hands. The fact that the dynamite does not as a rule explode with its full force is shown by the fact that more men are injured than killed by this operation. Attempts to use frozen dynamite should always be prohibited as aside from the danger of this practice, it is practically impossible to get the full explosive force from it. Out of 19 accidents in loading and tamping charged in the United Kingdom during the year 1910, 8 were due to attempts to use frozen dynamite.

Accidents from sparks, flames, etc., to be disastrous generally, though not always, require the presence of either black powder or primers. Thus throwing lighted matches around, a favorite American habit, gets immediate results with black powder, but only after a lapse of some tune in the case of dynamite cartridges, unless blasting caps or electric fuzes happen to be present. An occurrence which narrowly escaped being an accident happened in the New York subway tunnel under 194th street in March, 1904. The blaster after preparing his primers by inserting an electric fuze in each cartridge of a box of gelatin, proceeded to remove the wrappers from the cartridge of six more cases of gelatin. These wrappers soaked in paraffine and possibly containing a trace of nitroglycerine were heaped up over the box containing the primers. A driller from the heading came down to speak to the blaster and placed his naked bug light among the wrappers so that the flames just escaped reaching the paper by about half an inch. After burning cheerfully in that position what seemed an interminable period, the bug was casually removed by the blaster to the intense relief of at least one of the spectators.

The obvious remedy for this class of accidents is to keep sparks and flames away from all explosives. On no account should any explosive he taken into a blacksmith shop or boiler room. Smoking should be absolutely prohibited on any work while explosives are being used. The practice of removing the paper wrappers of cartridges of dynamite, while a common one in some parts of the country, should not he encouraged, or if it is impossible to prevent, the wrappers should be immediately taken away from the vicinity of the explosive. In one quarry in New Jersey it is the practice for laborers to save the paper wrappers from their dynamite cartridges for kindling their fires at home although they state that they do sometimes spoil a stove.

In the United Kingdom, the most common source of accidents in the use of explosives is from sparks, flame, etc. These all occurred with explosives of the blasting powder class. With the black powder class of explosives contact, with sparks or flame brings immediate action while with high explosives, unless detonators are attached, the explosive generally burns at least long enough to enable anybody in the immediate vicinity to escape. Practically all these accidents were caused by miners carelessly wearing open lights in their hats while preparing charges for blasting. The practice of wearing naked lights in the hat, common among a very large number of miners, while filling cartridges with black powder or while making primers of high explosives, is extremely dangerous and should be absolutely prohibited if possible. There are several records where men have lost both hands and sometimes have been blinded in addition, by the falling of a spark or a drop of hot candle grease from lights worn by them into an open box of blasting caps held in their hands. This has also been known to cause very disastrous explosions when this kind of accident has occurred in the presence of dynamite.

PREMATURE EXPLOSIONS AND FAILING TO GET AWAY IN TIME.

Accidents from these causes generally are the result of gross carelessness. This class of accidents both in the United States and in the United Kingdom claims a large number of victims.

A great many of these in the United States are caused by the use of too short a length of fuse, known in some mining districts as “skin em back” shots. In some sections of the United States, it is a common practice in loading holes to use only from one foot to eighteen inches of fuse on the primer. The miner lights the fuse, pushes the primer into the hole, shoves a tamping dummy on top and runs. Sometimes the primer sticks and the man gets caught while trying to dislodge it. One or two gas or dust explosions in coal mines have been caused by this method of blasting, where the flame blew out on account of poor tampering.

The writer saw a man narrowly escape death when using this method of blasting by pushing the lighted end of the fuse down on a primer of 60 per cent nitroglycerine dynamite. The preliminary burning of the dynamite allowed the man to get back about six feet from the hole when the fire reached the blasting cap, exploding the dynamite. This method of blasting should be absolutely prohibited as the saving in dynamite that can be made when it is properly tamped will more than pay for full amount of fuse necessary to reach outside the hole.

In England a large number of premature shots (nine during 1910) as well as hang fires (two during 1910) occurred with the use of squibs. While blasting with squibs may have certain advantages, the very greatest care should always be taken in using them to avoid getting caught by either “premature” or “hang fires.”

In the English report of 1910 there were records of ten accidents resulting in one death and injuries to nine persons from electric blasting with a man at the shot hole. All of these accidents occurred in coal mines. One accident in 1909 was caused by the lead wires accidently coming in contact with the terminals of a dry cell battery while the shot firer was connecting the shots at the face. Those of 1910 were due to the shot firer firing the blast before the persons at the shot hole had taken cover. Records of this class of accidents in the United States are very few. On September 14, 1909, at Nehalem, Oregon, a blast of 10,000 pounds of dynamite had been prepared. The blaster trying to move the connected blasting machine to a safe position, fell, pushing the plunger down, which caused a premature explosion killing one and injuring five persons. A safe rule to prevent this kind of accident is to have the man, who fires the shot, be the last to leave the face and for him alone to connect the leads to the blasting machine. Lead wires should never be connected with the source of the firing current until the time to fire the blast. This rule should never under any circumstances be disregarded. Occasionally miners get caught in wet places being delayed by the difficulty experienced in lighting fuses.

HANG-FIRES AND RETURNING TOO SOON.

This class results from the use of squibs, caps and fuse instead of electricity for firing the blast though not exclusively. It is entirely inexplicable why an electric exploder should ever hang fire, and that they ever do is doubted by many; nevertheless there have been several circumstantial accounts of an entire line of holes going off several seconds after the rack bar struck the shunt spring at the bottom of a blasting machine. Several authentic, cases are on record where the exploder set fire to the dynamite which after burning for some time in the bore hole eventually exploded. At one place a blast hole loaded with dynamite missed tire. The next clay, if is said that two holes were drilled near it, charged with black powder and fired. After a lapse of several seconds the blaster returned to the hole, when the dynamite exploded, injuring him fatally. In this case the dynamite was probably ignited by the gunpowder and burned until heat enough was generated to explode the remainder. With ammonia dynamite an accident of this kind would hardly be possible on account of the difficulty with which the ammonia dynamites are inflamed.

Three instances were reported in Great Britain in the year 1900 where a fuse hung lire for at least 55 minutes. At a quarry near Wilmington, Del., a case occurred where a fuse hung fire for ten minutes. Since the substitution of hemp and jute to the exclusion of cotton for the body of practically all but the cheapest fuse manufactured, the records of hang fires have almost entirely disappeared. However, it is a pretty safe rule to prohibit the approach of a missed cap and fuse shot for at least one hour, in some English and American coal mines the time is increased to 24 hours.

When practicable, it is most desirable that blasts in large quarries and mines should be so timed that at least half an hour must elapse before the workmen return. This is accomplished in most mines by having the men shoot when going to lunch and off shift. This also gives the faces a chance to be properly ventilated before the men come back to work.

TAMPERING WITH MISSED SHOTS.

This is the cause of quite a large number of accidents every year. Particularly in hard rock and where miners work by contract, the men will almost invariably try to save a missed hole by extracting the charge rather than drill a new hole. This is a very dangerous practice and should be avoided at all times. A number of accidents are also caused by drilling a new hole so close to a missed shot that the drill entered the unexploded charge. Another bad practice is the blowing out of missed charges by means of compressed air. A miner doing this at Webb City, Mo., on July 24th, 1909, killed himself and severely injured his partner.

Accidents in loading and tamping, tampering with missed shots and striking unexploded powder in debris are much more frequent in the winter than in the summer months. These are due largely to the tamping and use of frozen or chilled dynamite. In cold weather blasts, where nitroglycerine explosives are used, should be fired as soon as loaded to prevent the possibility of chilling or freezing on standing. With a view of giving details of these kinds of accidents, the writer inserts the following taken from the “Report of His Majesty’s Inspectors of Explosives” for the year 1910:

“With a view of throwing light on the occurrence of accidents under the three headings ‘Ramming, etc.,’ ‘Boring into unexploded charges,’ and ‘Striking unexploded charges in the debris,’ we again give a table showing the number of accidents which occurred each month. Only those in which an explosive containing over 10 per cent of nitroglycerine was involved are here shown. This table shows in a most marked way that the bulk of these accidents occur in the most three months of the year. They disappear almost entirely during the summer, and show a tendency to recur as the weather gets colder again. It is found that during the first three months of the year explosives of this class are more likely to be frozen than at any other time, as it takes some time for the explosive to become frozen in the magazines; indeed, it is more often that it becomes frozen during conveyance than during storage. These facts taken together render it more than probable that to the employment of frozen explosives may be attributed the great majority of accidents. It will be seen that during the past ten years 337 accidents have occurred during the winter months—December to May—while during the remaining six months the number was only 118.”

CAUSE—1910	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Ramming or Stemming the Charge....	3	2	1	3	3	....	1	....	....	....	3	3
Boring Into Unexploded Charges......	3	....	1	....	4	3	3	1	1	1	...	2
Striking Unexploded Charges in Removing Debris	1	1	....	1	1	....	....	....	....	....	2	2
Total of Above Causes	6	3	2	4	8	3	4	1	1	1	5	7
Total Number in Past Ten Years	62	69	77	48	32	22	21	12	19	17	27	49

These figures are such as to afford some reason for thinking that the efforts which have been made to induce users of this class of explosives to make a regular habit of using a warming pan during the winter and spring months are beginning to be effectual. We have been encouraging magazine owners to adopt some method of heating their magazines and already some have been so fitted. The best method seems to be the use of hot water circulating pipes heated by a slow combustion stove at some little distance from the magazine adapted for burning coke, anthracite or coalite. It would appear to be a fact that explosives which have never been allowed to become hard by solidification of the nitroglycerin do not show so much tendency to freeze as those which have been frozen once and subsequently thawed. Even so, however, any measure of warming magazines can only be regarded as a palliative for the evil, the true remedy for which is the regular and proper use of warming pans by the users.

Every year there are a few accidents due to loading holes too soon after springing. Some of these are due to pouring black powder in on smouldering pieces of fuse. Sprung holes should always be blown out when possible. Also it is a simple matter to let a tamping stick or scraper stand, in a sprung hole for a few minutes to see if the end gets warm.

The improper making of primers claims a few victims every year. One man in England was badly injured by trying to waterproof a blasting cap with candle grease. While making primers the wearing of open lights in a man's hat should he absolutely prohibited as a spark or drop of hot candle grease falling on the detonator under these conditions rarely fails to cause a serious accident.

In the United States there is always a large number of accidents caused by people, children in particular, playing with explosives and detonators. Those connected with explosives proper occur mostly in connection with, the celebration of the "Glorious Fourth."

The number of accidents due to playing with blasting caps in the United States is enormous (71 during 1910), when compared with other countries. The usual course pursued by a child upon finding a blasting cap is to try and extract the contents with a pin or nail, to make a pencil tip, hold a lighted match to it or pound it with a rock or hammer to see what will happen. In doing these no chances are taken, the result being a "sure thing," the only variation being in the number of fingers lost. While these accidents are rarely fatal in England, the superior ingenuity of the American boy in devastating amusements with blasting caps resulted in 10 deaths during the year 1909. In 1910 only one was killed in this manner. Practically all of these accidents are due to criminal negligence on the part of the people who leave blasting caps where children can find them.

Three accidents may be mentioned here, one showing the unreliability of newspaper accounts, and the other two the danger of employing explosives for other than their legitimate purpose. It was reported that a man held in his hand a stick of dynamite with a blasting cap and fuse. While attempting to insert the fuse in the cap, the cap exploded setting off the dynamite in his hand which in turn set off some dynamite stored in a shanty near where he was standing. The shanty was wrecked and the man knocked down but was not injured. This was said to have occurred at Waupaca, Wis., on June 15th, 1905. On May 20th, 1906, some Italians were playing cards near Trenton, N. J. One of them placed a stick of dynamite under one leg of the table to steady it. Later an Italian showed his great delight at holding a winning hand by hammering on the table with his fist. When the smoke had cleared away the enthusiast was discovered to be "shy" an arm, his companions bruised to a greater or less extent. The following is reported from Lusted, Oregon, April 5th, 1905: A man in order to kill his dog tied him to a tree, fastened a cartridge of dynamite to him, lighted the fuse and ram. Not wishing to spoil good rope or chain the dog was tied with an old piece of rope, so that when the man ran the dog broke loose and followed him. The man fled to his house and frantically threw boots, flat irons, stove lids and various household utensils at the dog to drive him away. The dog to avoid this storm retreated beneath the house where the dynamite exploded doing considerable damage to the house.

CONCLUSIONS.

In regard to the prevention of accidents with explosives, the first rule to be observed is to keep explosives and detonators apart until necessary to use them. In regard to preventing accidents in storage, it is best to have separate magazines for explosives and blasting supplies. The ground around a magazine should be carefully cleared to prevent any brush fires from communicating with it. The walls and roof should be constructed of uninflammable materials. Where large quantities of explosives are stored it is a very simple matter to make magazines bullet proof by having double walls with not less than an 8-inch space between them, this space to be filled with coarse sand or gravel. Coarse sand is more effective than fine, also angular grains are better than round. No person should be permitted to enter a magazine carrying matches or while smoking. Inflammable materials such as oils, etc., should never be stored with explosives.

Nothing can be more effective for the prevention of accidents in transportation than a close regard for the rules laid down by the "Bureau for the Safe Transportation of Explosives." These can be procured from any railroad.

To prevent accidents in the thawing of dynamite always keep the cartridges lying on their sides at temperatures not to exceed 80 to 90 degrees Fahrenheit, the lower temperature being best. Never thaw explosives on shelves or racks directly over the source of heat. Never thaw dynamite on heated stoves, rocks, bricks or metal, nor in an oven, and never thaw dynamite in front of, near or over a steam boiler or fire of any kind. Don't place a hot water thawing can over a fire and never put dynamite in hot water or allow it to come in contact with steam.

To prevent accidents in the use of explosives, requires the exercise of plain common sense. The practice of miners wearing lights in their hats or smoking while making primers and preparing charges cannot he condemned too strongly. It is nothing but criminal negligence. Any attempt to use frozen dynamite should be prohibited and the drilling out and tampering with misfires is extremely dangerous. Most miners do not realize that very few men have a chance to reform after their first accident with explosives. Where a charge apparently misses no return should be made to the place within an hour. As in cases of this kind it is necessary to draw an arbitrary line, the writer means not less than sixty minutes. In loading charges nothing but wooden tamping rods should be used. When drilling new holes near unexploded charges the greatest care should be taken to point the new hole in direction that will prevent any possibility of the bit striking the explosive in the missed hole. Blasting caps should never be left where children can find them. In short, if users of explosives will only realize what they are doing, accidents would be reduced about ninety per cent.

The following tables give statistics of accidents in general and in particular the use of explosives in the United States and Great Britain. They also show the accidents occurring with the different kinds of explosives. A study of these tables will show not only what kind of explosives are the most liable to be in accidents but what operations can be considered the most dangerous:

TABLE I.

*Showing all accidents with explosives in the United States for 1910 grouped under the several heads of Storage, Transportation, Use and Miscellaneous Use.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Storage	25	62	94	25	50
Transportation	2	1	4	5	7
Use	379	339	508	42	421
Miscellaneous Use	173	13	208	7	180
TOTALS	579	415	814	79	658

* Du Pont annual report for 1910

TABLE II.

