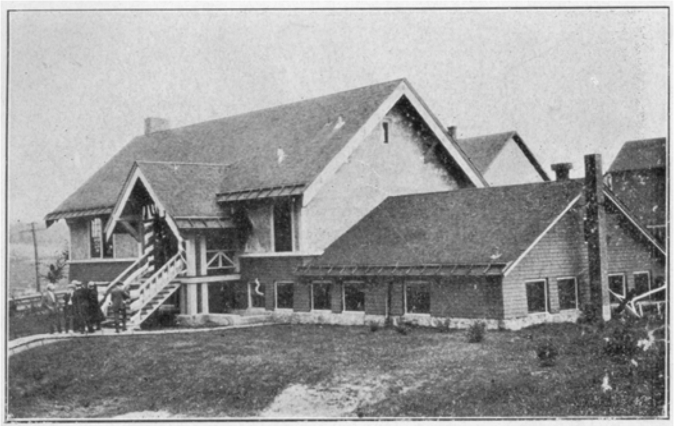
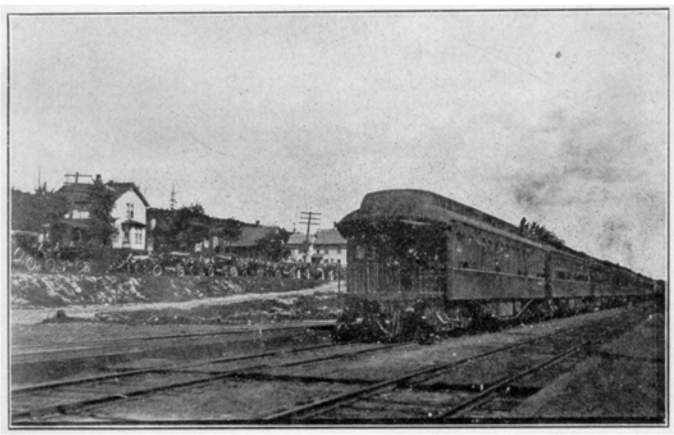
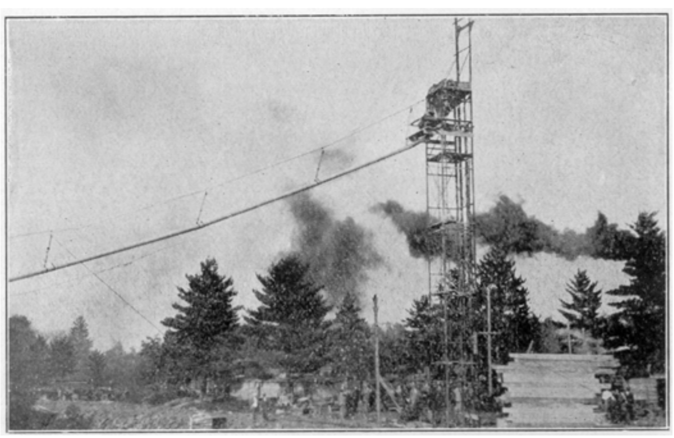


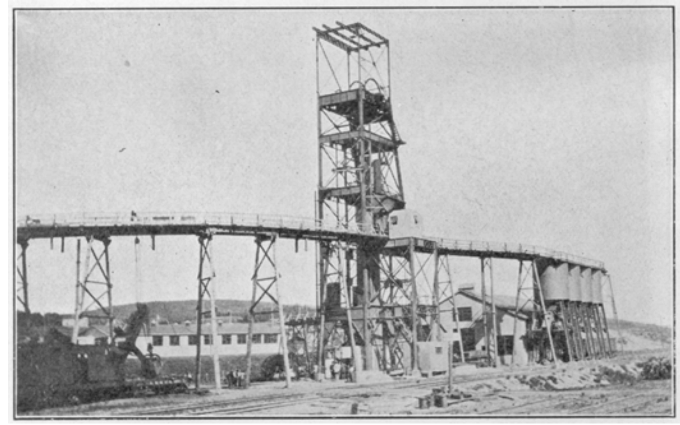
Baltic Mine, Pickands, Mather & Co., Miners' Club House, Palatka, Mich.



Special Trains and Automobiles at Vulcan, Mich.



Peninsular Power and Development Co. Constructing Dam at Twin Falls near Iron Mountain, Mich.



Brier Hill Mine, Penn Iron Mining Co., Vulcan, Mich. Steel Head Frame, Trestles and Circular Ore Pockets.

