in Paris at the Russian consulate. In order to prevent exasperating-delays, the visa should be arranged for beforehand through "Amtorg" (American Trading Organization), 17 Battery Place, New York. This organization represents Russia in U. S. A. The visa will cost $11.00, plus probably $2.00, for telegrams, and is good for two weeks after crossing the border. After arrival in Russia, a special permit is issued, good for three months, which costs eleven roubles ($5.72), and, another outgoing visa is necessary before leaving. This will cost eleven roubles more, and usually takes a week to obtain.

The best train to take to go to Russia is the Paris to Moscow express, leaving Paris at 10 p. m., via Berlin and Warsaw, and arriving at Moscow on the forenoon of the third day. It is necessary to change cars and go through the customs at Niegoroloye on the Russian border, forty-eight hours after leaving Paris. Baggage can be sealed and bonded through from Paris to Niegoroloye, and from Niegoroloye to Moscow or Kharkov at some additional expense, but this entails a delay of one day at Moscow, as bonded baggage cannot go out on the day of arrival. Unless there is some special reason for bonding through from Niegoroloye it is better to go through the customs there. By paying the sleeping-car conductor a fee of 10 per cent of the sleeping-car ticket, he will look after your baggage at all the borders between Paris and Niegoroloye. The average cost for transporting trunks from Paris to Kharkov is twenty cents a pound.

There are dining-cars on the trains from Paris to Moscow, but not on all those from Moscow to Kharhov, and it is well to carry some food with you whenever traveling off the main lines. However, the service is improving steadily in this regard.

For travel on the main lines tickets should be purchased through a travel agency, "De Rutra" or Sovtorgflot, and on branch lines an interpreter is absolutely necessary. Usually the "Trust" for whom you are working will supply one interpreter for every three engineers in a party.

On the most important trains there are "International" cars, corresponding to our Pullman sleepers. They have compartments with two berths each and with one washroom between each two compartments. There is a small ventilator in the roof, but none in the door as in other European sleepers. As women and men have absolutely the same status in Russia, no distinction between the sexes is made in assigning space in the sleeping cars, and for this reason women should never travel alone.

On other trains there are "second class" cars, or "soft wagons." These have compartments in which four persons ride and sleep. Sheets, a blanket and a pillow can be obtained from the porter by paying a small fee. Sometimes one-half of a car will be first class, and the other half second class.

On the branch lines one must usually ride in a third class car or "hard wagon." It is not upholstered, and has three axles, one at each end and one in the middle. A car forty-two feet long has sleeping space for fifty-six people.

The hours of meals in Russia are quite hard to get accustomed to, but are very satisfactory after one is used to them. There is breakfast about nine, a light lunch at noon, though this may be omitted, dinner at four-thirty or five, and tea (chai) sometime between nine o'clock and midnight. Coffee is poor, expensive and usually not obtainable, but good tea can be obtained almost anywhere. It is served with lemon and sugar in tumblers, and it is customary to drink it at all meals. It is unsafe to drink unboiled water, and the tea is more palatable than boiled water. Eight glasses of tea a day is not an unusual ration. A bottled water sold under the name of Narzon is obtainable almost anywhere and is delicious. Personally I liked Russian food very much, but I fancy that anyone, who does not like tea or cabbage soup, would have a hard time.

Food and general living expenses in Russia are about as high as in the country districts of the United States, but service is much cheaper. The older houses are heated with porcelain stoves built out from the wall, about three feet square and extending up to the ceiling. The walls are about a foot thick and the fire-box a foot square, with the fire-door usually opening into the hall. When once thoroughly hot these stoves will stay warm all night, but they are unsatisfactory in cold weather. The new apartment houses are often heated by hot water or steam. Sanitary arrangements are usually primitive, except in the new buildings.

In many of the apartments and houses the servants' quarters are between the front door and the rooms occupied by the family. This is for convenience and privacy, and seems a logical arrangement for apartments having only one entrance, although quite contrary to western practice.

In the larger cities there are taxicabs (all touring cars), busses and street cars, but the main transportation unit is the "droschke" a one-horse sleigh or cart, in which the driver occupies the front seat and the passengers a very narrow seat behind. The fare to be paid must always be bargained for in advance and even then there is likely to be disagreement. Bargaining with droschke drivers is a recognized outdoor sport.

Except in the larger cities hotel accommodations are likely to be unsatisfactory, and special arrangements should be made beforehand, whenever possible. There is a noticeable improvement taking place in such facilities, especially in the towns along the more important lines of railway.

DEVELOPMENT OF UNDERGROUND ORE LOADING.

EARLY SLUSHER EXPERIMENTS.