*Showing all accidents in the Keeping, Conveyance, Use and Miscellaneous in the United Kingdom during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Keeping	9	3	11	2	11
Conveyance	....	..	..	..	....
Use and Miscellaneous	373	57	406	1	374
TOTALS	382	60	417	3	385

*Report of His Majesty's Inspectors of Explosives for 1910.

TABLE III.

*Showing total number and nature of accidents shown in Table I, caused by each description of explosives in the United States as compiled from newspaper clippings for 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Dynamite	266	251	345	35	301
Fuse	0	0	0	0	0
Ammunition	31	9	29	2	33
Black Powder	85	55	135	6	91
Fireworks	8	1	9	12	20
Gunpowder	20	5	22	2	22
Smokeless Powder	4	20	10	0	4
Guncotton	0	0	0	0	0
Nitroglycerine	10	10	6	7	17
Blasting Caps	97	2	140	2	99
Railroad Torpedoes	12	0	16	0	12
Dynamite and Black Powder	1	0	1	3	4
Flashlight Powder	4	1	25	0	4
**Unspecified	41	66	76	10	51
TOTALS	579	420	814	79	658

*Du Pont annual report for 1910.
**This large number is due to incomplete details given in the newspapers.

TABLE IV.

*Showing total number and nature of accidents caused by each description of explosives in the United Kingdom during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Black Powder Class	162	15	176	12	174
Dynamite	174	38	166	20	194
Chlorate Mixture	16	4	15	2	18
Fulminate	5	1	5	1	6
Ammunition and Miscellaneous	8	2	7	0	8
Fuse	2	0	2	0	2
Detonators	33	0	40	6	39
Fireworks	5	5	10	1	6
Unknown	2	1	1	1	3
TOTALS	407	66	422	43	450

*Report of His Majesty's Inspectors of Explosives for the year 1910 Revised to American Standards.

TABLE V.

*
**Showing the total number and nature of accidents in the Transportation of the different kinds of Explosives in the United States during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Dynamite	0	0	0	2	2
Dynamite and Black Powder	0	0	0	1	1
Fireworks	1	1	0	1	2
Black Powder	0	0	0	1	1
Smokeless Powder	1	0	4	0	1
TOTALS	2	1	4	5	7

*Du Pont annual reports for 1910.
**There were no accidents reported in the "Conveyance" of Explosives in the United Kingdom during the year 1910.

TABLE VI.

*Showing the total number and nature of accidents in the Use of the different Explosives in the United States during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons Killed	No. Persons Inj'r'd		
Dynamite	217	210	239	22	239
Black Powder	71	36	114	2	73
**Unspecified	34	57	52	5	39
Gunpowder	10	2	9	0	10
Blasting Caps	21	1	48	1	22
Nitroglycerine	6	5	5	3	9
Smokeless Powder	3	20	6	0	3
Flashlight Powder	3	1	24	0	3
Fireworks.	8	2	6	3	11
Ammunition	9	7	6	0	9
Railroad Torpedoes	1	0	1	0	1
TOTALS	383	341	510	36	419

*Du Pont annual report for 1910.
**This large number is due to incomplete details given in the newspapers.

TABLE VII.

*Showing detail of accidents classified in Table VI.

Summary	Accidents Causing Loss of Life and bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
DYNAMITE—					
Thawing	24	31	22	4	28
Premature and Delayed Explosions	106	114	106	4	110
Tamping and Loading	5	3	4	0	5
Striking Overlooked Charges	29	9	38	0	29
Drilling out Unexploded Charges	8	7	15	0	8
Overcharges	6	2	7	12	18
No Details	31	30	20	0	31
Hit by Rock	1	5	10	0	1
Sparks, Flames, etc.	4	3	3	2	6
Fumes	1	3	12	0	1
Careless Handling	1	1	0	0	1
Lightning	1	2	2	0	1
BLACK POWDER—					
Sparks, Flames, etc.	26	14	50	0	26
Premature and Delayed Explosions	24	9	41	0	24
No Details	14	7	14	2	16
Opening Keg with Pick	2	2	1	0	2
Striking Overlooked Charges	2	4	1	0	2
Contact with Mine Trolley Wire	1	0	4	0	1
Drilling Out Unexploded Charges	1	0	1	0	1
Overcharges	1	0	2	0	1
UNSPECIFIED EXPLOSIVES—					
Overcharges	8	3	8	5	13
Premature and Delayed Explosions	18	13	32	0	18
No Details	6	41	5	0	6
Sparks, Flames, etc.	2	0	7	0	2
GUNPOWDER—					
Sparks, Flames, etc.	2	0	2	0	2
No Details	8	2	7	0	8
BLASTING CAPS—					
No Details	14	1	36	1	15
Premature and Delayed Explosions	2	0	2	0	2
Run Over by Wagon	1	0	1	0	1
Striking Overlooked Charges	2	0	2	0	2
Sparks, Flames, etc.	2	0	7	0	2
NITROGLYCERINE—					
Striking Overlooked Charges	2	1	1	0	2
No Details	1	1	0	3	4
Premature and Delayed Explosions	3	3	4	0	3
SMOKELESS POWDER—					
No Details	2	8	1	0	2
Premature and Delayed Explosions	1	12	5	0	1
FLASHLIGHT POWDER—					
No Details	1	1	21	0	1
Premature and Delayed Explosions	2	0	3	0	2
FIREWORKS—					
No Details	5	2	3	0	5
Sparks, Flames, etc	1	0	1	2	3
Premature and Delayed Explosions	2	0	2	1	3
AMMUNITION—					
No Details	5	2	3	0	5
Premature and Delayed Explosions	3	5	2	0	3
Burst Guns	1	0	1	0	1
RAILROAD TORPEDOES—					
Run Over by Mine Car	1	0	1	0	1
TOTALS	383	341	510	36	419

*Du Pont Annual Report for 1910.

TABLE VIII.

*Showing total number and nature of accidents occurring in the Miscellaneous Use of different explosives in the United States for the year 1910.

Summary	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life or Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
Dynamite	36	5	45	2	38
Gunpowder	9	3	9	0	9
Blasting Caps	76	1	92	1	77
Ammunition	22	2	23	1	23
Black Powder	11	1	15	0	11
Unspecified	4	1	4	3	7
Railroad Torpedoes	11	0	15	0	11
Flashlight Powder	1	0	1	0	1
Nitroglycerine	1	0	1	0	1
Fireworks	2	0	3	0	2
TOTALS	173	13	208	7	180

*Du Pont Annual Report for 1910.

TABLE IX.

*Showing the Details of the Accidents Classified in Table VIII.

Summary	Accidents Causing Loss of Life and Bodily Injury.			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
DYNAMITE—					
Thrown into fire	11	3	17	1	12
Left in coal	0	0	0	1	1
Playing with	24	2	27	0	24
Shooting at	1	0	1	0	1
GUNPOWDER—					
Playing with	7	2	7	0	7
Thrown into fire	2	1	2	0	2
BLASTING CAPS—					
Playing with	70	1	86	1	71
Thrown into fire	5	0	5	0	5
No details	1	0	1	0	1
AMMUNITION—					
Playing with	13	2	11	0	13
Thrown into fire	9	0	12	1	10
BLACK POWDER—					
Cleaning out chimneys	1	0	1	0	1
Playing with	7	1	11	0	7
Thrown into fire	3	0	3	0	3
UNSPECIFIED EXPLOSIVES—					
Playing with	3	1	3	1	4
No details	0	0	0	2	2
Burst guns	1	0	1	0	1
RAILROAD TORPEDOES—					
Playing with	10	0	14	0	10
Run over by car	1	0	1	0	1
FLASHLIGHT POWDER—					
Thrown into fire	1	0	1	0	1
NITROGLYCERINE—					
Thrown into fire	1	0	1	0	1
FIREWORKS—					
Thrown into fire	1	0	1	0	1
No details	1	0	2	0	1
TOTALS	173	13	208	7	180

*Du Pont Annual Report for 1910.

TABLE X.

*Showing the total number and nature of accidents in the Use of different explosives and under Miscellaneous Circumstances in the United Kingdom during the year 1910.

Summary	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
Black Powder Class	155	13	167	..	155
Dynamite	165	33	177	..	165
Chlorate Mixture	15	3	14	..	15
Fulminate	1	..	1	..	1
Ammunition	2	..	2	..	2
Fuse	2	..	2	..	2
Detonators	29	..	35	1	30
Fireworks	2	4	7	..	2
Unknown	2	1	1	..	2
TOTALS	373	57	406	1	374

*Report of His Majesty's Inspectors of Explosives for the year 1910, Revised to American Standards.

TABLE XI.

*Showing details of accidents in the Use of Explosives and under Miscellaneous Circumstances in the United Kingdom during the year 1910. (Details of Accidents shown in Table X.)

Summary	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
BLACK POWDER CLASS—					
Prematures and failing to get away on time	18	1	18	....	18
Firing by electricity when persons are at shot hole	3	..	3	....	3
Not taking proper cover	22	4	20	....	22
Projected debris	7	..	7	....	7
Hang fires and returning too soon to shot hole	16	1	16	....	16
Tampering with missed shots	5	..	5	....	5
Loading and tamping the charge.	15	2	17	....	15
Sparks, flame, etc	57	..	62	....	57
Boring into unexploded charges	2	..	2	....	2
Striking unexploded charges in removing debris	..	..	..	....	..
Preparing charges	1	..	1	....	1
Lighting fuse before inserting charge	1	..	1	....	1
Loading too soon after springing hole	7	4	5	....	7
Various	..	..	..	....	..
DYNAMITE					
Premature and failing to get away on time	8	3	7	....	8
Firing by electricity when persons are at the shot hole	7	1	6	....	7
Not taking proper cover	39	5	37	....	39
Projected debris	21	..	21	....	21
Hang fires and returning too soon to shot hole	23	4	24	....	23
Tampering with missed shots	8	2	8	....	8
Tamping and loading the charge	19	5	16	....	19
Sparks, flame, etc	..	..	..	....	..

TABLE XI. (Continued)

Summary	Accidents Causing Loss of Life and Bodily Injury — Number of Accidents	No. of Persons — Killed	No. of Persons — Injured	Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
Boring into unexploded charges...	20	6	23	....	20
Striking unexploded charges in removing debris................	9	6	15	....	15
Preparing charges...............	2	..	3	....	2
Lighting fuse before inserting charge.......................	..	..	..	....	..
Loading too soon after springing .	..	..	..	....	..
Various	3	1	3	....	3
CHLORATE MIXTURES					
Prematures and failing to get away on time.................	..	..	..	....	..
Projected debris	6	..	6	....	6
Hang fire and returning too soon to shot hole........	1	..	1	....	1
Tampering with missed shots.....	1	..	1	....	1
Boring into unexploded charges...	1	..	1	....	1
Loading too soon after springing .	1	1	..	....	1
Loading and tamping.	2	..	3	....	2
DYNAMITE AND BLACK POWDER					
Premature and failing to get away in time.................	1	..	1	....	1
Tampering with missed shots.....	1	..	2	....	1
CHLORATE MIXTURES AND BLACK POWDER					
Prematures and failing to get away in time.................	1	1	..	....	1
Tampering with missed shots.....	1	1	..	....	1
DETONATORS					
Hang fires and returning too soon.	1	..	1	...	1
Sparks. flame, etc	1	..	1	1	2
Striking unexploded charges in debris	4	..	4	. .	4
Preparing charges................	5	..	5	....	5
Various	4	..	4	....	4
FUSE					
Various	1	..	1	....	1
MISCELLANEOUS					
Playing with detonators..........	13	..	19	....	13
Playing with other explosives.....	4	..	4	....	4
Destroying explosives	2	1	8	....	2
Explosives in coal................	5	1	3	....	5
Illegal Manufacture..............	1	..	3	....	1
Thawing	2	4	10	....	2
Fireworks display.................	1	3	7	....	1
Firing a maroon..................	1	1	..	....	1
Shell	1	..	1	....	1
TOTALS................	373	57	406	1	374

*Compiled from the "Report of His Majesty's Inspectors of Explosives for 1910."

NOTES ON TABLE XI.

Details of Accidents in the Use of Explosives in the United Kingdom in the Year 1910.

9 premature shots with black powder were fired by means of squibs.

2 hang fire shots with black powder were fired by means of squibs,

2 accidents were caused by twisting a copper needle in a hole loaded with black powder in preparing it to be shot by means of squibs.

2 accidents were caused by using a steel drill to remove obstructions from holes being loaded with black powder.

3 accidents were caused by tamping charges of black powder with steel rods,

4 accidents were caused by tamping charges of black powder with copper or bronze rods. In 1909 there were 7 accidents with copper tamping rods.

3 incidents were caused by tamping dynamite with copper rods and 1 with an iron rod. In 1909 there were 6 accidents with copper and 1 with steel tamping rod.

8 accidents were caused loading and tamping frozen nitroglycerine explosives.

90 per cent of the accidents from sparks and flames in the presence of black powder were due either to the miners wearing open lights in close proximity or then smoking.

2 accidents caused by men trying to force a nail into a frozen dynamite cartridge in making primers.

1 accident was caused by the violent handling of a cartridge of frozen dynamite.

TABLE XII.

*Showing average annual number of accidents in the use of explosives in the United Kingdom from each cause for the five years ending with 1910:

Premature and failing to get away from shot hole..........	25
Firing by electricity when persons are at the shot hole.....	11
Not taking proper cover	28
Projected debris (two years)............................	32
Hang fires and returning too soon to shot hole............	40
Tampering with missed shots	22
Tamping and loading the charge	45
Sparks, Flame, etc..	72
Boring into unexploded charges	12
Striking unexploded charges in removing debris............	23
Preparing charges	5
Lighting fuse before inserting charge....................	1
Fumes	1
Loading too soon after springing the hole................	11
Various	4

*Report of His Majesty's Inspectors of Explosives for 1910.

THE RELATION OF THE MINING INDUSTRY TO THE PREVENTION OF FOREST FIRES.

BY THOS. B. WYMAN, MUNISING, MICH.

It is a pleasure to again have an opportunity to appear before the Lake Superior Mining Institute and an even greater pleasure to note that the program shows the names of men standing so high in the ranks of their professions that yon are sure of receiving a wealth of valuable thought and suggestion even though my own contribution be of a simple nature.

In the title of my so-called paper I have indicated that certain relationships exist between the mining interests and the prevention of forest fires. At first thought this relationship seems very remote if, indeed, it can be said to exist at all, and I may first have to offer evidence of kinship in order to warrant further procedure.

The "Mining interests" are broad, so broad that they include not only the corporate and private explorations, developments and established mines, but the men engaged in daily work within the mines and for the mines. In the wonderful ramifications of the industry, the matter of supplies, of power, of transportation, of technical and legal education, etc., all have important places and each is linked to the others by threads which become stronger as the development of the industry becomes more intense. For our mines we must look to Mother Earth; for our supplies and power to the same source. Transportation can be had only at the expense of natural supplies, and for the many derivatives of human ingenuity, which advance the industry, direct tracings can be had to the things of nature.

Secretary-Forester Northern Forest Protective Association.