PROCEEDINGS OF THE Lake Superior Mining Institute SIXTEENTH ANNUAL MEETING

MENOMINEE RANGE, MICHIGAN

JUNE 22, 23, 24, 1911

VOL. XVI.

ISHPEMING, MICH.
PUBLISHED BY THE INSTITUTE.
AT THE OFFICE OF THE SECRETARY,
1911

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M'DONALD, D. B. .... Virginia, Minn.
M'DONALD, JAMES A. .... Hancock, Mich.
M'DOWELL, JOHN .... Hibbing, Minn.
M'GEE, M. B. .... Crystal Falls, Mich.
M'GONAGLE, WILLIAM A. .... Wolvin Bldg., Duluth, Minn.
M'GREGOR, SILAS J. .... Iron Mountain, Mich.
M'CORMICK, EDWARD .... Hibbing, Minn.
M'CORKINDALE, W. J. .... Ishpeming, Mich.
M'INDOE, JAMES A. .... Norway, Mich.
M'KEEVER, R. T. .... 82 Devonshire St., Boston, Mass.
M'KEE, WILL E. .... Warren, Ariz.
M'LAUGHLIN, W. J. .... Loretto, Mich.
M'LEAN, JOHN H. .... Duluth, Minn.

M'LEAN, RICHARD EARLE .... Wells, Delta Co., Mich.
M'NAMARA, THOMAS B. .... Ironwood, Mich.
M'NAMARA, TIMOTHY .... Fierro, New Mexico
M'NAIR, F. W. .... Houghton, Mich.
M'NEIL, E. D. .... Virginia, Minn.

NELSON, S. T. .... 1170 W. Lake St., Chicago, Ills.
NEWETT, GEORGE A. .... Ishpeming, Mich.
NEWTON, L. L. .... 1324 La Salle Ave., Chicago, Ills.
NEWBY, WILLIAM .... Ironwood, Mich.
NICHOLAS, THOMAS J. .... Aurora, Minn.
NICHOLS, F. W. .... Houghton, Mich.
NIXON, JOHN A. .... Ishpeming, Mich.
NOBLE, THOMAS H. .... Marquette, Mich.

OLCOTT, WILLIAM J................................Duluth, Minn.
ORBISON, THOMAS W...............................Appleton, Wis.
ORR, FRANK D.......................Exchange Bldg., Duluth, Minn.
OSBORN, CHASE S..........................Sault Ste. Marie, Mich.

PALMER, E. V......................308 McPhee Bldg., Denver, Colo.
PARKER, RICHARD A.............929 Foster Bldg., Denver, Colo.
PASCOE, PETER W................................Republic, Mich.
PASCOE, WILLIAM ....Hibbing, Minn.
PATRICK, RICHARD S.........314-15 Sellwood Block, Duluth, Minn.
PENTECOST, JOHN ....Calumet, Mich.
PENTON, JOHN A..............Iron Trade Review, Cleveland, Ohio
PENGILLY, EDWARD ....Crystal Falls, Mich.
PERKINS, SAMUEL J.............................Ironwood, Mich.
PETERSON, JOHN O.............921 Railroad Ave., Hancock, Mich.
PHILLIPS, W. G...................................Calumet, Mich.
PIPER, JAMES ....Miami, Arizona
PITKIN, S. H........................682 W. Market St., Akron, Ohio
PLATTO, FRANK ....Ishpeming, Mich.
POLLOCK, CHARLES S..........................Minneapolis, Minn.
POPE, GRAHAM ....Houghton, Mich.
POWELL, D. W...................................Marquette, Mich.
PRESCOTT, FRED M..................Oregon St., Milwaukee, Wis.
PRESCOTT, L. L.................................Menominee, Mich.
PRESHO, EDWARD W...........................Houghton, Mich.
PRYOR, R. C.....................................Houghton, Mich.

QUIGLEY, G. J.......................................Antigo, Wis.
QUINE, JOHN THOMAS.............413 Vine St., Ishpeming, Mich.
QUINN, CLEMENT KRUSE.........................Virginia, Minn.