BY E. W. R. BUTCHER, 1405 ALWORTH BLDG., DULUTH, MINN.*

Mechanical ore loading in the underground iron ore mines of the Lake Superior district is now the general practice where formerly ore was mucked by hand. The present almost universally used double-drum electric tugger hoist is the result of considerable years of trials and experiments with this and other types of loading machines. Both individuals and companies have spent large sums of money and a great deal of personal effort in this development work. Of the many other early types of machines which have been tried out only a few are now in use, and these only to a limited extent.

It is believed that the first attempt to use a small hoist and slushers in place of hand mucking in the Lake Superior iron ore mines was made by Mr. Nels Flodin, of Marquette, Michigan. Mention of Mr. Flodin's pioneer efforts is given on page 215 of the 1915 proceedings of the Lake Superior Mining Institute†, and also on pages 370 and 371 of the United States Bureau of Mines and Missouri School of Mines and Metallurgy, joint book on Mechanical Underground Loading in Metal Mines, published in 1924.

Mr. Flodin conceived the idea of using a slusher and small hoist in 1910 while on the Lake Superior Mining Institute trip which in that year was made on August 24th-26th, to Gary, Indiana. He, together with Captain William Bond, of the Newport mine, and Captain W. J. Trevarthan, of the McKinney Steel Company, were standing on a sight-seeing flat car, and the latter two were criticising the lack of effort to improve mechanical conditions underground while so much attention was given to the mine surface equipment. While this conversation was going on, Mr. Flodin noticed a man near the car moving dirt with a horse and slusher. He turned to Mr. Joseph P. Hodgson, who was then at the Mary Charlotte mine and is now with the Phelps Dodge Company at Arizona, and said: "Why not handle the ore underground in the same way but use a small hoist instead of the horse." Mr. Hodgson answered, "By gosh, Flodin, you have got it." He told Mr. Flodin to get a patent at once and that he would stand all the expense for it, which he later did. On his return home from the Institute trip, Mr. Flodin constructed a small model similar to the patent drawing shown herewith. He showed this to some mechanical engineers, but they condemned it as being too simple and working on the wrong principle. They said it should not work backwards like a crab walks, but should push the ore ahead similar to the manner of the steam shovel operation.

*Mining Engineer, Republic Iron & Steel Co.

†"Progress in Underground Ore Loading," by M. E. Richards.

In spite of criticism, a patent was applied for and filed October 28, 1910, Serial No. 589,643, and was issued May 14, 1912. The patent, which is number 1,026,502, was given jointly to Mr. Flodin and Mr. Hodgson. After the patent was received the Lake Shore Engine Works, of Marquette, undertook to place the machine on the market and succeeded in obtaining an order for one machine. On account of the large amount of adverse discussion and criticism about it, actual construction was never commenced. An examination and study of the patent drawing and specification shows that Mr. Flodin's ideas on mechanical loading included many features which are in use today, including a scraper for transporting the ore, small hoist for pulling the scraper, the placing of the hoist, or tugger, on a separate truck and the use of the incline for pulling the ore into the top of the cars.

Although Mr. Flodin's ideas as set forth in the patent specifications may not have been responsible for similar ideas since adopted in the mechanical handling of ore underground, he should at least be given credit for conceiving the practicability of their use and attempting to have them adopted. In addition to his pioneer work with the slusher, Mr. Flodin, through his connection with the Lake Shore Engine Works, was also instrumental in making several improvements in the parts of diamond drill machines which greatly reduced the cost of diamond and churn drilling. It was also partly due to his efforts that the first cradle dump cars and roller bearings on mine cars were adopted.

ESTIMATED IRON ORE OUTPUT IN THE UNITED STATES FOR 1928.

The iron ore mined in the United States in 1928, exclusive of ore that contained 5 per cent or more of manganese in the natural state, is estimated by the United States Bureau of Mines at 62,151,000 gross tons, an increase of nearly 1 per cent as compared with that mined in 1927. The ore shipped from the mines in 1928 is estimated at 63,244,000 gross tons, valued at $154,491,000, an increase of 3 per cent in quantity and of 2 per cent in total value as compared with the figures for 1927. The average value of the ore per gross ton at the mines in 1928 is estimated at $2.44; in 1927 it was $2.47. The stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently decreased from 10,104,673 gross tons in 1927 to 9,266,000 tons in 1928, or 8 per cent.

The Bureau of Mines estimates are based on preliminary figures furnished by producers who in 1927 mined about 99 per cent of the total iron ore. They show the totals for the principal iron ore producing states and, by grouping together certain states, the totals for the Lake Superior district and for groups of southeastern, northeastern and western states.

LAKE SUPERIOR DISTRICT.