It is, then, indisputable that mining is dependent upon the earth and upon the natural earthy assets, the forest is the greatest visible, natural asset known to the world. There are hundreds of thousands of uses to which the forest has been advantageously put and one of the most important has been the development of your industry. It is recognized that the mining interests depend to a large degree upon the forests and, this being so, the safety and continuance of forest assets is of the greatest import. Granted safety and perpetuation the forest will supply to thousands of industries the necessities of progress. Remove safety and allow destruction to timberlands and dependent industries will be demoralized and die. Danger to the forest does not lie in harvesting wood fibre either for the mill or the mine. Danger does not lie in the failure of seed crops and resultant young growth. Danger does not lie in the fact that it takes years to develop a marketable crop of timber. The real danger to forests—seeds, seedlings, saplings, polewoods and standards of softwoods, and hardwoods alike—is from fire.

The statement has been made many times that fire destroys more timber annually than is cut by the lumberman. So, when it is considered that upon the basis of an annual cut of fifty billion feet at an estimated average stumpage of $3.00 per thousand, the value exceeding $150,000,000 per year, the loss to the nation is very apparent. This general loss is felt directly by every timber using industry, not immediately, unless the fire destroys forests from which supplies are being received, but by doubling the annual harvest the length of time which the present supply will last is halved. Again, every fire prepares the way for succeeding fires by partially consuming the material and leaving the balance in a highly inflammable condition. Young growth, coming in from natural seeding among this blackened and burnable materials, is exposed to a serious risk for many years and will, in all probability, be lost before reaching marketable size.

Seed trees, injured by burning, are unable to bear heavy seed crops and those few seeds which are borne, scattered and germinate may be lost. Had it not been for fires we would not have an acre of barren plain land, for our yearly operations have not been of such magnitude but that natural seeding would have taken place and covered the soil with species of value to you in your industry. Stull timber and lagging would be abundant and obtainable at minimum cost; mine poles and ties would command a price consistent with the available supply. All could be obtained from territory logged off years ago, where the so-called "logging chance" was of the best and the logging cost extremely low. There is no delight in operating a bottomless swamp for tamarack, spruce and cedar, building corduroy roads or breaking down the snow into the mud so it will freeze and give bottom for the winter haul. There is delight in operating level lands, where roads can be rightly and easily planned and constructed, where the haul can be made by sleigh or by railroad, and where immediate repossession of the area can be had by seeding pines and hardwoods.

To you, who own lands suited to the growth of timber, but which are not of agricultural value, this immediate repossession of surface is important for each year's growth is a year nearer the harvest, a year of taxation saved, and a year in which investment in soil value is a producing investment instead of a losing venture. Can you think of a more simple way of turning a non-producing investment into a thing of ultimate worth, than by protecting against fire at a cost too immaterial to be seriously considered as a hindrance? Can you conceive of any department of your mine running on, year after year, losing money, tying up capital, when by spending from one-fifth to one-half of one per cent you could turn it to a department of conceded value? Most of you have a department of the nature mentioned. I do not say it critically, but simply because you have likely considered that the well has already been drained, when in reality, there is a spring from the solid rock of nature which will refill it in due time if permitted to do so.

Forest protection, of which fire prevention is ninety-nine per cent, costs from one and one-half cent to three cents per acre depending on conditions; two cents is considered a reasonable average cost and when spent judiciously the protection should be very efficient. Efficient protection can be had only through cooperation, education and organization. Cooperation should consist in mutual help, in a mutual understanding of forestal policies, in mutual efforts toward needed legislation. Educational activities should be extended in every direction; every medium used, every individual approached to the end that the great menace may be fully understood and, by personal appreciation, combated. Organization necessitates a banding together of all who own timber, to put into the field active preventative forces.

It was my privilege to appear before this body on a previous occasion, some few years ago, and at that time I advocated the formation of a, protective association designed to give the protection which should be furnished through taxation. *At this time I am glad to say that just such an organization is actively patrolling the timber lands of the Upper Peninsula — many of you are members. Its work is being recognized and its efforts are meeting with success.

The Northern Forest Protective association has today, a listed area of 2,000,000 acres, and is patrolling over five million acres. It has eighteen fire wardens in the field posting notices, influencing settlers, woodsmen, hunters, fishermen, section crews, campers and berry pickers. It is cooperating with the State and National Governmental Forest Departments. It has secured concessions from the United States Postoffice Department and is now putting up appropriate notices in the three thousand postoffices of the states of Michigan and Wisconsin. The serious fires of the Lower Peninsula have proven the absolute need of organized effort and I trust that the timber holders of that section will either become members of our association or organize a similar one of their own.

*Ref. Paper by Mr. Wyman, "How Reforestation May Be Applied to the Mine Timber Industry," Vol. XIV, 1909, pp. 116-130.

We have been fortunate this season in having frequent rains which have given us favorable conditions under which to perfect our organization and our fire risk has been lessened by them. But with the same conditions existing as were prevalent at Oscoda and Au Sable, I believe that fires could not gain the headway here which caused such great destruction because, with the appreciation of the possible results which is now held by our people, it is safe to presume that someone, probably many, would assume the duty of preventing loss to others by early attack and control. If my surmise is correct you, who own surface improvements and timber, can begin to rest in peace for history has proven that destructive fires are the outcome of small fires, unheeded until the proper conditions of drought and wind have fanned them into a furnace. When every resident of and visitor to our Upper Peninsula will make it his business to quench any fire he may see there will be little to fear.

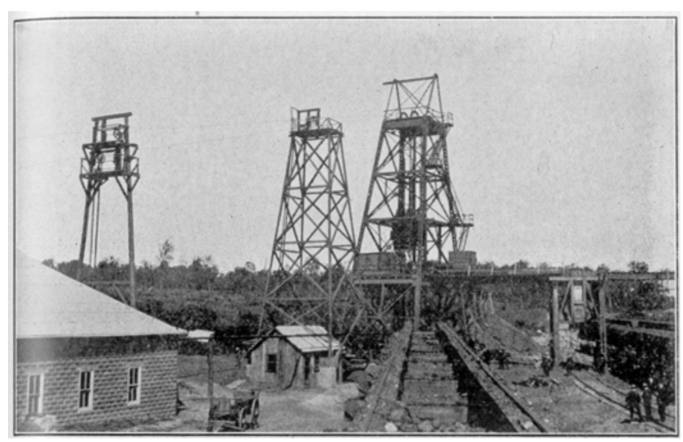
You may be interested to learn somewhat of the proportionate origin of forest fires and I desire to give yon the figures in order that your influence may be directed towards the source of greatest danger. A number of state and association reports were consulted in arriving at this average and the figures are somewhat surprising. Settlers, clearing land, burning brush, etc., cause 45 per cent of all fires. You can surely influence the settlers of your community to greater care. Sparks and live coals from locomotive stacks are charged with 28 per cent, a very high proportion when one considers that the state law provides that efficient spark arresters must be used. Campers, fishermen, and hunters have 7 per cent marked against them and the causes of 25 per cent of fires are unknown. Of this latter percentage let us make a guess. By a course of elimination we can say with reasonable accuracy that none of the unknown causes are the settlers' fires, for evidence of such a ways exists. In the same way nearly every lire originating from railroads can be properly placed and the percentage of unknown origin still remains at 25. Let us say, to be liberal that 5 per cent are traceable to lightning, an unwarranted assumption, and that of the 20 per cent remaining 10 per cent are from miscellaneous causes—where will we place the other 10 per cent? Our experience gives us the right to say that the smoker can stand 10 per cent and be let off rightly. Ten per cent of all forest fires traceable to the man with the pipe, cigar and cigarette, and, of course, the match.

Let me ask how many smokers, of your own number, if yen will, ever make it a point to see that your match is out before throwing it aside? I am not trying to fasten blame to any individual but I am fastening the blame for 10 per cent of our fires to a habit, which can be and needs be overcome. Summing up, we have charged but 5 per cent of the whole to uncontrollable causes; there remains 95 per cent chargeable to controllable causes, which, since they were not controlled, must be the result of carelessness.

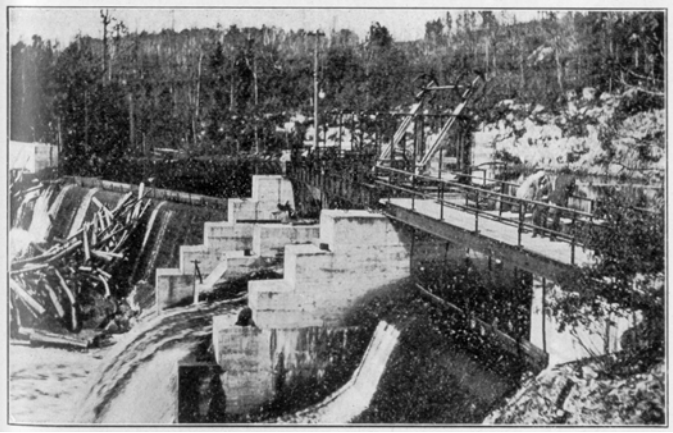
It was carelessness, due to familiarity with small fires, that resulted in the loss of over four hundred lives and destroyed eleven equipped mines in the Porcupine region of Ontario. Woodsmen and miners, familiar with possible results, allowed many small fires to burn without hindrance until, fanned by terrific winds, they were united into one vast furnace which swept all before it. Miners employed by mining corporations allowed these fires to destroy the property of their employers without making an effort toward protection, until too late. Does this not indicate a distinct need of complete understanding between employer and employee? Is it not a relationship between your interests and the prevention of a menace which threatens them? You encourage your employes to take a few days off, hunting or fishing. They go to your lands, into your timber, through your fields. Are they thoughtful of your interests? Do they put their camp fires out? Do they dump the heel of that pipe of Peerless in a safe place, or wherever the thought strikes them? Do they refrain from smoking when in dangerous localities? I ask you these questions because as their employers, you should know.

Your woodsmen, cruisers, exploring parties, compassmen and others who visit your timberlands, have occasion to observe and report, or better to put out incipient fires. Are your files teeming with such reports? I trust that they are and that action has been swift.

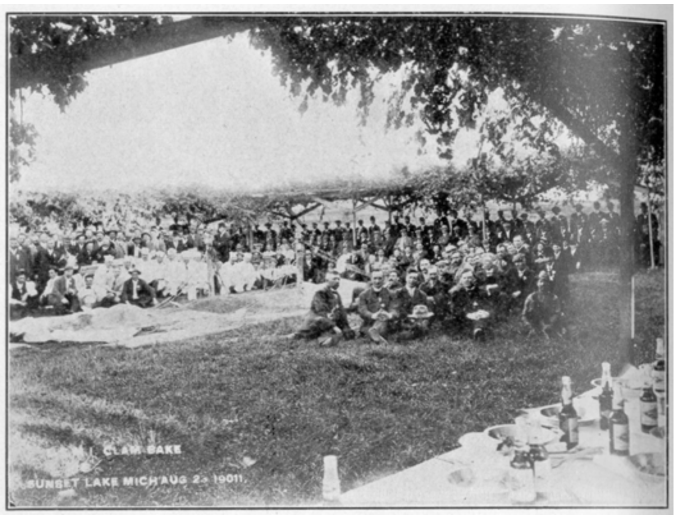
As conditions are, relationships exist between employer and employe, between lawyer and client, between retailer and customer, among families, among secret orders, among community dwellers. So long as our conditions remain dormant you must recognize this relationship, this dependence upon those who serve you and are bound to you. But the thing for which we must all stand—all strive with constant zeal is a relationship characterized by the desire of every man to safeguard every other man and every other man's property.



James Mine, Iron River, Mich.



Penn Iron Mining Co., Hydro-Electric Plant, Sturgeon Falls, Menominee River, Showing Dam and Spill-way.



Clam Bake at Sunset Lake, Iron River, Mich.

Crystal Falls, Mich.

BLOCK CAVING AND SUB STOPE SYSTEM AT THE TOBIN MINE, CRYSTAL FALLS, MICH.

BY FRED C. ROBERTS, CRYSTAL FALLS, MICH.

The systems of mining used at the Tobin Mine were arrived at after trial of several methods, each of which proved more or less unsuitable to the peculiar nature of the ground to be mined.

Underhand stoping was tried, but soon discontinued on account of the continual falling of ground from the back of the stope. Back-stoping was next tried, but the danger from frilling ground was still too great. Sub-stoping was the third method used, and in some parts of the mine proved satisfactory, and is still used to some extent where the ore body is too narrow or of too firm a nature to be mined by the block caving system. Block caving was the next method used, and proved so well adapted to the conditions and physical characteristics of the ore that it has been adopted as the principal means of mining.

The levels at the Tobin are 125 feet from floor to floor, and the main haulage drift follows very closely the hanging wall.

In the block to be mined by caving, parallel cross-cuts, 24 feet from center to center, are driven from the main drift, as nearly at right angles as may be, to the foot-wall, and are connected at the foot-wall side by a small drift for ventilating purposes. Throughout the length of these cross-cuts, chute-raises are put up alternately on the right and left sides at intervals of 15 feet, to the sub-level 25 feet above. (Fig. 1).

The sub-level is opened 25 feet above the back of the main level. A drift is driven, parallel with and about 15 feet from the hanging wall, the entire length of the block to he mined. Cross-cuts are driven to the foot-wall from this sub-level drift directly above the cross-cuts on the main level. Opposite each cross-cut on the sub-level a raise inclined about 45 degrees is put up from the sub-drift to the hanging wall, the object being to leave an additional thickness of back above the main haulage drift. The cross-cuts on the sub-level are connected every 15 feet by drifts over the line of chutes, leaving small pillars of about 10 ft.x16 ft. It is sometimes necessary to cross-cut these small pillars again, depending upon the nature of the ground. A drift is also driven along the foot-wall connecting all the cross-cuts. (Fig. 2).

After the pillars have been reduced to a suitable size, they are drilled with a sufficient number of holes so that they may be all blasted at once. The pillars furthest from the man-way being drilled first. Holes are also drilled around the tops of the chute-raises and blasted, making the raises funnel-shaped at the top. At the ends of the block to be caved. It is necessary to weaken the ground so that it will cave square with the pillar. Raises are put up from the end cross-cuts at varying intervals, depending on the nature of the ground. These raises are connected by two cross-cuts 25 and 50 feet respectively above the sub-level. (Fig. 3).