RAHT, CHARLES......................29 Broadway, New York City

RAISKY, F. H....................................Ishpeming, Mich.
RALEY, ROBERT J..................Spalding Hotel, Duluth, Minn.
RASHLEIGH, WILLIAM J............................Aurora, Minn.
RATTLE, W. J.................33 Commercial Bldg., Cleveland, Ohio
REDFERN, JOHN A................................Hibbing, Minn.
REEDER, J. T.....................................Houghton, Mich.
REEDER, EDWIN C.................1917 Fisher Bldg., Chicago, Ills.
REEDER, J. H.....................................Calumet, Mich.
REIGART, JOHN R................................Princeton, Mich.
REYNOLDS, M. K..................430 E. Arch St., Marquette, Mich.
RICHARDS, WILLIAM J........................Crystal Falls, Mich.
RICHARDS, MORRIS EARL.........................Virginia, Minn.
RICHARDS, WILLIAM J.........................Painesdale, Mich.
RICHEY, E. W...........211 Railway Exchange Bldg., Chicago, Ills.
RIDLEY, FREDERICK WILLIAM...................Calumet, Mich.
ROBERTS, HARRY ....Duluth, Minn.
ROBERTS, RICHARD ....Negaunee, Mich.
ROBERTS, ALTON T..............................Marquette, Mich.
ROBERTSON, HUGH J............................Escanaba, Mich.
ROBINSON, JAMES A...............................Hibbing, Minn.
ROHN, OSCAR ....Butte, Mont.
ROOD, DANA C....................................Hibbing, Minn.
ROSE, R. S.......................................Marquette, Mich.
ROSKILLY, JOSEPH ....Virginia, Minn.
ROUGH, JAMES H................................Negaunee, Mich.
ROWE, HENRY ....Ironwood, Mich.
ROWE, WM. C......................................Bessemer, Mich.
RUEZ, GEORGE F................................Ishpeming, Mich.
RUMSEY, SPENCER S.............610 Wolvin Bldg., Duluth, Minn.
RUNDLE, A. J...............................Iron Mountain, Mich.
RUSSELL, C. W.......................R. W. & F. Co., Detroit, Mich.
RYAN, JOHN A...............................Iron Mountain, Mich.

SALOMONSON, H...................................Norway, Mich.
SALSICH, L. R...................................Coleraine, Minn.
SALVICK, WILLIAM V............................Houghton, Mich.
SAVAGE, J. A.....................................Hibbing, Minn.
SCADDEN, FRANK............................Crystal Falls, Mich.
SCHLESINGER, H. J.............................Milwaukee, Wis.
SCHUBERT, GEORGE P...........................Hancock, Mich.
SCHULZE, W. J...................................Virginia, Minn.
SCOTT, D. D.......................535 W. Paul St., Rochester, N. Y.
SEAMAN, A. E...................................Houghton, Mich.
SEBENIUS, JOHN UNO.................Wolvin Bld., Duluth, Minn.
SEELYE, R. W..............................Sault Ste. Marie, Ont.
SELLS, MAX ....Florence, Wis.
SENTER, A. W....................................Hubbell, Mich.

SEPARK, E. A........................Wolvin Bldg., Duluth, Minn.
SHEA, J. D.......................................Bessemer, Mich.
SHERLOCK, THOMAS ....Escanaba, Mich.
SHERRERD, JOHN M............340 Spring Garden St., Easton, Pa.
SHIELDS, IRVIN J...............................Houghton, Mich.
SIEBENTHAL, W. A..............................Republic, Mich.
SILL, GEO. A.....................504 Marquette Bldg., Chicago, Ills.
SIMMONS, CHARLES ....Beacon, Mich.
SJOGREN, PROF. H...........................Nynashamn, Sweden
SKINNER, MORTIMER B.558-560 W. Washington Blvd., Chicago, Ills.
SLAUGHTER, WILLIAM F...........................Vulcan, Mich.
SLINEY, DAVID J...............................Ishpeming, Mich.
SMITH, FRED ....Kearsarge, Mich.
SMITH, GEORGE M.................................Duluth, Minn.
SMITH, WILLARD J...............................Mohawk, Mich.
SMITH, CARL G..................................Montreal, Wis.
SMITH, ALFRED L..............................Wakefield, Mich.
SMYTH, H. L........................Rotch Bldg., Cambridge, Mass.
SOADY, HARRY ....Duluth, Minn.
SORNBERGER, E. C..............208 Lancaster Ave., Buffalo, N. Y.
SPERR, F. W.....................................Houghton, Mich.
SPORLEY, CHARLES L...........................Negaunee, Mich.
STAKEL, CHARLES J............................Ishpeming, Mich.
STANTON, F. McM....................208 5th Ave., New York City
STANTON, J. R......................11 William St., New York City
STEPHENS, JAMES ....Ishpeming, Mich.
STEVENS, THOMAS J.............................Ironwood, Mich.
STEVENS, HORACE J............................Houghton, Mich.
STOEK, H. H.....................University of Illinois, Urbana, Ills.
SUESS, JOSEPH E...............................Negaunee, Mich.
SULLIVAN, F. J..................................Ironwood, Mich.
SUTHERLAND, D. E..............................Ironwood, Mich.
SWAIN, RICHARD A........General Electric Co., Minneapolis, Minn.
SWEENEY, E. F.............................Baxter Springs, Kan.
SWIFT, GEORGE D.................................Duluth, Minn.
SWIFT, H. LEIGH................................Houghton, Mich.
SWIFT, PAUL D..................................Houghton, Mich.