About 85 per cent of the iron ore shipped in 1928 came from the Lake Superior district, in which approximately 52,467,000 gross tons was mined and 53,610,000 tons was shipped, increases of 2 and 5 per cent, respectively, as compared with the quantities mined and shipped in 1927. The ore shipped in 1928 was valued at the mines at $133,543,000, an increase of 5 per cent. These totals include the ore from mines in southern Wisconsin and ore shipped by rail as well as by water from all mines, but exclude manganiferous ores amounting to approximately 1,080,000 gross tons in 1928 and 1,300,084 tons in 1927 that contained 5 per cent or more of manganese in the natural state. The ore is chiefly hematite. The stocks of iron ore in this district apparently decreased from 8,850,638 gross tons in 1927 to 7,980,000 tons in 1928, or 10 per cent. The stocks at the end of 1928 were about 1,382,000 tons less than the average for the preceding five years. The shipments of iron ore by water from the Lake Superior district in 1928 (including manganiferous iron ores), according to the Lake Superior Iron Ore Association, amounted to 53,980,874 gross tons, an increase of 6 per cent as compared with these shipments in 1927. The average value of the ore at the mines in the Lake Superior district in 1928 was $2.49 a ton; in 1927 it was $2.50.

SOUTHEASTERN STATES.

The Southeastern States, which constitute the second largest iron ore producing area, including the Birmingham and Chattanooga districts, mined approximately 6,646,000 gross tons of iron ore in 1928, a decrease of 2 per cent as compared with 1927. The shipments of iron ore from mines in these states in 1928 amounted to 6,462,000 gross tons, valued at $12,784,000, decreases of 6 and 8 per cent, respectively, in quantity and value as compared with 1927. The ore is mainly hematite; brown ore and magnetite come next in order. The average value of the ore produced in these states in 1928 per gross tons was $1.98; in 1927 it was $2.04. The stocks of iron ore at the mines in this group of states, mainly in the Birmingham district, increased from 873,539 gross tons in 1927 to 1,057,000 gross tons in 1928. These stocks are about 286,000 tons more than the average for the preceding five years.

NORTHEASTERN STATES.

The Northeastern States, which include the Adirondack district, New York, and the Cornwall district, Pennsylvania, in 1928 mined 1,980,000 gross tons of iron ore and shipped 2,114,000 tons, valued at $6,596,000, decreases of 12 per cent in quantity mined, 7 per cent in quantity shipped, and 17 per cent in value of shipments compared with 1927. The stocks of iron ore in this group of states decreased from 368,331 gross tons in 1927 to 217,000 tons in 1928. These stocks are considerably less than usually carried over at these mines, being about 246,000 tons below the average for the preceding five years. The average value of the ore in these states in 1928 per gross ton was $3.12; in 1927 it was $3.53. Most of this ore is magnetite.

WESTERN STATES.

The Western States that ordinarily produce iron ore named in order of their importance are Wyoming, Utah, New Mexico, Colorado, Montana and Washington. Occasionally California, Idaho, and Nevada contribute small quantities. All the ore from Wyoming, New Mexico, and Colorado and most of that from

Utah is used for the manufacture of pig iron. Much of the remainder is used as a flux in smelting copper and the precious metals. It is estimated that the Western States mined and shipped in 1928 approximately 1,058,000 gross tons of iron ore, valued at $1,568,000, a decrease of 2 per cent in the quantities mined and shipped but an increase of 2 per cent in value of shipments as compared with 1927. The ore comprises hematite, magnetite and brown ore.

IMPORTS AND EXPORTS.

The imports of iron ore reported for the eleven months ended November 30, 1928, amounted to 2,280,247 gross tons, valued at $4,996,191, or $2.19 a ton. The imports for the year 1927 were 2,620,717 gross tons, valued at $6,068,283, or $2.32 a ton. The reported exports of iron ore for the eleven months ended November 30, 1928, amounted to 1,269,202 gross tons valued at $4,764,143, or $3.75 a ton, as compared with exports for the entire year 1927 or 898,793 tons, valued at $3,425,435, or $3.81 a ton. These statistics of imports and exports were compiled from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

The table herewith shows the quantity and value of the iron ore mined and shipped in the United States by the principal producing states. The figures for 1927 are final, but those for 1928 are subject to revision:

ESTIMATES OF IRON ORE MINED AND SHIPPED IN THE UNITED STATES IN 1928 AND ACTUAL OUTPUT IN 1927.