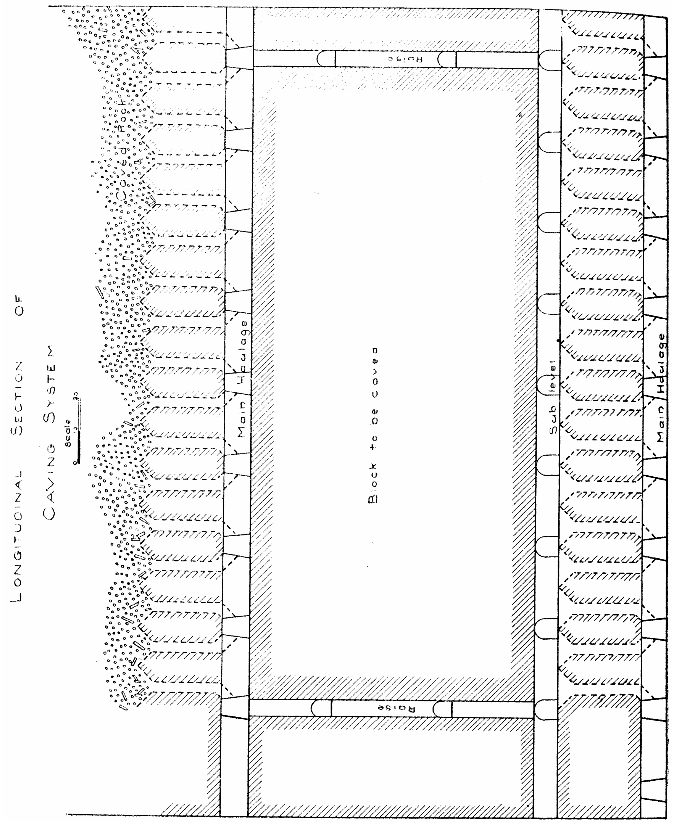


FIG. 1

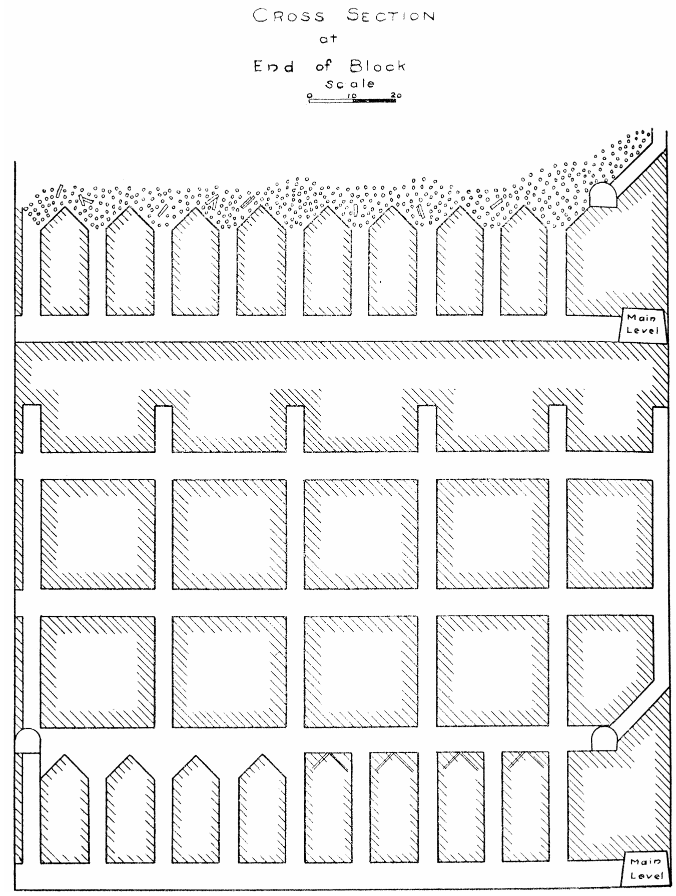


FIG. 3

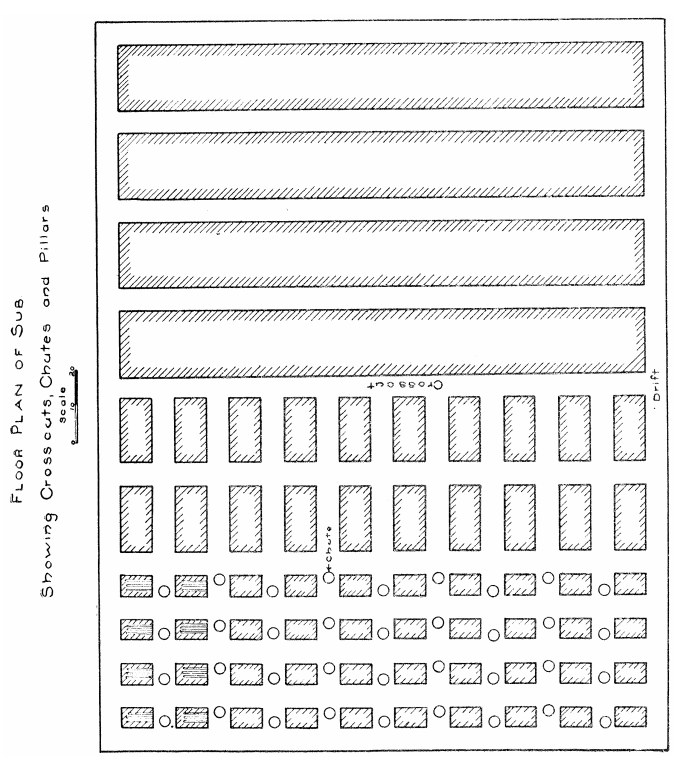


FIG. 2

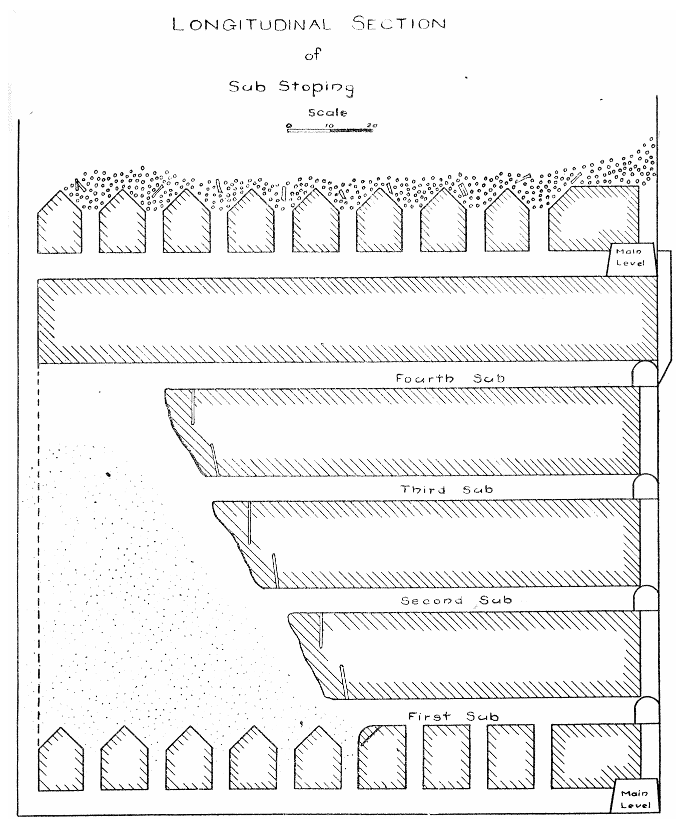


FIG. 4

After all the necessary raising, drifting, and cross-cutting have been completed, the holes in the pillars of the sub-level arc all blasted at once, undercutting the entire block, which settles down on the back of the level below. The ends of the block not: being entirely cut off from the pillar, the ore does not drop down in one solid block, but breaks up in settling and comes down in such shape that it can be handled through the funnel shaped chute-raises with only occasional blasting of masses that lodge in the chutes. The caved ore is drawn uniformly throughout the level, so that it will settle down evenly, and this keeps the caved rock from the old level above from getting mixed into the ore. For this method of handling the block-caving system, as far as known to us, we are the originators. (Fig. 4).

Sub-stoping is used where caving is not practical; at the narrow ends of the ore body, and in pockets and smaller deposits that are sometimes found separated from the main body. Conditions vary so in these cases, that they have to be met in different ways. The nature of the ground and dimensions of the ore body have to be taken into consideration in each case, and the method of mining adapted to it.

The usual method of working these places is to drive a drift on the main level the entire length of the ore body in question, and determine the width of the same by cross-cuts. Chute-raises are put up at intervals of about 15 feet. From a raise, at the end of the ore nearest the shaft, a sub-level is opened 15 feet above the main level. This sub-level consists of a drift the length of the ore and connected at the far end with a raise from the main level. Second, third, and fourth subs are opened in a similar manner above the first, twenty feet being the usual distance from the back of one sub-level to the floor of the next above. The raise at the far end of the ore is carried through to the upper sub.

All preliminary development work being completed, stopping is begun at the far end of the ore on the lower sub-level. Upper and underhand holes are drilled and blasted around the raise which connects all the subs at the far end. The ore thus broken falls into the chute at the bottom of the raise. This is repeated until the lower sub is drawn back 12 or 15 feet, (Fig. 5) when the miners on the second sub begin stoping in a similar manner to that done on the first sub. The second sub having been drawn back to a safe distance, the third sub stope is begun. In this way each gang of miners is always working under solid ground and far enough back to escape falling ground from the stopes above.

The width of stope that can be carried this way depends upon the nature of the ground. In the Dunn and Great Western mines where the ground was exceptionally firm, with a strong capping above, stopes were worked out 80 feet wide. The first stope was carried 30 feet wide through the middle of the ore, beginning at the far end and drawing back. Benches (Fig. 6) were then cut at each sub-level the entire length of the ore pillar on each side of the stope. These benches were cut into the pillar far enough to protect the men from falling ground from the others working above. Beginning at the far end and drawing back, these benches were stoped, out by upper and underhand holes, the broken ore falling into the open slope. The process was repealed to remove the remaining ore in the pillars.

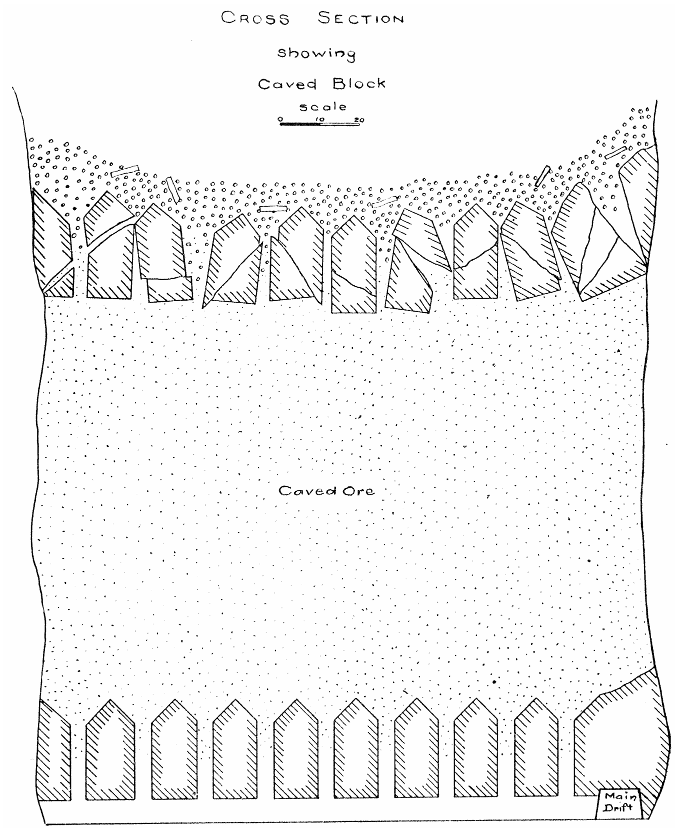


FIG. 5

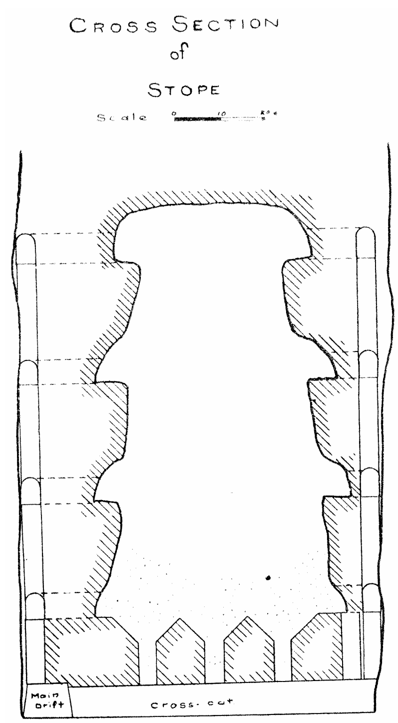


FIG. 6

DISCUSSION.

F. W. SPERR—Mr. Roberts' reference to the necessity of drawing off the ore uniformly, is a consideration of the highest importance in the block-caving method; for, if ore should be drawn from one chute continuously without drawing any from the surrounding chutes, a vertical pipe of material with a diameter about equal to that of the bottom of the chute would move downward all the way from surface. If a large unbroken block of ore obstructs the vertical passage, a hole will work itself out to one side, forming a new chute to continue its way upward to surface or to the bottom of another large piece, making a devious, narrow path for the material to pass through. The overburden of sand or other waste material will appear at the bottom before any ore comes in from the sides. The gathering in from the sides always begins at the top. But, if all the chutes are drawn evenly, the whole mass of ore will settle evenly, and the overburden will follow without mixing with the ore.

THE CORNWALL, PA., MAGNETITE DEPOSITS.

BY E. B. WILSON, SCRANTON, PA.

That there has been considerable speculation over the genesis of the Cornwall magnetite deposit in Lebanon County, Pa., is due to its structure, composition, and geological surroundings differing materially from the magnetite deposits of New Jersey and New York.

Persifor Frazer, Jr.,* in Vol V. of the Transactions of the American Institute of Mining Engineers, says: "It is not quite certain how much of the magnetic particles with which these ores are mixed may have come from the trap itself. * * * It is likely that much is to be ascribed to this source; but, however that may be, it cannot but be of the greatest significance that the two plates of trap which occur near these mines inclose or cover the greater number of producing deposits."

The foot-wall of the Cornwall ore deposit is trap rock approximating basalt, that forms a kind of basin in which the ore is found. The hanging wall or cover immediately above the ore to the south of Middle Hill mine is limestone, and through this there is a nearly vertical trap dike that places the age of the former as older than the latter. As the country rocks are sedimentary it is not difficult to understand that they would naturally be shattered and fissured by the intrusion of die trap rock, and that the mineral solutions which accompanied the intrusion and continued for some time afterward would circulate through the fissures. It is presumed therefore that these deposits were formed by replacement and are not of magmatic origin as are the magnetite deposits of New Jersey and New York. This hypothesis is based on the fact that there is an almost horizontal bedding of the ore which indicates that stratification antedates the formation of the ore, in fact limestone is found alternating with thin streaks of ore that give the whole a banded and often a serpentinized appearance. On Grassy Hill there is a limestone outcrop that is covered with decomposed buff-colored clay that resembles the clay covering of limonite deposits. Traditional reports state that considerable red hematite was mined from one part of this hill, while to the north and west, adjacent to the trap wall, the greenish black magnetic ore was mined.

*Vol. V Trans. A. I. M. E., page 142.

According to E. V. D'Invilliers, who, after a careful study and examination of the deposits wrote a monograph for the Second Geological Survey of Pennsylvania, "the original formation was made up probably of lime shales containing magnesia, silica, alumina, and iron pyrites. This probability is increased by the bedded and laminated stratification, and it is converted into a certainty by the fact that a considerable thickness of unchanged lime shale layers, passing upwards into solid beds of hard limestone, show themselves near the southern side of Middle Hill mine in the body of the ore mass. These unchanged lime shales at one place are seen resting upon the ore; at another place the limestone beds dip under the ore layers at the same angle and apparently change gradually into ore."

Conditions so far as exploitation goes have changed somewhat since Mr. D'Invilliers' inspection of Middle Hill. Serpentine and other magnesian silicates are found near the junction of the limestone and particularly near the dike, which points rather conclusively to the alteration coming from solutions that were capable of metamorphosing the limestone.

It is possible that the Cornwall deposits, since they are not magnetite magmas like those of New Jersey and New York, may have been formed in one of two ways by the ascending thermal solutions: First, the deposits may have been hematite masses that were changed by the solutions into magnetic masses. Second, the deposits may have been limestone, or such as D'Invilliers describes, that were changed by solutions, in either case it is assumed on good grounds that they were formed by ascending solutions.