TANCIG, A..Hibbing, Minn.
TARR, S. W.........................610 Wolvin Bldg., Duluth, Minn.
TAYLOR, JAMES HALL......................Box 485, Chicago, Ills.
THIEMAN, EDWARD ....Florence, Wis.
THOMAS, WILLIAM ....Ironwood, Mich.
THOMAS, KIRBY......................505 Pearl St., New York City
THOMS, REUBEN KNIGHT.............................Ely, Minn.
THOMPSON, G. H.................................Hibbing, Minn.
THOMPSON, HENRY S..............................Beacon, Mich.

THOMPSON, A. W..................................Vulcan, Mich.
THOMPSON, JAMES R...........................Ishpeming, Mich.
TILLINGHAST, EDWARD S.......................Hibbing, Minn.
TOBIN, JAMES ....Florence, Wis.
TOWNSEND, C. V R...............................Negaunee, Mich.
TRAVER, WILBER H....................Fisher Bldg., Chicago, Ills.
TREBILCOCK, JOHN ....Ishpeming, Mich.
TREBILCOCK, WILLIAM ....North Freedom, Wis.
TREPANIER, HENRY ....Iron Mountain, Mich.
TREZONA, CHARLES ....Ely, Minn.
TREVARROW, HENRY ....Negaunee, Mich.
TREVARTHAN, W. J............................Bessemer, Mich.
TREVIRANUS, GEORGE.....Care D. M. & N. Docks, Duluth, Minn.
TRIPP, CHESTER D.......1515 Corn Exchange Bldg., Chicago, Ills.
TRUETTNER, IRVING W.........................Bessemer, Mich.
TRUDGEON, JOHN ....Wakefield, Mich.
TUFTS, JOHN W................900 Hackett Ave., Milwaukee, Wis.
TURNER, CHAS. N............Colby-Abbott Bldg., Milwaukee, Wis.
TYLER, CHARLES ....Negaunee, Mich.

UREN, WILLIAM J................................Calumet, Mich.
UHLER, FRED WALTER ....Buhl, Minn.

VALLATT, BENJ. W...............................Ironwood, Mich.
VAN DYKE, W. D................................Milwaukee, Wis.
VANDEVENTER, VIVIAN H......................Ishpeming, Mich.
VAN EVERA, JOHN R............................Marquette, Mich.
VAN EVERA, WILBUR............................Virginia, Minn.
VAN MATER, J. A......................55 Wall St., New York City
VAN ORDEN, F. L................................Houghton, Mich.
VAN VALKENBURG, ALLEN J...................Abbottsford, Wis.
VILAS, P. M...........425 New York Life Bldg., Minneapolis, Minn.
VILAS, ROYAL L................................Ishpeming, Mich.
VIVIAN, JAMES G................909 Alworth Bldg., Duluth, Minn.
VIVIAN, DAVID L..Gay, Mich.
VOGEL, F. A.........................25 Broad St., New York City

WADE, JEPTHA H....................Wade Bldg., Cleveland, Ohio
WAGNER, JOHN M................................Houghton, Mich.
WALL, JAMES S.................................Iron River, Mich.
WALLACE, GEORGE ....Marquette, Mich.
WALKER, ROBERT L................................Diorite, Mich.
WARE, JOHN FRANKLIN................128 Park St., Dayton, Ohio
WARE, FRED ....Negaunee, Mich.
WARREN, O. B.....................................Hibbing, Minn.
WARNE, EDW. S................................Point Mills, Mich.
WARRINER, S. D.................................Wilkesbarre, Pa.