	Ore mined (gross tons)		Ore shipped 1927		Ore shipped 1928	
	1927	1928	Gross tons	Value	Gross tons	Value
Lake Superior:						
Michigan	15,075,079	13,725,000	14,532,831	$ 37,135,364	14,254,000	$ 36,716,000
Minnesota	35,461,138	37,457,000	35,563,177	87,935,099	37,969,000	93,114,000
Wisconsin	1,091,118	1,285,000	937,935	2,567,078	1,396,000	3,713,000
	51,627,335	52,467,000	51,033,943	$127,637,541	53,610,000	$133,543,000
Southeastern States:						
Alabama	6,445,464	6,297,000	6,508,419	$ 12,973,597	6,113,000	$ 11,758,000
Georgia	50,312	91,000	50,312	147,068	91,000	259,000
Missouri	78,605	100,000	78,605	315,670	100,000	395,000
North Carolina	32,528	....	32,528	81,753	....	....
Tennessee	121,914	130,000	121,220	274,620	130,000	290,000
Virginia	64,592	28,000	66,897	172,877	28,000	82,000
	6,793,415	6,646,000	6,857,981	$ 13,965,585	6,462,000	$ 12,784,000
Northeastern States:						
New Jersey	220,660	234,000	202,720	$ 860,393	328,000	$ 1,244,000
New York	853,159	724,000	936,850	4,568,244	764,000	3,041,000
Pennsylvania	1,170,435	1,022,000	1,124,883	2,559,916	1,022,000	2,311,000
	2,244,254	1,980,000	2,264,453	$ 7,988,533	2,114,000	$ 6,596,000
Western States	1,076,096	1,058,000	1,076,096	1,534,161	1,058,000	1,568,000
Grand total	61,741,100	62,151,000	61,232,473	$151,125,820	63,244,000	$154,491,000

COMPARATIVE STATEMENT OF ORE SHIPMENTS FROM UPPER LAKE PORTS TO CLOSE OF SEASON 1927 AND 1928.

Port and Dock—	Season 1927	Percentage of Total	Season 1928	P. C. of Total
Escanaba—C. & N. W.	4,303,688	8.42	3,884,690	7.20
Escanaba—C. M. & St. P.	1,561,536	3.06	1,602,866	2.97
Marquette—D., S. S. & A.	826,304	1.62	758,736	1.41
Marquette—L. S. & I.	2,412,551	4.72	2,652,166	4.91
Ashland—C. & N. W.	4,497,425	8.80	4,574,275	8.47
Ashland—Soo Line	1,742,349	3.41	1,906,883	3.53
Superior—Great Northern	12,945,606	25.33	13,469,476	24.95
Superior—Soo Line	1,091,075	2.13	1,135,600	2.10
Superior—Northern Pacific	591,255	1.16	808,618	1.50
Duluth—D. M. & N.	15,432,188	30.19	17,454,063	32.34
Two Harbors—D. & I. R.	5,703,159	11.16	5,733,501	10.62
Total	51,107,136	100.00	53,980,874	100.00
1928 increase	....	....	2,873,738	5.62

Season—		Season—	
1919	47,177,395	1924	42,623,572
1920	58,527,226	1925	54,081,298
1921	22,300,726	1926	58,537,855
1922	42,613,229	1927	51,107,136
1923	59,036,705	1928	53,980,874

TONNAGE OF LAKE SUPERIOR ORES ON HAND AT FURNACES AND LAKE ERIE DOCKS JANUARY 1ST, 1929 AND 1928.

(Extract from Report Lake Superior Iron Ore Association.—By Permission.)

	Central District Furnaces.	Eastern Furnaces.	Lake Front Furnaces (A)	All Rail Furnaces.	Total.
Ore on hand at furnaces January 1st, 1929	13,481,329	701,981	14,519,956	748,602	29,451,868
Ore on hand at furnaces January 1st, 1928	14,946,750	1,019,842	14,272,152	738,861	30,977,605
Ore on Lake Erie docks January 1st, 1929	5,669,624	25,596	....	....	5,695,220
Ore on Lake Erie docks January 1st, 1928	6,567,695	36,644	....	....	6,604,339
Total ore on hand at furnaces and Lake Erie docks January 1st, 1929	19,150,953	727,577	14,519,956	748,602	35,147,088
Total ore on hand at furnaces and Lake Erie docks January 1st, 1928	21,514,445	1,056,486	14,272,152	738,861	37,581,944
Total number of furnaces represented above, 1929	133	27	97	11	268
Total number of furnaces represented above, 1928	137	28	97	11	273
Number in blast on last day of December, 1929	88	11	64	8	171
Number in blast on last day of December, 1928	66	8	61	9	144
Increase December 31st, 1929	22	3	3	1*	27

(A) Including Canadian furnaces. *Decrease.