Dana, in his System of Mineralogy, stated that: "Deville formed crystals of magnetite artificially by the action of hydrochloric acid on heated ferric oxide; and also by the decomposition of ferric oxide with boracic acid."

Prof. Thomas A. Eggleston, in Vol. V, page 131, of the Transactions of the American Institute of Mining Engineers, says that "some of the hematite ores of Lake Superior contain boracic acid," and he gave the following instructions for its identification:

"Pulverize, calcine and moisten the pulp with sulphuric acid. Heat some of the mass on a platinum wire to expel the sulphuric acid, then moisten with glycerine, and flame. If boracic acid is present it will infallibly give a green flame." This ore gives a green flame, but it may be due to copper, which also gives a green flame.

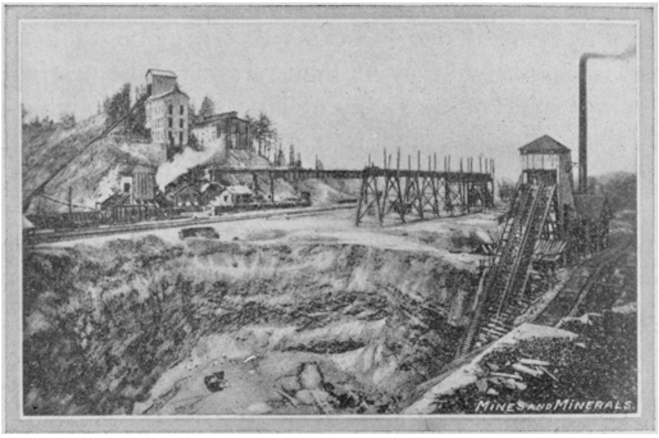


FIG. 1—CORNWALL ORE MINES
No. 1 Steam Hoist to right; Robesonia Hoist in center near tracks; No. 2 Hoist and substation on the hill; Ore bin and Stockpile in middle.

The structure of the Middle Hill ore is mostly massive, with small pit marks here and there containing small crystals of magnetite, and through the ground mass, pyrite chalcopyrite, and other minerals are found. D'Invilliers mentions 25 different kinds of minerals as being found at these mines, the copper minerals being a cuprous variety of pyrite, chalcopyrite, covelite, cuprite, hydrocuprite, chrysocalla, malachite, and azurite. No analysis of the ore is free from copper. At one time copper was mined as a commercial proposition, approximately $175,000 worth being sold. This was mostly green and blue carbonates and chalcopyrite.

The gangue of the ore is sand, which in places seems to he laminated. The sand is line and light colored, showing it has been leached, and frequently it appears in small thin folds and contortions like the various layers of hornblende, mica, and quartz in gneiss.

This indicates that acid solutions displaced the limestone, and the sand particles, being insoluble, segregated as found.

Mining operations are said to have commenced at Cornwall in 1740, which is 16 years earlier than at the Forest of Deans mine near Port Montgomery, in New York state. Tradition states that artillery was made for the Continental army at the old Cornwall furnace.

Prom the three deposits in Big Hill, Middle Hill, and Grassy Hill over 20,000,000 tons of ore have been removed. The greatest quantity mined in one year was. approximately 835,000 tons; however, with the present facilities this no doubt could be increased to 1,000,000 tons, if there was such a demand for the ore. The Lackawanna Steel Company and the Pennsylvania Steel Company are the principal consumers, the market for the ore being narrowed by its low tenor in metallic iron and its high sulphur. The ore, when exposed to the weather, is oxidized to some extent, and loses some sulphur. However, before being charged in a blast furnace it is roasted. An analysis of the ore in percentages is as follows: Silica, 15; alumina, 4; lime, 3.5; magnesia, 5.5; metallic iron, 48; sulphur, 3.5. After it is roasted in Gjers kilns the sulphur is reduced to about 1.07 per cent, and in this condition it is possible to smelt Bessemer pig owing to the extremely low phosphorus content.

Ore is roasted in Colby furnaces very successfully with blast furnace gas by the Pennsylvania Steel Company.

FIG. 2—Open Cut Workings in Middle Hill.

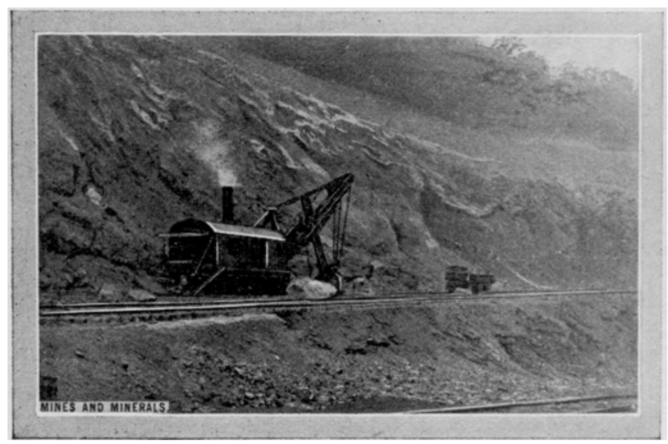


FIG. 3—Steam Shovel Loading Iron Ore.

In Fig. 2 is shown the open-cut workings in Middle Hill, taken from Big Hill in the foreground, which is practically worked out. Between Big Hill and Middle Hill the railroad tracks are supported on ore left there for that purpose. This view, although taken in 1908, does not materially differ from the conditions governing the mines today, although there have been a number of important surface improvements. Grassy Hill mine is to the rear and right of Middle Hill mine and does not show in the illustration.

The Middle Hill mine has been worked to a depth of 150 feet for approximately a half of a mile; however, there is a considerably greater area to be stripped and exploited besides 150 feet more depth before the bottom of the deposit is reached. In the process of mining, a comparatively light cover of soil and rock is removed, as shown in Fig. 3 on the top bench above the stream shovel. The removal is accomplished by putting down a series of drill holes, then chambering or bulling them, and finally loading and firing them with a battery. The cover is thus broken in sizes that the steam shovel can readily load into dump cars. When the cover has been removed a wide bench of ore remains that can be broken so that; it falls to the bench on which the steam shovel is working, shown in Fig. 3. In this way there has been formed a series of four stopes or benches from which ore is mined. Fig 4 shows a steam shovel on the floor of the third stope on the foot-wall side of the mine. The locomotive zigzags with the loaded cars from the lower to the upper stopes, although on the present main level the ore is delivered in 50-ton cars to the incline of the crushing and screening plant. The ore car shown attached to the locomotive in Fig. 4 is a 50-ton car which dumps into a steel-foot frame pocket. To break down the ore it has been customary to put down a series of 18 to 24-foot drill holes with, air drills on each bench, then charge and shoot the holes simultaneously. In this way a quantity of broken ore can be kept ahead of the steam shovels. Recently two small traction well-drilling machines have been installed to put down holes where depth greater than the air drills can furnish is desired. These are worked on benches ahead of the steam shovels, and although slower than air drills, their holes, being larger and deeper, probably even up to the quantity of material broken over a given time. The ore broken from the stopes falls in all sizes, making it necessary to block hole extra large pieces and "block blister," smaller and more suitably shaped pieces. To "block blister," a piece of dynamite has a cap and fuse attached in the usual way, after which it is placed on the ore to be broken and covered with loose dirt. The dynamite, when exploded, breaks up the material into pieces that can be scooped up by the steam shovels, although that machine delivers pieces weighing 3 or 4 tons at times into the cars.

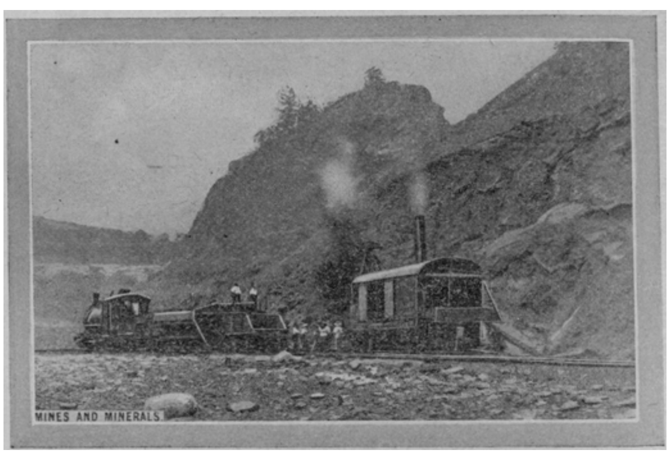


FIG. 4—Steam Shovel and Ore Car on Third Stope.

The extreme eastern hoist at the foot of Big Hill is known as hoist No. 1 of the Cornwall Ore Banks Company. This is operated by steam but is at present closed down. Ore from the Big Hill basin is taken through tunnels to the Cornwall Ore Banks Company's No. 2 hoist operated by electricity.

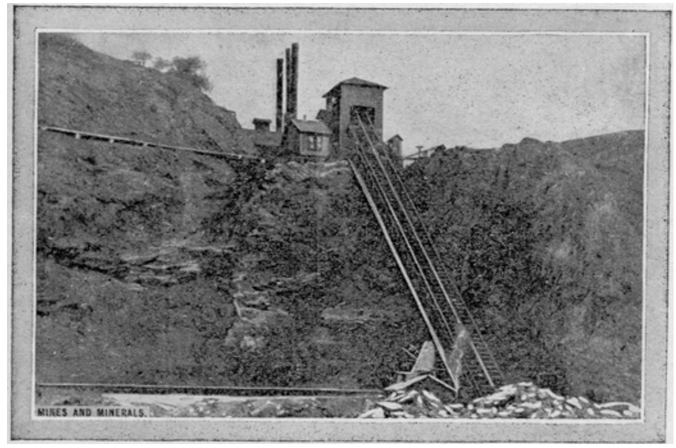


FIG. 5—Eastern Incline Middle Hill Mine.

While a large tonnage of ore could be removed from the west end of the Middle Hill mine by cars attached to locomotives, at the present time all ore is hoisted at the eastern end of the Middle Hill mine up two inclines. At this end of the mine it is necessary to sink in order to form a stope that can be carried the length of the mine, and this stope, which is from 40 to 60 feet high is worked at right angles to the length, that is, the width, for about 400 feet.

The eastern incline in Middle Hill mine, shown in Fig. 5, is operated by the Robesonia Iron Company, who have the right to mine sufficient ore for one furnace only. This company loads ore directly into skip cars which are hauled by mules over several tracks on the main level to the steam hoist where they are hooked to the cable and hoisted from the pit.

At the top the ore is dumped directly into chutes that load the broad-gauge cars. This arrangement necessitates loading cars by hand and sledging up pieces of ore so the men can handle them. However, when in this condition the product is about ready for the furnace. Attention is called to the trap dike to the left of the incline, and to the small quantity of rock in this deep pit.

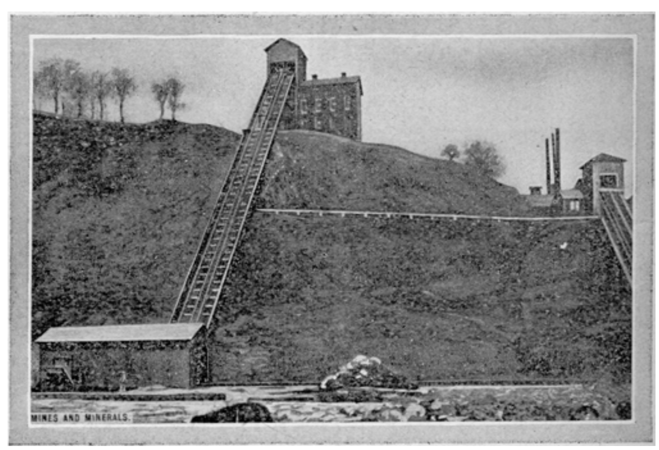


FIG. 6—No. 2, Incline and Skip-Loading Bin.