WATSON, CHARLES H.........................Crystal Falls, Mich.
WEARNE, WILLIAM ....Hibbing, Minn.
WEBB, FRANCES J..............519 Providence Bldg., Duluth, Minn.
WEED, LOUIS B...............................Sunrise, Wyoming.
WELLS, PEARSON ....Ironwood, Mich.
WELKER, W. F.....................................Ashland, Wis.
WENGLER, MATT P.........1055 Cambridge Ave., Milwaukee, Wis.
WESSINGER, W. E..................610 Wolvin Bldg., Duluth, Minn.
WESSINGER, HENRY J.............610 Wolvin Bldg., Duluth, Minn.
WEST, WILLIAM J.................................Hibbing, Minn.
WHEELWRIGHT, O. W.............................Florence, Wis.
WHITE, WILLIAM ....Virginia, Minn.
WHITE, EDWIN E..............................Ishpeming, Mich.
WHITEHEAD, R. G...................................Amasa, Mich.
WHITESIDE, DR. JOHN W........................Ironwood, Mich.
WILLEY, NORMAN W........Shenango Furnace Co., Hibbing, Minn.
WILKINS, WILLIAM ....Ashland, Wis.
WILLIAMS, THOMAS H...............................Ely, Minn.
WILLIAMS, HERBERT H.........................Marquette, Mich.
WILLIAMS, PERCIVAL S...........................Ramsay, Mich.
WILSON, EUGENE B...............................Scranton, Pa.
WINCHELL, HORACE V........505 Palace Bldg., Minneapolis, Minn.
WINTER, JOSEPH H..............................Negaunee, Mich.
WITHERBEE, F. S...........................Port Henry, New York
WOODBRIDGE, DWIGHT E..........................Duluth, Minn.
WOODWORTH, G. L..............................Iron River, Mich.
WOODWORTH, R. B..............427 Carnegie Bldg., Pittsburg, Pa.
WORDEN, EUCLID P.............................Milwaukee, Wis.

YATES, WILLIAM H..............................Negaunee, Mich.
YOUNG, H. OLIN ....Ishpeming, Mich.
YOUNGS, FRANK W.............................Iron River, Mich.
YOUNGS, G. W..................................Iron River, Mich.
YUNGBLUTH, A. J...............................Ishpeming, Mich.

ZAPFFE, ...213 Citizens State Bank Bldg., Brainerd, Minn.

DECEASED MEMBERS

ARMSTRONG, J. F................................March 3rd, 1898
BAWDEN, JOHN T..1899
BENNETT, JAMES H...
BIRKHEAD, LENNOX ....April, 1911
BROOKS, T. B...1902
BULLOCK, M. C................................January 12th, 1899
COWLING, NICHOLAS 1910
CONRO, ALBERT ....January 10th, 1901
CLEAVES, WILL S..1910
CHADBOURNE, T. L..............................April 18, 1911
CUMMINGS, GEO P...............................March 14, 1911
DANIELS, JOHN ....September 13th, 1898
DICKENSON, W. E................................June 15th, 1899
DOWNING, W. H..................................October, 1906
DUNCAN, JOHN ....June, 1904
DUNSTON, THOMAS B...
GARBERSON, WILLIAM R.........................April 29th, 1908
HALL, CHAS. H...................................February, 1910
HARPER, GEORGE VANCE............................March, 1905
HASELTON, H. S..................................July 27th, 1911
HAYDEN, GEORGE ....July 27th, 1902
HINTON, FRANCIS 1896
HOLLAND, JAMES ....September 3rd, 1900
HOLLEY, S. H......................................July 4th, 1899
HOUGHTON, JACOB ....December 30th, 1903
HYDE, WELCOME ....
JEFFERY, WALTER M.............................May 26th, 1906
JOCHIM, JOHN W..............................January 17th, 1905
KRUSE, JOHN C................................October 28th, 1907
LUSTFIELD, A.. ....May 26th, 1904
LYON, JOHN B................................February 13th, 1900
MARR, GEORGE A......................................March, 1905
MITCHELL, SAMUEL ....May 10th, 1908
M'VICHIE, D................................September 14th, 1906
NINESE, EDMUND ....January 3rd, 1909
OLIVER, HENRY W............................February 8th, 1904
PEARCE, H. A...1905
PERSONS, GEORGE R............................March 26th, 1908
ROBERTS, E. S...
ROWE, JAMES ....March 26th, 1911
RYAN, EDWARD 1901
SHEPHARD, AMOS ....June 6th, 1905
STANLAKE, JAMES ....September 23rd, 1910
STANTON, JOHN...............................February 23rd, 1906
STURTEVANT, H. B..........................November 22nd, 1910
THOMAS, HENRY ....December, 1905
TREVARTHEN, G. C.................................January, 1898
TRUSCOTT, HENRY ....May 7th, 1910
VAN DYKE, JOHN H..1906
WALLACE, JOHN 1898
WHITE, PETER ....June 6th, 1908
WHITNEY, J. D..1894
WILLIAMS, W. H..1897

LIST OF PAPERS PUBLISHED IN PRECEDING VOLUMES.