BALANCE OF IRON ORE ON DOCK AT LAKE ERIE PORTS APRIL 1, 1928—RECEIPTS FOR THE SEASON—BALANCE ON DOCK JANUARY 1ST, 1928 AND 1929.

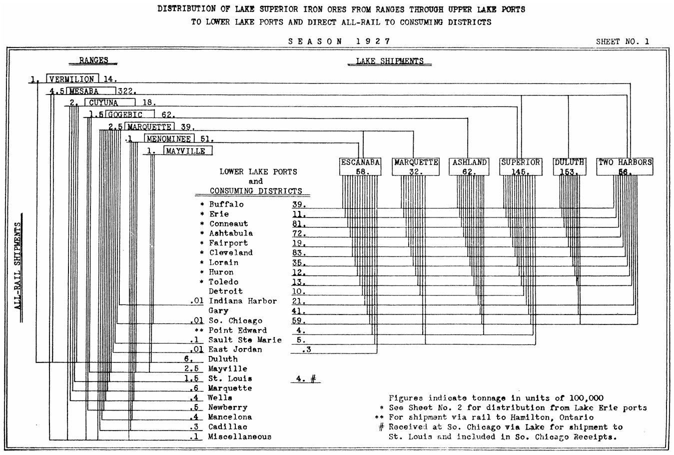
	Dock Balance April 1st, 1928.	Receipts for Season.	Dock Balance January 1st, 1928.	Dock Balance January 1st, 1929.
Buffalo, North Tonawanda, Port Colborne	5,432	4,337,313	6,178	3,433
Erie	67,948	653,233	67,948	59,645
Conneaut	1,471,794	8,437,401	1,796,198	1,734,035
Ashtabula	1,896,797	6,376,035	2,353,597	1,996,654
Fairport	327,060	1,839,171	425,860	298,610
Cleveland	1,167,135	9,375,764	1,237,085	1,081,366
Lorain	144,541	3,423,111	184,681	715,38
Huron	403,884	1,010,927	449,285	387,225
Toledo	83,507	1,503,387	83,507	62,714
Total	5,568,098	36,956,342	6,604,339	5,695,220

SHIPMENTS FROM LAKE SUPERIOR COPPER MINING COMPANIES FOR CALENDAR YEAR 1928.

	Pounds Re-
Calumet & Hecla Mining Company (including Isle Royale Copper Company)	142,927,092
Copper Range Company	29,448,123
Mohawk Mining Company	21,687,010
Quincy Mining Company	1,852,207

NOTE—The figures given above are shipments from smelters, and not production. The Quincy Mining Company has been working on a development program only, and has done no active mining.

[Distribution of Iron Ores from Upper Lake Ports, Chart]



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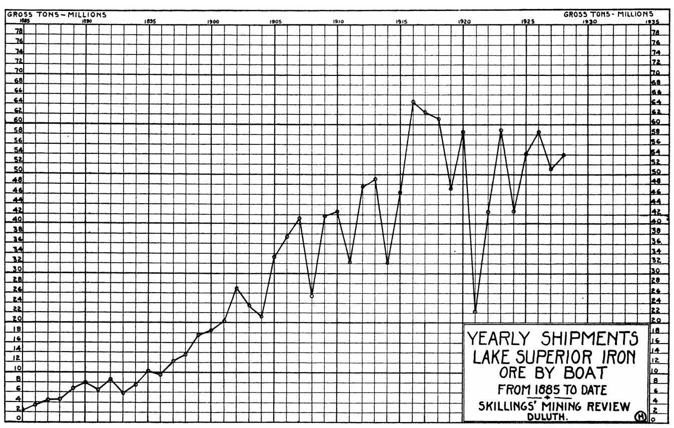
[Iron Ore Shipments from 1885 to Date, Chart]



BIOGRAPHICAL.

CLARENCE MORTON BOSS.

Clarence Morton Boss was born in Pittsfield, Washtenaw County, Michigan, on January 2, 1850. He attended the district school at that place and finished his college preparatory work at Ypsilanti and Oliver, Michigan, graduating from the University of Michigan in 1870. Immediately after graduation he assisted Major T. B. Brooke, geologist in the Geological Survey of the Marquette Range in the Upper Peninsula, also surveying the Champion and New York mines at Ishpeming.

After spending some time in his home, he again returned to the Northern Peninsula in 1871 and engaged in the following work:

In 1871 he was assistant engineer on the Marquette, Houghton & Ontonagon Railway with headquarters at L'Anse until the completion of the road in 1872. Leaving the railway, he became mining engineer for the Michigamme mine. In 1873 he left this work and engaged in the general practice of mining engineering in Marquette County. In 1876 he surveyed the Republic mine and superintended the construction of a water power plant for compressing air. This required a transmitting pipe a mile long, which he erected. At the time the plant was considered a very large one.