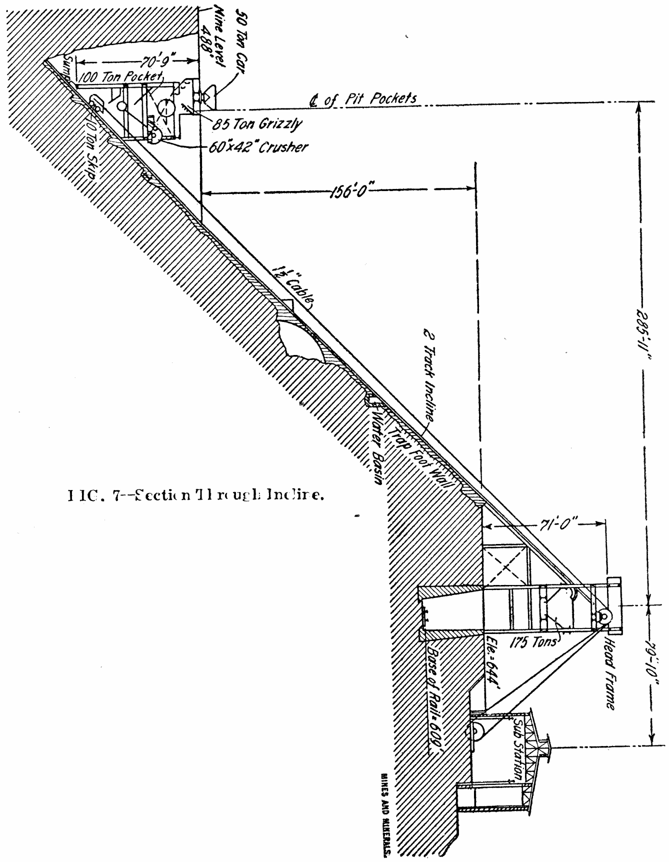


FIG. 7—Section Through Incline

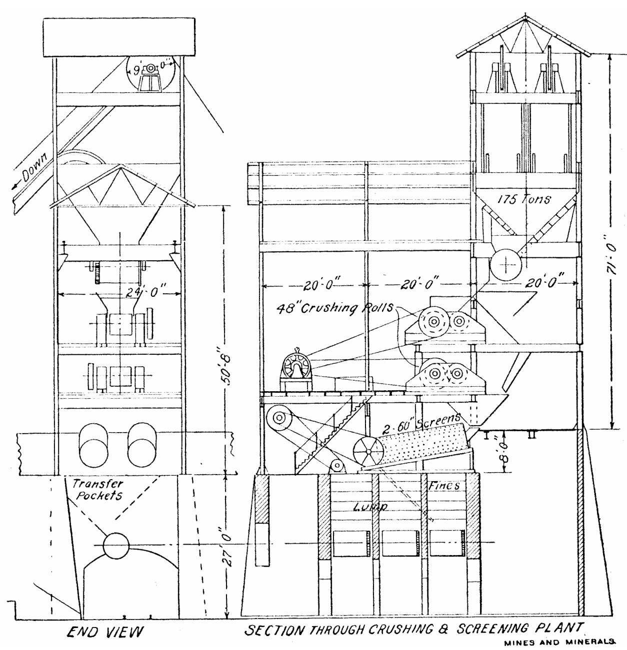


FIG. 8—End View and Section Ore Preparing Plant

To the west of the Robesonia incline is a second, or No. 2, incline, show in Fig. 6, which was constructed in 1909. This is a most interesting installation, consisting of a steel foot house or frame, combining with crusher and skip-loading bin, and a steel head-frame combining with crushing, screening, and transfer arrangements. The foot-frame is 20 ft. x 30 ft. x 70¾ ft., and is covered as shown in the illustration. The large 50-ton ore cars when loaded are run into the shed above the frame and dumped into a large hopper which, in Fig. 7, is termed an 85-ton grizzly. Whatever is small enough to pass through the grizzly bars falls into the 100-ton pocket from which the skip is loaded; but whatever passes over them is fed by a 9-foot rotary drum to a 60"x42" Farrel jaw rock crusher. This machine will receive a piece of ore weighing 4 or 5 tons and crush it to 12-inch sizes. To work this crusher it requires 150-horsepower, 25-cycle, three-phase Westinghouse induction motor, making 860 revolutions per minute at 440 volts and 210 amperes. The feed-drum to the crusher sometimes becomes clogged by ore jamming, in which case if the pieces are large and cannot be started by bars, they are blasted. Occasionally a large piece of ore will fall over the mouth of the crusher in such a way as to lodge. To turn this so as to insert it in the jaws a compressed-air hoisting crane, installed for this purpose, is brought into use. The ore from the crusher falls to the 100-ton ore bin, where it joins the material that passed the grizzly. The ore from this bin is loaded into 10-ton iron skips by means of 6-foot diameter roller feed. Along the foot-wall above the pit there is a water basin or ditch excavated, which catches the water from the foot-wall and leads it to a brook so that it does not enter the pit. It is only in times of thaws or heavy rains that water is plentiful in the slope sumps, and this is cared for by steam and electric pumps. The hoisting engineer is down in the foot-frame where he can see to the loading of the skip, in fact he controls the motors that rotate the drums. However, he has an assistant who opens and closes the chute gates to the skips. The hoisting is done on two tracks by 10-toii skips attached to 1½-inch steel ropes that are wound on drums driven by electric motors. To hoist, the engineer moves a master switch to the right or left, and as the skip nears the dump at the head-frame, the power is automatically gradually shut off. As the dump is reached, the power is entirely turned off and the air brake goes on. At this point the skip is discharged and held by the compressed air until the engineer releases it by reversing the lever. An end view of the crushing and screening plant attached to the head-frame is shown in Fig. 8. In this plant, motor-driven rolls crush and screen and size the ore previous to its being transferred by a 50-ton electric dump car to the 2,500-ton loading pockets, or 35,000-ton capacity stockpile trestle. At the pockets the 5-foot roller feed-gates can load a 45-ton car in 4 minutes, including spotting and delivering to the railroad company's tracks. The ore from the stock pile is loaded by steam shovel into railroad cars in case there should be a temporary cessation of hoisting for any purpose. The head-frame, loading pockets, and stock trestle are connected by a steel viaduct which passes over the several railroad tracks, as shown in Fig. 1. The electric power for the various machines is generated at Lebanon, about 6 miles away from the Cornwall ore bank. At Lebanon a furnace belonging to the Pennsylvania Steel Company has a Semet-Solvay byproduct coke-oven installation that supplies sufficient gas to run two twin Westinghouse gas engines, each of

1,200 horsepower for the electric power needed "at the mines. These gas engines run 3,750-kilowatt Westinghouse dynamos that generate current at 440 volts, which is stepped up to 11,000 volts for transmission to Cornwall. To the rear of No. 2 head-house is the substation where the current is stepped down to 440 volts for use in the various motors. To take care of the heavy peak load in the skip hoist, a rotary converter is provided to give direct current for the 500-horsepower hoisting motor. An electrically operated Ingersoll-Rand air compressor, furnishing 3,200 cubic feet of free air per minute, supplies 13 compressed-air drills and other labor-saving machines at the mine.

TOP SLICING AT THE CASPIAN MINE.

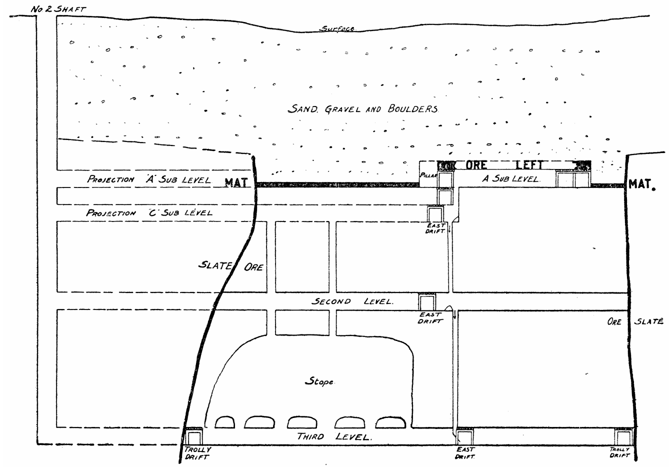
BY WM. A. MCEACHERN, IRON RIVER, MICH.

The Caspian ore body was found in 1900 by churn and diamond drilling. The surface averaged 130 feet and many of the holes were only chopped into the ledge to determine the best location for a shaft. In January 1902, No. 1 shaft was started. This was a drop shaft and was landed April, 1902, with difficulty, on account of sand and water. The shaft was continued to 380 feet. From the shaft crosscuts were started on the second and third levels and continued across the ore body. Drifts east and west and then crosscuts, 50 feet apart, parallel to the main crosscut, were continued to the rock. No. 2 was also a drop shaft and was sunk to the third level. This shaft is used for lowering men and timber.

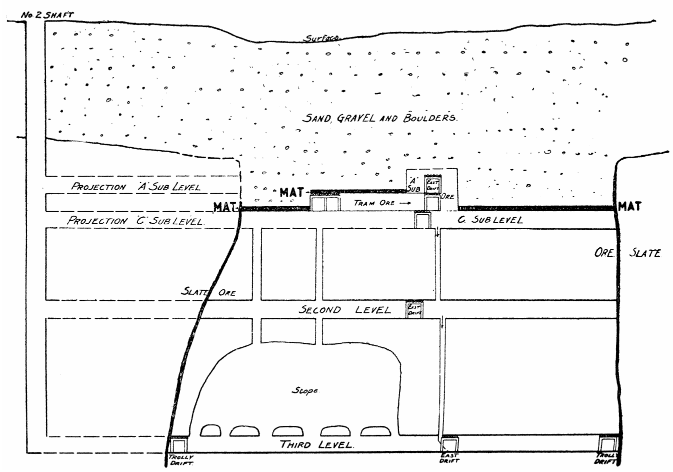
STOPING—Between the second and third levels, nine stopes were opened up. These were started directly over and about ten feet above the back of the crosscut. The method used was back stoping; drilling holes into the back and blasting, then standing on the broken ore and drilling another round of holes. The average size of the stopes was one hundred feet long, twenty-five feet wide and fifty feet high, leaving a pillar of twenty-five feet between the stopes.

DRAINING THE SAND—The ore near the ledge could not be mined until the water was drained from the sand. Very little work was done on the first level, now called "C" sub-level, until 1908. This level was then extended and crosscuts started directly over the crosscuts on the second level. Small raises were put up from this level in various parts of the mine. A twelve-foot test hole was drilled ahead of each cut to ascertain the height of the sand, then six-foot holes were drilled and blasted. When the test hole reached the sand, six-foot holes were again drilled and blasted, leaving five or six feet of ore to hold up the sand. Three more holes were drilled to hasten the drainage. Forty-eight raises were put in and some ran with little decrease in water for over a year.

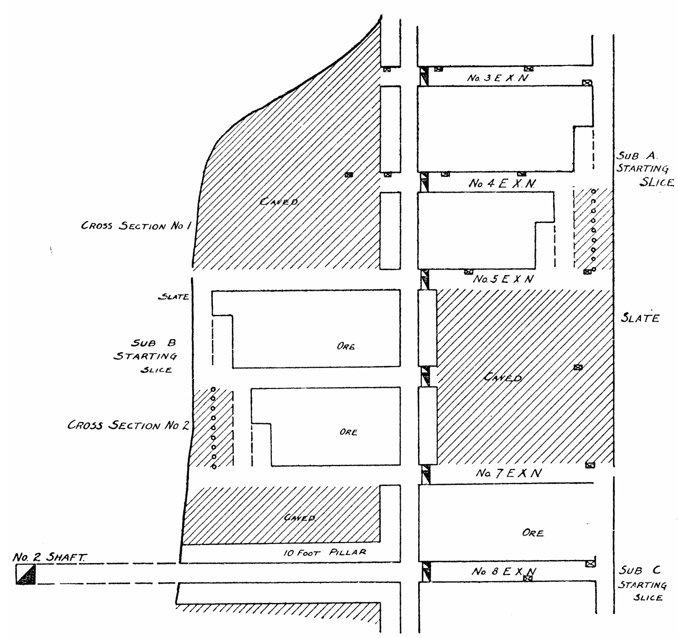
CASPIAN MINE
CROSS SECTION No. 1



CASPIAN MINE
CROSS SECTION No. 2.



CASPIAN MINE.
PLAN OF SUBLEVELS.



TOP SLICING—Top slicing at the Caspian mine is the method by which the ore is mined off at the top in slices ten feet thick and directly under the overburden. In June 1908, a raise twenty feet high was started from No. 5 east crosscut on the first level. This was a cribbed raise and had two compartments, one for ladders and one for ore. The height was determined by the distance to the ledge. When this raise was completed other raises were started and crosscuts east and west were started from them and continued to the rock. This was the beginning of the top or "A" sub-level. The crosscuts were timbered using eight-foot caps and legs and lagging in the back. Connecting the crosscuts on the end completes one slice as shown on the plan. The machine was moved back and another slice eight feet wide was started. These were timbered the same as the crosscuts and lagging laid on the floor when the slice was finished. When the fourth slice was finished the middle legs of the first two sets (shown on plan as small circles) were drilled and blasted bringing the overburden to the floor. The mat which prevents the sand from mixing with the ore consists here of five feet of ore left behind, and the caps and legs of timber sets and lagging from the back and the floor. The slicing of the pillars was continued until only a ten-foot pillar was left at the main drift. (Cross section No. 1). This operation was carried on in as many crosscuts as the demand for ore required and pillars were left on each side of the main drift for the transportation of timber to the two succeeding sub-levels.

"B" SUB-LEVEL—The back of this level was even with the mat and is ten feet below "A" sub-level. On "B" sub-level there were three points where the operation differed from "A" sub-level:

(a) No back holes were drilled as the ore stripped off the mat.

(b) The timber was kept closely to the breast to hold up the mat.

(c) Boards were used on the floor instead of lagging.

No. 2 cross section shows "B" sub-level on the west side half drawn back, and on the east side finished with the exception of a ten-foot pillar to support the drip. On the east side is also shown a crosscut in "C" sub-level ready for slicing. In any part of the mine slicing or cross-cutting is not begun until the ore is taken out above it.

SUB-LEVELS BETWEEN THE STOPES—Within the next ten years, if one sub-level a year is finished, the sub-levels will be down to the stopes. The stopes must be filled with ore and trimmed and then crosscuts run between the stopes to the rock. The pillars will be sliced the same as before.

When the overburden is let down part will rest on the floor of the pillar and part on the filling in the stope. It will be necessary to carefully watch the chutes to the stope as lowering the filling might ruin the mat and allow sand to mix with the ore.

ELECTRICAL OPERATION OF THE PLANTS OF THE PENN IRON MINING COMPANY.

BY FRANK H. ARMSTRONG, VULCAN, MICH.

All of the machinery of the Penn Iron Mining company, with the exception of two hoists, has been operated by electrical power since the month of March in the year 1908. The hydro-electric plant, from which the power is obtained, was described and illustrated in a paper which was read at the 13th annual meeting of the Lake Superior Mining Institute in the month of June, 1908. A general description of the methods of applying the electric power to the mining machinery was also given in that paper.

Plate I shows the power obtained from the Menominee river for a period of nearly four years. In the year 1910 a 1500 K. W., 3600 R. P. M. Westinghouse-Parsons steam turbine was installed to supplement the hydro-electric plant and for use in case of a break-down at the power plant, or on the transmission line. Since the installation of the turbine, the curves show both the power output from the hydro-electric plant and the mine requirements. The cross hatched area between the two curves represents the amount of power supplied by the steam turbine.

The largest part of the power used for mining is consumed by three classes of machinery, viz: pumping, air-compressing and hoisting.

PUMPING.

For three and a half years there has been in operation at the East Vulcan mine one, and at the West Vulcan mine two Worthington 8-inch, 8-stage turbine pumps, pumping against a head of a little over 1,200 feet. (For description and illustration, see paper referred to above).

The principle improvement made on the pumps since they were installed is in the method of controlling the thrust. The water-step bearing that was put on the discharge end of the pumps soon after starting was at first supplied with water from the discharge pipe at 550 pounds pressure. This is now supplied by a small triplex power pump giving a constant volume of water through the step and positively preventing the revolving and stationary parts of the step from coming in contact. After priming, and opening a 4-inch by-pass valve, the pump is started and then the by-pass valve is gradually closed until the pump is discharging against the full head. The pressure on the step gradually increases from 25 pounds to nearly 400 pounds per square inch, and then decreases as the by-pass valve is still further closed, to approximately 25 pounds.

At the East Vulcan mine a Prescott 8-inch, 8-stage pump was recently installed, having an oil pump driven by the main pump that keeps a constant quantity of oil flowing through the thrust. This oil is circulated continually and relieves the pump-of all thrust troubles.

The efficiency of these pumps varies with their condition from 63 per cent to 56 per cent wire at the motor to water at surface. Their capacity can be readily varied from 1300 G. P. M. to 500 G. P. M. by throttling the suction.

At the bottom of the mines, pumping to these station pumps, there are turbine pumps of similar design, with two or three stages according to the lift. As the shaft is sunk deeper, and the pumps are put lower down, the number of stages may be increased by combining the pumps in series. One pump is designed to permit increasing the diameter of the impellers to accommodate the higher head.

The delays due to wear, breakage or accidents, on the one pump at the East Vulcan mine, which had no spare electric pump and was always kept running, except when idle for repairs, amounted to 346 hours in thirty-three months. In other words, the pump was idle due to wear, breakage or accidents about 1½ per cent of the time. The replacing of the steel bushings that prevent the packing from wearing the shaft is the principal repair required.

For smaller quantities motor driven reciprocating pumps are used. There are two for 175 gallons per minute 200 feet head and one for 125 gallons per minute 810 feet head.

COMPRESSORS.

There are in use four motor-driven compressors in the Penn group of mines, as follows:

2 Ingersoll-Rand Compressors.........3100 cu. ft. capacity
1 Laidlaw-Dunn-Gordon Compressor..2200 cu. ft. capacity
1 Ingersoll-Sergeant Compressor...... 950 cu. ft. capacity

(All compress to 80 pounds gage pressure).

The three larger machines are rope-driven, using the Dodge-American system. The smaller machine is driven by a belt. The rope drives are very satisfactory, being quiet, efficient and durable. On the two largest machines owing to lack of space the distance between pulley centers was so short that it was necessary to use a deflector pulley. This puts a reverse bend in the rope and reduces the life somewhat. On the 2200 cu. ft. compressor the first rope (1¼") lasted three and a quarter years. With this machine no deflector pulley is used. The motor pulley is 50 inches in diameter and the compressor wheel is 12 feet in diameter.