Later Mr. Boss studied locomotive boiler construction at Jackson, Michigan, and then returned to make explorations for iron ore near Sault Ste. Marie, Ontario. In 1880 he returned to railroading and became division engineer in charge of construction of the first division of the Madison branch of the C. & N. W. Railway, between Milwaukee and Waukesha.

Again he returned to his father's farm and from there tried the grocery business at Ypsilanti, Michigan. In 1885 he gave that business up to work for the Chicago Edison Company, at Chicago, working particularly on the wiring of buildings, tunnels and later erecting lighting plants at Wausau, Neillsville, and other points in Wisconsin.

In 1886 he went to Bessemer, Michigan, on the then new Gogebic Range, engaging in mining surveying and consulting engineering. He was elected the first mayor of Bessemer in 1889, re-elected in 1890, refused to run in 1891, but was elected for a third term from 1890 to 1896.

In the summer of 1896 he became superintendent for the Franklin Iron Mining Company with headquarters at Virginia, Minnesota, having charge of the Franklin, Bessemer and Victoria mines, and one property at Ely, Minnesota. When the Company ceased operations in 1898, he became assistant engineer of the Duluth, Missabe & Northern Railway, making a complete survey of the road and its branches, to replace records lost in a fire.

In 1899 he became superintendent of the Great Lakes Copper Company, at Sudbury, Ontario, remaining there until 1901. In that year he became mining superintendent of the Algoma Commercial Company, in charge of the Elsie mine near Sudbury. This Company suspended operations in 1903 and Mr. Boss returned to Sault Ste. Marie, becoming a consulting engineer, reporting on mining prospects in Canada, north of Lake Superior in Montreal and Quebec.

In 1904 he accompanied a surveying party through the North Ottawa River to the vicinity of Hudson Bay. In 1905 he was appointed government inspector in the vicinity of the Sault. In October 1905, he was sent by the Canadian Copper Company to superintendent the development of a new nickle property in the Sudbury District.

In 1906 he entered the employ of the Oliver Iron Mining Company at Duluth, in charge of prospecting on the Cuyuna Range, then recently discovered. In April, 1907, he was sent to Pyrites in northern New York to investigate an experiment with a deposit of iron pyrites. In September, 1907, he was appointed mine inspector for the properties of the Oliver Iron Mining Company in Michigan, and later was transferred to the Minnesota District in the same capacity, and remained such until his death on May 11, 1927.

RICHARD C. FLANNIGAN.

Although not actually engaged in the work of mining, Richard C. Flannigan was connected with so many mining companies in a legal capacity and so intimately known by so many of the operators, that the record of his life is properly placed in the Proceedings of the Lake Superior Mining Institute.

Mr. Flannigan was born December 12, 1857, at Ontonagon, Michigan, a son of Captain James Flannigan, a pioneer in that locality. Soon after his birth the family moved to Marquette, where he attended school under Harlow Olcott. At the age of eleven he started to work as a clerk in the offices of the

Marquette, Houghton & Ontonagon Railway. After occupying several positions, he became station agent at Humboldt, Michigan, leaving that position to become a student and clerk in the law offices of Parks & Hayden, at Marquette. After four years in this office he entered the University of Michigan and studied there for one year. He then entered the office of M. H. Maynard, applied for admission to the bar, and successfully passed his examinations.

In 1881 he moved from Marquette to Norway, Michigan, where he commenced the practice of law in the firm of Kruse & Flannigan. During his career following his opening of a law office, he served his state and county in many capacities. He served two terms as prosecuting attorney of Menominee County. He was first mayor of Norway and also was a member of the board of education for eighteen years. He served as a member of the constitutional convention for the State of Michigan in 1907-8. In 1909 he was appointed by Governor Warner circuit judge of the 25th Judicial Circuit, and was elected and re-elected to this responsible position until September 29, 1927, when Governor Green appointed him to the supreme bench of the state.

In January, 1928, he was compelled to go to a hospital, where he died on February 17, 1928.

Shortly before his death, Pope Pius XI conferred upon him through Bishop Joseph G. Pinten, of Grand Rapids, Michigan, the Grand Cross of St.Gregory for his interest and work in the Roman Catholic Church.

Judge Flannigan presided at the trial of Roosevelt vs. Newett and at its conclusion was complimented by ex-President Roosevelt for his fairness and just decisions during the entire trial. He had hundreds of friends amongst all classes in society and retained throughout his life their respect and confidence.

MICHAEL H. GODFREY.

He was born April 13, 1872, in Champion, Michigan. He finished High School in Champion and attended college at Joliet, Canada. For a short time he clerked in the Postoffice at Norway, Michigan, and also in the store of the Penn Iron Company.

In 1893 he came to the Mesaba Range from Norway with Mr. Phil Scadden, who at that time was in charge of the Minnewas Mine. From that mine in 1894 he went to the Mountain Iron Mine in Mountain Iron, Minnesota. In December 1895 he moved to the Lake Superior Consolidated Mines at Hibbing, then in charge of Mr. Pentecost Mitchell. In January 1902, he was made General Surface Foreman of the Hibbing District; in January 1903, he was assistant Superintendent of the Clark, Chisholm, Pillsbury and Glen Mines; July 1, 1905 he became Superintendent of the Hull-Rust Mine; January 1, 1906 he was made assistant General Superintendent of the Hibbing District. From January 1909 until April 1917, he was General Superintendent of first the Chisholm District, then the Canisteo District and finally the Virginia District. On the latter date he was made District Manager of the Western District of the Mesaba Range and continued in that position until his death on January 16, 1928.

WILLIAM H. JOHNSTON.

William H. Johnston was born in Herkimer County, New York, on December 1, 1847.

At an early age he moved with his parents to Appleton, Wisconsin, where his father erected the first dwelling in that town. His father was also the first postmaster and president of that village.

He received his common school education in Appleton and also studied at Lawrence University in that city.

In 1876 Mr. Johnston obtained employment at the Lake Superior Mine at Ishpeming as assistant bookkeeper and time keeper, succeeding Mr. F. P. Mills, Jr.

Later he was made superintendent under Agent C. H. Hall and continued in that capacity until the fall of 1897, when he was made agent of that Company. This position also included the operation of the Regent Group of mines at Negaunee.

Upon the formation of the Oliver Mining Company he remained with the operations in Ishpeming and Negaunee and later became the General Superintendent for the Marquette Range for the Oliver Iron Mining Company, the operating company in the Lake Superior region for the United States Steel Corporation. In this position he continued until his retirement in 1917.

He occupied many public positions of trust and importance during his stay in the Lake Superior region. He served the public as Mayor of Ishpeming several times, and also as Alderman and Supervisor. He was also President of the Lake Superior Mining Institute in 1913.

An affable, courteous gentleman, he drew a host of friends to him during his life in the mining country and each year greeted them on his return from his Florida home.

He died in Maitland, Florida, on October 30, 1927.

JOHN TYLER JONES.

John Tyler Jones, the first individual to employ a steam shovel to load iron ore from an open pit mine, died May 4, 1928, in Sharon, Pa. He was for many years a leading figure of the mining industry of the Lake Superior district.

Mr. Jones was born in Pittsburgh, Pa., in 184-1, and there he learned the machinist’s trade under the direction of his father. He worked in Sharon and Middlesex for six years and then came to the Lake Superior district to assume the management of mining properties for P. L. Kimberley, who was at that time operating on the Menominee range. Later these operations were transferred to the Mesabi range. While on the Menominee range he was at different times connected with the Emmet, the Millie, the Hamilton and the Merriam properties. It was in 1883 that Mr. Jones prospected with diamond drill and located the Hamilton ore body, adjoining the famous Chapin mine.

Mr. Jones arrived on the Mesabi range shortly after the first merchantable iron ore had been discovered there. It was at the Biwabik mine that the steam shovel was first employed in loading direct from mine to railroad car, thus doing away with the stocking of ore from open pit operations.

Following the panic of 1893, Mr. Jones went to Kentucky to take charge of coal properties for Mr. Kimberley and Frank Buhl, and later he spent some time in Utah obtaining leases on iron ore lands that are now in possession of the Colorado Fuel & Iron Company.

In 1903 Mr. Jones invented a revolving furnace for the smelting of iron ore, carrying on these experiments in Iron Mountain, Republic, Marquette and Salt Lake City. He proved his method a success, but the costs were excessive. His last work was done at Goodreau, Ontario, Canada, where he managed a mining property. He concluded a long and active career in 1920, when he retired.

JAMES BROOKS KNIGHT.

He was born on March 19th, 1850, in a small town called Diamond Grove, near Mineral Point, Wisconsin. In the spring of 1851 his father moved to Rockland, Michigan, where he was employed at the old Minnesota mine, and brought his family there in the fall of that year.

Mr. Knight lived in Rockland until he was about seventeen years old, working with his father in the blacksmith shop. During this period he lost the sight of one eye by being struck by a piece of steel. He attended school in Rockland and Ontonagon. He also worked in the store of S. D. North in Rockland and later in the store of the Huron mine.