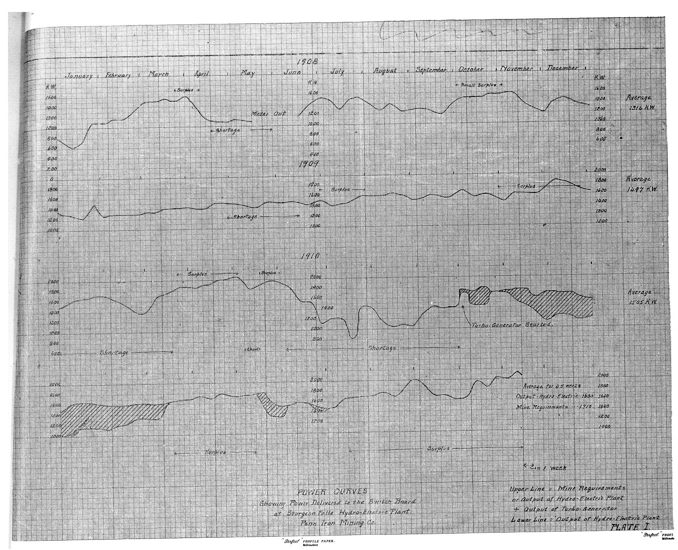
Several tests on the Ingersoll-Rand compressors show the efficiency from motor terminals to indicated horsepower of air-cylinders to be 85 per cent.

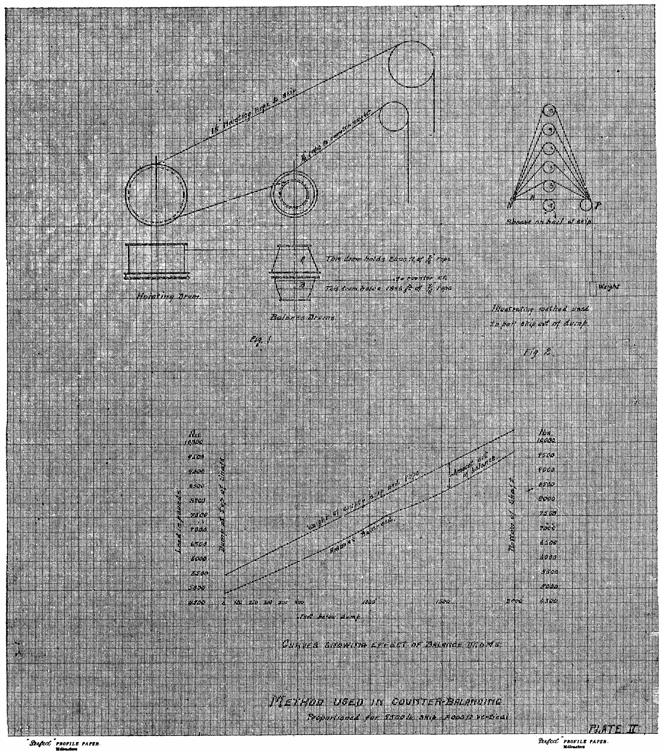
HOISTS.

Only the second motion or geared hoists were converted from steam power to electric power. A single skip is sufficient to hoist all the ore at any of the company's shafts. The method of making the change, with illustrations of some of the hoists, is given in the paper referred to above. All of the electric hoists, with the exception of one, have two drums arranged in tandem, keyed to their shafts and driven by Lane band clutches from each of two spur gears running loose on the drum shafts. These two gears are driven by a pinion, which shaft is also a 22-foot rope-wheel. This wheel is driven from a standard 2200 volt induction motor by a manila rope-drive. The method of starting is to bring the rope-wheel up to speed (which takes from twenty to forty seconds), and then start the drum and load by slowly throwing in the clutch. The question has been asked as to whether this method of starting is hard on the clutch.

Practically the same method has been used for years with all geared hoists. The practice has always been to bring the engine nearly up to speed before throwing in the clutch. The clutch on the new hoist, at the Brier Hill mine, which has been in active operation for nearly two years has never been renewed and shows almost no wear. The clutches on the converted steam hoists last fully as long as they did when they were operated by steam.

In order to approximate closely the efficiency of first motion plants it is necessary to counter-balance the dead weights of skip or cage and rope. The method used for this purpose is illustrated in Plate II of this paper. The two balance-drums are keyed to the same shaft, and of course, revolve together. Drum "A" is the larger of the two and is connected by a ⅞ inch rope to the main hoisting drum. From the other drum ("B") a ⅞ inch rope leads to the counter-weights hanging in the shaft. Drum "B" is smaller than drum "A," thus giving the counter-weight a shorter travel than the skip, so that it is never above the collar of the shaft, at which point it might freeze while the skip is at the bottom waiting for a load. The tapers on these drums are designed so as to give as nearly a perfect balance as possible, at all points in the shaft. The curves at the bottom of Plate II show this. It is, of course, necessary to be out of balance enough to pull the drums around in lowering.





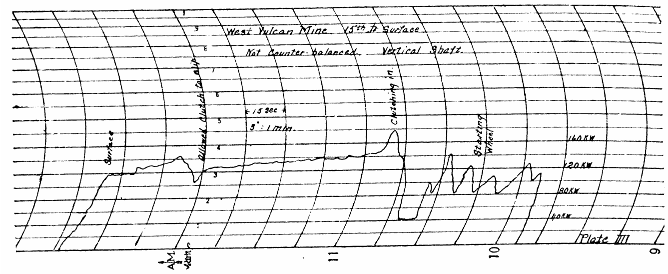
Without some further device a Kimberly skip as perfectly balanced as shown by the curve would not come out of the dump, where a large part of the weight of the skip is supported. To pull the skip out of the dump, and allow more perfect balancing, a device is used in the shaft-house, the principle of which is illustrated in Figure 2 of Plate II. Across the skip road is a rope ("R"), one end of which is anchored at "N." This rope then goes over pulley ("P") and supports a weight as shown. On the bail of the skip is a 30-inch sheave ("S") which strikes the rope ("R") when the skip is coming up, just as the skip begins to tip. As more of the weight of the skip is carried by the dump, more downward pull is exerted by the weight through rope ("R"). Anchor ("N") and pulley ("P") are stationary while sheave ("S") on skip bail rises to various positions as shown.

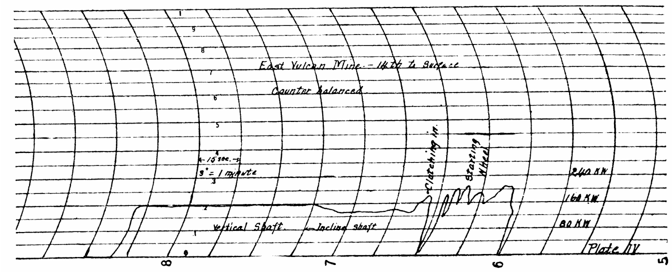
The results of this method of hoisting are shown by the curves on Plate III, IV and V.

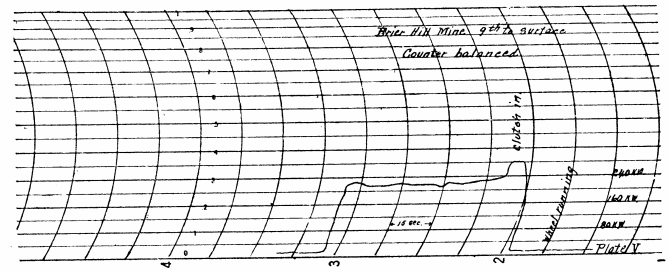
Plate III is the load curve for hoisting a cage of men vertically, taken with a curve-drawing wattmeter. This cage is not balanced and the effect of the weight of the rope is plainly seen.

Plate IV is the load curve for hoisting ore in a shaft, the lower part of which is at an incline of 60 degrees from the horizontal. The increase in power required from the turn up in the shaft is shown. This skip is balanced and the wattmeter curve shows almost perfect balancing.

Accurate information as to the number of K. W. hours used for hoisting under various conditions is valuable. Below are two tables showing the average K. W. hours used per day, per ton, and per ton-foot at the Brier Hill mine. The skip holds 6 tons of ore. Both skip and cage are counterbalanced. Before making these tests, a switch was put in the meter circuit that enabled the brakemen to cut out the meter when the cage was being hoisted. The first table and results are for hoisting ore only. The second table includes the operation of the cage, handling men, timber, tools, etc.







The following table gives the distance the skip travels from level to dump in a vertical shaft, the average number of tons of ore hoisted per day from each level (the records covered one week of 5½ days), and the K. W. hours used for the 5½ days, as recorded by a calibrated polyphase integrating wattmeter.

TABLE I.

Level	Distance	Tons	Ton Feet	Meter Reading	K. W. Hours
5th	480 ft.	4.8	2304	7 A. M. Monday......	5947040
6th	592 ft.	30.0	17760	6 P. M. Saturday......	5950236
8th	780 ft.	178.8	139464	Difference...............	3196
9th	887 ft.	255.6	226717	Divide by 5½ days,Aver of	.581
Tot., Av. day		469.2	386245	K. W. Hours per day.	

The above table gives 1.238 K. W. hours per ton of ore from an average vertical depth of 823 feet, or a power consumption of .001504 K. W. hours per ton foot.

TABLE II.

Level	Distance	Tons	Ton Feet	Meter Reading	K. W. Hours
5th	480 ft.	12	5760	7 A. M. Monday......	5955210
6th	592 ft.	8.4	4973	6 P. M. Saturday......	5960040
8th	780 ft.	246.6	192348	Difference...............	4830
9th	887 ft.	261.6	232039	Divide by 5½ days,Aver.of	.878
Tot., Av. day		528.6	435120	K. W. Hours per day.	

The above table gives 1.66 K. W. hours per ton of ore from an average depth of 823 feet, or a power consumption of .002018 K. W. hours per ton foot,

REMINISCENCES OF THE EARLY DAYS ON THE GOGEBIC RANGE.

BY JOHN H. HEARDING, DULUTH, MINN.

IRONWOOD IN 1887.

When I first arrived in Ironwood in April, 1887, the only railway completed into the town was the old Milwaukee, Lake Shore & Western, now a division of that excellent system, the C. & N. W. It was April 20th and very warm in Milwaukee when I left; but, as I dressed at about 6 a. m., I noticed that the small lakes we were passing were still coated heavily with ice, and an occasional patch of snow could be seen in the heavy timber.

I was met by an old Milwaukee friend, John G. Thompson, who was then cashier of the Norrie Mine; and, let me explain here that the purpose of this article is to bring back to the memory of some of the "old timers" the familiar faces and figures that were prominent and well known at that time in this city. The train came up by way of Watersmeet, as the Rhinelander cut-off had not been built. The depot was on the other side of the track from where it now stands, and, as I remember, we walked directly from there to the corner of Suffolk and Ayer streets. Ayer street was commonly known as "Front street" because the town was built up along this street originally; as the railway yards were parallel and opposite, as now, and naturally it was the first to be improved, in order to take care of the unloading of freight—a very important thing in a new town.

On one corner of Suffolk street and Ayer there stood the store of Bingham and Perrin—a combination building of frame and logs. Opposite or on the westerly side was the St. James Hotel, a building of two stories extending nearly to the alley. In the corner store of the St. James was the Bank of Ironwood, over which presided as cashier, Otto Karste. Going westerly from the St. James Hotel on Ayer street one saw numerous wooden buildings, with a variety show and saloons in them; the largest was the Alhambra Theater, a two-storied variety show of the worst character, run by one Paddy O'Neil, whose boast was that of a head so hard that he could butt the panel out of any bar in town.

Occupying a corner similar to the St. James but a block east was the Walker House, the first hotel in town, I was given to understand. Across from that building was Fred Prescott's hardware store, a group of low single story buildings that have only been removed during recent years. Westerly from Bingham & Perrin's store were the usual two-story frame buildings occupied by different business enterprises, mostly saloons, excepting the further corner one which was occupied by the Ironwood Store company, whose destinies were presided over by Thos. Atkinson.

Up Suffolk street on Bingham & Perrin's side were several frame buildings, one a saloon of an old French-Canadian, a Civil war veteran and quite a character. His family difficulties were generally settled between himself and his wife in public; his wife occupying the middle of the road, which was generally knee deep in mud, and he occupying the front door. Their language on such occasions was hardly repeatable in any society, and one of the preliminaries at the fray was his carrying her sewing machine down to the express office and ordering it sent to Peshtigo, their old home, which was never done by W. L. Pierce, the agent for the company, whose office was next to the Bank of Ironwood on Ayer street. The corner building, where Davis and Fehr's store now stands, was a frame one occupied by diet Boyer's saloon. Across from there was Harry Weeden's drug store and Will Winslow's jewelry store, where the Bank of Ironwood now stands. Between that building and the St. James were several buildings, one of which was occupied by the postoffice, the postmaster being George Kelly; another, as I remember, was occupied by I. M. Beans' jewelry store.

This was the general view I obtained of the town when I arrived. The frost was just going out of the streets and before getting my breakfast I went to Bingham & Perrin's and purchased a pair of rubber boots, as Mr. Thompson told me they would be absolutely necessary. We then went to breakfast at the St. James and I then met several of the gentlemen I have already mentioned. At this time, I believe, I also met Mr. C. H. Munger, then superintendent of the Odanah Mining company.

The dining room of the St. James was in reality a store. The office another store room with the rear partitioned off to make a kitchen. Naturally there was a door in the front part of the dining room that opened immediately onto the sidewalk. The door was supplied with a screen and usually hooked on the inside. Its being unhooked caused considerable embarassment to the speaker one day when a total stranger, with more liquid refreshments inside than was good for him, walked into the dining room and up to the table where I was seated with several others, and to their great amusement gave out the following sentiment: "Say Jimmy, if you're going to be a sport, blow yourself." He was removed by the proprietor, C. J. Laughren, immediately. After breakfast I went up to the Norrie mine and was initiated by Mr. Thompson into the duties of timekeeper. As we walked up Suffolk street I noticed several buildings and will mention them to possibly bring to the minds of others who were there at the time those that I have forgotten.

Where the First National Bank building now stands, there was a vacant lot, on the third lot from the corner was a hardware store run by Ed. Maxon, and next to the alley where it now stands was Mullen Bros.' furniture store. A hotel building was being erected where the new St. James now stands, called the Grand Hotel, from which the new St. James was remodeled. On the corner of Aurora and Suffolk, opposite the present First National was a residence occupied by Matt Fitzsimmons, Sr. I believe one other store building was erected in that block, but I am not absolutely sure. Pierce's Opera House graced its present site with Wm. Rothschilds building opposite facing on Ashland street. A few other buildings were also erected further up the street, among them, George Kerbitz saloon, well known and liberally patronized, but exactly how many I do not remember. On the left hand side of the last block were two boarding houses, and between them and town was J. H. D. Stevens, the then new probate judge's residence.

An amusing incident occurred in his election which had just taken place. His opponent was a painter, who later ran a saloon in Ironwood. The majority for Stevens was about 5, as I remember it, but after the election and within two years, a quiet looking gentleman arrived in town from Chicago and invited Stevens' opponent to return to that place under charge of highway robbery. Had Stevens received three less votes Gogebic County's first probate judge would have had to leave his honorable position for an Illinois penitentiary. I believe his sentence was reduced to one year on account of his life in Ironwood.

A conspicuous land-mark at the head of Suffolk street was No. 3 shaft house, Norrie mine. Between the end of the street and the shaft were large piles of timber and a large log barn; also a double log camp, which was the original exploration camp. In the log camp lived the surface foreman of the Norrie; none other than Jim Redmond, at one time sheriff of Florence County, and then a victim of tuberculosis. His trouble was caused by a bullet wound in his lungs inflicted by the County attorney of that County. He told me the story, which is a familiar one to many of our Menominee Range members. Even the old log barn had an experience, for in later days, it partially slid into a cave with John Bridges, the barn boss, and about 10 horses in it.

The last house on the left of the street, and next to a saloon hearing the familiar sign, "First and Last Chance," was occupied by Captain William Trebilcock of the Xorrie mine. The Norrie in the spring of 1887 had three operating shafts, Nos. 3, 4 and 5, No. 4 shaft being the original. They were all working on the second level with the shafts down to the third. No. 6 shaft was being sunk and No. 7 was a small shaft down to one level. At the East Norrie No. 3 shaft was the only opening, there being a small open pit in connection with it on the first and second level. The mining captain of the East Norrie was our present president, D. E. Sutherland. S. S. Curry was president and general manager, J. D. Day was superintendent, William Trebilcock captain of the Norrie and W. H. Knight, well known as "Bill" Knight, was night captain. The Norrie and East Norrie were then operated by the Metropolitan Iron & Land Co.

At the Ashland mine, J. H. Taylor was superintendent and Jas, McKenzie captain. The engineer and chemist of the Ashland was then a young man who lived in a small room adjoining the laboratory, and boarded in Hurley, one of the best liked and brightest men in the community, with a good nature that has lasted him until now. He rose from that position through various others to the head of the largest iron mining corporation in the country, which position he now occupies—Mr. W. J. Olcott, our ex-president. Another of our ex-presidents was then mine inspector of Gogebic County, J. Parke Channing. The superintendent of the Aurora mine was Captain Nat Hebbert and Geo. Brewer was mining captain. Major Baetz was superintendent of the Pabst mine and I think W. W. Stevens was mining captain. My recollection is that Chas. (Chuck) Stevens was then superintendent of the Iron King, now the Newport. Captain Mat Fitzsimmons was sinking an exploration called the North Aurora. The Bonnie, Blue Jacket, First National, Geneva, Puritan, Ironton and Valley mines were then working between Ironwood and Bessemer, and at Bessemer was the first mine to ship from the range, the Colby, whose manager was Jos. Sellwood, and Harry Roberts was mining captain.

West of the Montreal river on the Wisconsin side an exploration was going on called the Minniwawa operated then by the Pence & Snyder Development Co. R. J. Trimble was the manager and R. R. Trezona, superintendent. This same firm was also interested in the Pence and Father Hennepin mines. Then came the Germania on top of the hill back of Hurley, which was under the same management as the Ashland, and whose head was the present insurgent congressman from California, "Red" E. A. Hayes. His brother, J. O., was also in the management. Beyond the Germania came the Nimicon, Kakagon, Bessemer and Odanah mines with many others farther west that then were only explorations. These names and their locations are written from memory and I may not be entirely accurate though in the main I think they are.

During the spring of 1887 there was a great deal of building throughout Ironwood and new buildings could be seen springing up all over the town. Marquette street had just been cut out of the timber and new houses were going up all along it. Vaughn street terminated at its present juncture with Mansfield and the timber covered all of the ground now occupied by the residence portion of the town east of Mansfield street. The timber continued through without hardly a break to the Pabst mine. On the north side of the county road there were no breaks in the trees. The hills back of the Norrie and East Norrie mines were covered with the original forest which continued unbroken to the south. On the north side of the tracks only a few pioneers, such as Jas. Monroe, Robert E. Mace, Al. Hammond and W. H. Knight, Jr., had ventured to build. During the winter of '87-'88 wolves could often be heard howling in the swamp south of the East Norrie and deer were very plentiful close to town.

On September 17th, 1887, a fire originating in a small frame building close to the Alhambra Theater on Ayer street extended rapidly to the surrounding building's. There was nothing in the town in the way of fire protection and it soon extended easterly along Aver street, burning south toward the mines as far as the alley between Aurora and Ashland streets, practically clearing out all the business portion of the city. In spite of this disaster the town soon rebuilt, but the business section moved to its present location, and this description of old

Ironwood is given to explain to those who did not see it, some of its past glories.

BIOGRAPHICAL NOTICES.

GEORGE P. CUMMINGS.

George P. Cummings, whose death occurred in the city of Marquette, Michigan, March 13, 1911, was born, at Morgan, Vermont, Nov. 18, 1826. Early in life he was identified with railroad construction in his state, he being a, civil engineer. At one time he held the position of master of transportation on the Concord, Manchester & Lawrence railroad. He was married in Vermont to Hannah Elsen Ropes in 1851. One son, Charles, survives his parents. Mr. Cummings resided in the city of Marquette since 1857. He held the positions of civil engineer, surveyor and land agent, and for many years was the official surveyor for Marquette county. Mr. Cummings took a great interest in the mineral development of the Lake Superior country, was an ideal American citizen and a pioneer whom all who knew him admired.

CAPTAIN THOMAS OLIVER.

At the age of 59 years, 4 months and 18 days, Captain Thomas Oliver passed away at his home in Norway, Michigan, June 5, 1911.

Captain Oliver was a native of Cornwall, England, raised in early youth among the mines of his birthplace, engaging in the mining pursuit at a very early age as was common with boys of his time. While still young he came to America, entering mining work in Marquette county. In 1880 he removed to the Menominee iron range where he was for several years at the Norway mine. Later he took charge of the underground workings of the Curry mine of the Penn Iron Mining Company. Later he went to the Gogebic iron district where he took charge of mining operations at the Newport mine, Ironwood. He remained in this position several years when he returned to Norway, where he built a line residence and proceeded to enjoy the fruits of his activities, but in which pursuit he was early cut off by an insiduous disease that baffled the skill of the best physicians. His widow, five sons and two daughters survive him. Captain Oliver was a thorough miner and did his full share in the development of the mineral resources of this region.

DONALD ARCHIBALD CAMERON.

Donald Archibald Cameron, whose death occurred at Norway, Dickinson County, Michigan, April 7, 1911, was born in Martintown, Ontario, Province of Canada, August 15, 1861. He was a graduate of Toronto University, adopting law, opened an office at Toronto where he practiced a couple of years, after which he came to the United States, locating at Iron Mountain, Michigan, in 1887, where he continued in the practice of his profession. He was married in 1894 to Miss,Eva Monroe, who with two children, Claire and Paul, survive him.

GEORGE C. STONE.

Born, at Shrewsbury, Massachusetts, November it, 1822; died at Duluth, Minnesota, October 25, 1900.

To no one man can more credit be given for the opening of the mines of the state of Minnesota to the industrial world than to George: C. Stone. It was largely due to his energy, persistence and faith that the hard ore deposits at Soudan were first brought to the light of the commercial day, developed, and given their true significance to the country at large.

Early in life Mr. Stone had come West. For many years, at different times he was banker and merchant in Iowa and Minnesota. He had made and lost several fortunes. In 1876 he moved to Philadelphia. He was "broke" and engaged in a small manufacturing business, but his mind had bigger things in view and he soon returned to Duluth to investigate outcrops of iron ore about Vermilion Lake, from which place an explorer, and government surveyor, Mr. George R. Stuntz, had secured attractive samples which-he had shown to Mr. Stone. Having known Mr. Charlemagne Tower, of Philadelphia, as a successful coal mine operator, he sought his aid, and finally, after many trials, secured it after he had the property examined by Professor Albert H. Chester, of Hamilton College, New York, who reported favorably upon it. Mr. Stone then took up his residence at St. Paul, Minnesota, to carry out the plan he and his associates had formulated. After much delay the Minnesota Iron company was the result of the effort, the organization having a capital of ten million, very high for that period. Then followed years of the hardest kind of struggle to keep the enterprise going. A panic interfered. It was a new field, seventy miles from anywhere, prejudices against it were many. For several years supplies were received by sleds in the winter season the swamps being impassable at other times of year. It was a long, hard fight, but it finally won. Mr. Stone cleaned up half a million for his work, while Mr. Tower recovered the three million he had invested with big interest. Elisha Morcum, who was superintendent of the Chapin mine, Menominee range, Michigan, was the mining manager for the Soudan, the initial iron ore mine in Minnesota. He brought with him Amos Shephard and a large crew of Cornish miners. During those years Mr. Tower was president of the Minnesota Iron company while Mr. Stone was its general manager and treasurer. Mr. Stone was also president of the Duluth & Iron Range Railroad company, and later became managing director of the mining company.

H. B. STURTEVANT.

PL B. Sturtevant, whose death occurred Nov. 22, 1910, at Philadelphia, was born in Delavan, Wisconsin, in

October, 1857. He was educated as a civil engineer, his first services being with the Chicago & Northwestern Railway company, where he was engaged for several years when he became the engineer for the Lake Superior Iron company, Ishpeming, where he filled important positions in his line, resigning to take charge of mining properties at Ely, Minnesota, where he was located until a few years before his death hen ill health compelled him to seek another climate. Mr. Sturtevant was a most active man in all work he undertook and had many warm friends throughout the mining regions of the Lake Superior country.

PAST OFFICERS

PRESIDENTS.

Nelson P. Hulst	1893
J. Parke Channing	1894
John Duncan	1895
William G. Mather	1896
William Kelly	1898
Graham Pope	1900
W. J. Olcott	1901
Walter Fitch	1902
George H. Abeel	1903
O. C. Davidson	1904
James MacNaughton	1905
Thomas F. Cole	1906
Murray M. Duncan	1908
D. E. Sutherland	1909
William J. Richards	1910

(No meetings were held in 1897, 1899 and 1907).

VICE PRESIDENTS.

	1893.	
John T. Jones. F. P. Mills.	J. Parke Channing.	Graham Pope. M. W. Burt.
	1894.	
John T. Jones. F. P. Mills.	R. A. Parker.	Graham Pope. W. J. Olcott.
	1895.	
F. McM. Stanton. Geo. A. Newett.	R. A. Parker.	Per Larsson. W. J. Olcott.
	1896.	
F. McM. Stanton. Geo. A. Newett.	J. F. Armstrong.	Per Larsson. Geo. H. Abeel.
	1898.	
E. F. Brown. James B. Cooper.	Ed. Ball.	Walter Fitch. Geo. H. Abeel.
	1900.	
O. C. Davidson. T. F. Cole.	M. M. Duncan.	J. H. McLean. F. W. Denton.
	1901.	
J. H. McLean. M. M. Duncan.	Nelson P. Hulst.	F. W. Denton. William Kelly.
	1902.	
William Kelly. Nelson P. Hulst.	Fred Smith.	H. F. Ellard. Wm. H. Johnston.
	1903.	
H. F. Ellard. Fred Smith.	James B. Cooper.	Wm. H. Johnston. John H. McLean.
	1904.	
M. M. Duncan. Fred M. Prescott.	F. W. McNair.	John H. McLean. James B. Cooper.
	1905.	
M. M. Duncan. Fred M. Prescott.	F. W. McNair.	J. M. Longyear. F. W. Denton.
	1908.	
J. M. Longyear. F. W. Denton.	David T. Morgan.	D. E. Sutherland. Norman W. Haire.
	1909.	
W. J. Richards. Charles Trezona.	J. H. Rough.	John M. Bush. Frederick W. Sperr.
	1910.	
W. J. Richards. John M. Bush.	Frederick W. Sperr.	Charles Trezona. James H. Rough.

MANAGERS.

	1893.	
John Duncan. Walter Fitch.	William Kelly.	James MacNaughton. Charles Munger.
	1894.	
Walter Fitch. John Duncan.	M. E. Wadsworth.	C. M. Boss. O. C. Davidson.
	1895.	
F. P. Mills. Ed. Ball.	M. E. Wadsworth.	C. M. Boss. O. C. Davidson.
	1896.	
F. P. Mills. Ed. Ball.	C. H. Munger.	Graham Pope. William Kelly.
	1898.	
M. M. Duncan. J. D. Gilchrist.	T. F. Cole.	Graham Pope. O. C. Davidson.
	1900.	
E. F. Brown. Ed. Ball.	James B. Cooper.	Walter Fitch. George H. Abeel.
	1901.	
James B. Cooper. James MacNaughton.	(One Vacancy)	James Clancey. J. L. Greatsinger.
	1902.	
James Clancey. J. L. Greatsinger.	Amos Shephard.	Graham Pope. T. F. Cole.
	1903.	
Graham Pope. Amos Shephard.	Wm. J. Richards.	T. F. Cole. John McDowell.
	1904.	
John McDowell. Wm. J. Richards.	John C. Greenway.	William Kelly. H. B. Sturtevant.
	1905.	
John C. Greenway. Jas. R. Thompson.	William Kelly.	H. B. Sturtevant. Felix A. Vogel.
	1908.	
James R. Thompson. Felix A. Vogel.	John C. Greenway.	J. Ward Amberg. Pentecost Mitchell.
	1909.	
F. E. Keese. W. J. Uren.	L. M. Hardenburg.	Charles E. Lawrence. Wm. J. West.
	1910.	
Frank E. Keese. Charles E. Lawrence.	William J. Uren.	L. M. Hardenburg. William J. West.

TREASURERS.

C. M. Boss	1893
A. C. Lane	1894
Geo. D. Swift	1895-1896
A. J. Yungbluth	1898-1900
Geo. H. Abeel	1901-1902
E. W. Hopkins	1903-....

SECRETARIES.

F. W. Denton	1893-1896
F. W. Denton and F. W. Sperr	1898
F. W. Sperr	1900
A. J. Yungbluth	1901-....

LIST OF PUBLICATIONS RECEIVED BY THE INSTITUTE.

American Institute of Mining Engineers, 99 John St., New York City.

Canadian Mining Institute, Ottawa.

American Society of Civil Engineers, 220 W. 57th St., New-York City.

Institution of Mining Engineers, Neville Hall, Newcastle-upon-Tyne, England.

Massachusetts Institute of Technology, Boston, Mass.

Chemical, Metallurgical and Mining Society of South Africa, Johannesburg, S. A.

Western Society of Engineers, 1734-41 Monadnock Block, Chicago.

The Mining Society of Nova Scotia, Halifax, N. S.

Canadian Society of Civil Engineers, Montreal.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

State Bureau of Mines, Colorado, Denver, Colo.

Stahl und Eisen, Dusseldorf, Germany, Jacobistrasse 5.

Reports of the U. S. Geological Survey, Washington, D. C.

Geological Survey of New South Wales, Sydney, N. S. W.

Geological Survey of Ohio State University, Columbus, O.

The Mexican Mining journal, Mexico City, Mexico.

Mines and Mining, 1824 Curtis St., Denver, Colo.

Engineering-Contracting, 355 Dearborn St., Chicago, Ills.

Mining Science, Denver, Colo.

Mining & Scientific Press, 667 Howard St., San Francisco, Cal.

University of Oregon, Library, Eugene, Oregon.

Case School of Applied Science, Department of Mining & Metallurgy, Cleveland, Ohio.

University of Illinois, Exchange Department, Urbana, Ills.

University of Missouri, Columbia, Mo.

Iowa State College, Ames, Iowa.

Mining and Metallurgical Society of America, 505 Pearl St., New York.

American Mining Congress, 1510 Court Place, Denver, Col.

Oklahoma Geological Survey, Norman, Okla.