In 1869 the Knight family moved to Franklin mine, in Hancock, and Mr. Knight was given charge of the warehouse, where he stayed one year. The family then moved to Escanaba and Mr. Knight was employed in the shops of the Chicago & Northwestern Railway. In 1870 he kept time and did other clerical work at the Escanaba docks then under construction, and while so engaged had the misfortune to lose part of his right hand.

In 1872 he went to the Smith mine, at Swanzey, now called Gwinn, where he worked for some months, and then went to Ishpeming as timekeeper at the old Saginaw mine. In 1873 he moved to Republic, where he worked in the store of the St. Clair brothers.

During the next six years he worked at several occupations, including test-pitting and clerking. In 1879 Dr. Nelson P. Hult employed him as timekeeper at the Norway mine, at Norway, Michigan, which was just being developed. He was employed as cashier and chief accountant at the Menominee Mining Company, which included operations at Quinnesec and Florence. In 1882 he resigned his position with the mining company and engaged in the insurance business.

In 1885 August C. Cook bought the old Chronicle newspaper plant in Norway and on September 7th of that year was issued the first number of the "Norway Current." He engaged Mr. Knight to assist in the reportorial work, and a few months later Mr. Cook sold the paper to Mr. Knight. From that time until his death Mr. Knight continued to publish that newspaper.

Owing to his wide acquaintance throughout Northern Michigan and his familiarity with the mining business in general, Mr. Knight was appointed first inspector of mines in Menominee County. In 1891 he served as alderman in the 3rd ward in Norway. In 1895 he was appointed Commissioner of Mineral Statistics for the State of Michigan. He also served four regular and three special sessions of the Legislature of Michigan, in 1903, 1905, 1907 and 1911.

He died at Norway, Michigan, November 8, 1926.

GEORGE A. NEWETT.

George A. Newett, who was for many years the editor and publisher of the Ishpeming, Mich., Iron Ore, died at his home in that city, May 26, 1928, following an illness of several years' duration.

Mr. Newett was born on a farm near Janesville, Wis., October 8, 1856, and there he remained until 1873, when he went with his parents to Ishpeming. He learned the printer's trade and in 1889 formed a partnership with John McCarthy and they commenced the publication of the Iron Agitator. Within a few years Mr. McCarthy's interest in the business was purchased by Mr. Newett and the name of the newspaper was changed to the Iron Ore.

Mr. Newett was a firm believer in the future of the Lake Superior district and always a friend of the mining industry. He numbered among his acquaintances men of almost every district of the country and paid frequent visits to their properties. From 1896 until 1900 he served the State of Michigan as commissioner of mineral statistics and reports which he compiled annually are valuable records of the iron and copper industry of Michigan.

At the time of his death, Mr. Newett had served for eight years as a member of the directorate of both the Calumet & Arizona Mining Company and the New Cornelia Copper Company, both operating in Arizona. He was one of the early members of the Lake Superior Mining Institute and contributed a number of papers on iron and copper mining to the annual proceedings.

Surviving are the widow, three daughters and three sons.

SPENCER S. RUMSEY.

Spencer S. Rumsey, chief engineer for the Oliver Iron Mining Company, at Duluth, Minnesota, died very suddenly in Chicago, Thursday, September 8, 1927, at the age of 51 years.

Mr. Rumsey was born at Berlin, Wisconsin, May 23, 1876. After graduating from the high school at Milwaukee he entered the University of Wisconsin, from which he was graduated in 1897 in the department of civil engineering. Following his university training he was for two years with the Allis-Chalmers Manufacturing Company at Milwaukee. In 1899 he entered the employ of the Oliver Iron Mining Company at Ironwood, Michigan, being transferred to Duluth in 1901. On October 1, 1911, he was made chief engineer of the Oliver Iron Mining Company with headquarters at Duluth, and held that position at the time of his death.

Mr. Rumsey took an active part in the progressive introduction of larger, heavier and more efficient mining equipment in the Lake Superior iron mining districts. This involved larger and specially designed equipment for the open pit mines on the Mesabi Range, consisting of railway locomotives, steam shovels and stripping cars, and more recently the proper electrification of this and allied equipment.

Mr. Rumsey was a member of the American Society of Mechanical Engineers, American Iron & Steel Institute and the Lake Superior Mining Institute. He was a Scottish Rite Mason and a member of the Aad Temple of the Shrine. He also was a member of the Psi Upsilon Fraternity, the Northland Country Club and the Kitchi Gammi Club of Duluth.

Mr. Rumsey is survived by his wife, formerly Miss Mary Bartlett of Duluth, his daughter Helen, and three sons, John, Robert and James.

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