LIST OF MEETINGS OF THE INSTITUTE AND THEIR LOCALITIES FROM ITS ORGANIZATION TO AUGUST, 1911.

No.	Place.	Date.	Proceedings.
1	Iron Mountain, Mich	March 22-23, 1893	Vol. I
2	Houghton, Mich	March 7-9, 1894	Vol. II
3	Mesabi and Vermilion Ranges	March 6-8, 1895	Vol. III
4	Ishpeming, Mich	August 18-20, 1896	Vol. IV
5	Ironwood, Mich	August 16-18, 1898	Vol. V
6	Iron Mountain, Mich	February 6-8, 1900	Vol. VI
7	Houghton, Mich	March 5-9, 1901	Vol. VII
8	Mesabi and Vermilion Ranges	August 19-21, 1902	Vol. VIII
9	Ishpeming, Mich	August 18-20, 1903	Vol. IX
10	Ironwood, Mich	August 16-18, 1904	Vol. X
11	Iron Mountain, Mich	October 17-19, 1905	Vol. XI
12	Houghton, Mich	August 8-10, 1906	Vol. XII
13	Mesabi and Vermilion Ranges	June 24-27, 1908	Vol. XIII
14	Ishpeming, Mich	August 25-27, 1909	Vol. XIV
15	Ironwood, Mich	August 24-26, 1910	Vol. XV
16	Crystal Falls, Mich	August 22-24, 1911	Vol. XVI

Note—No meetings were held in 1897, 1899 and 1907.

RULES OF THE INSTITUTE.

I. OBJECTS.

The objects of the Lake Superior Mining Institute are to promote the arts and sciences connected with the economical production of the useful minerals and metals in the Lake Superior region, and the welfare of those employed in these industries, by means of meetings of social intercourse, by excursions, and by the reading and discussion of practical and professional papers, and to circulate, by means of publications among its members the information thus obtained.

II. MEMBERSHIP.

Any person interested in the objects of the Institute is eligible for membership.

Honorary members not exceeding ten in number, may be admitted to all the privileges of regular members except to vote. They must be persons eminent in mining or sciences relating thereto.

III. ELECTION OF MEMBERS.

Each person desirous of becoming a member shall be proposed by at least three members approved by the Council, and elected by ballot at a regular meeting (or by ballot at any time conducted through the mail, as the Council may prescribe), upon receiving three-fourths of the votes cast. Application must be accompanied by fee and dues as provided by Section V.

Each person proposed as an honorary member shall be recommended by at least ten members, approved by the Council, and elected by ballot at a regular meeting, (or by ballot at any time conducted through the mail, as the Council may prescribe), on receiving nine-tenths of the votes cast.

IV. WITHDRAWAL FROM MEMBERSHIP.

Upon the recommendation of the Council, any member may be stricken from the list and denied the privilege of membership, by the vote of three-fourths of the members present at any regular meeting, due notice having been mailed in writing by the Secretary to him.

V. DUES.

The membership fee shall be five dollars and the annual dues five dollars, and applications for membership must be accompanied by a remittance of ten dollars; five dollars for such membership fee and five dollars for dues for the first year. Honorary members shall not be liable to dues. Any member not in arrears may become a life member by the payment of fifty dollars at one time, and shall not be liable thereafter to annual dues. Any member in arrears may, at the discretion of the Council, be deprived of the receipt of publications or be stricken from the list of members when in arrears six months; Provided, That he may be restored to membership by the Council on the payment of all arrears, or by re-election after an interval of three years.

VI. OFFICERS.

There shall be a President, five Vice Presidents, five Managers, a Secretary and a Treasurer, and these Officers shall constitute the Council.

VII. TERM OF OFFICE.

The President, Secretary and Treasurer shall be elected for one year, and the Vice Presidents and Managers for two years, except that at the first election two Vice Presidents and three Managers shall be elected for only one year. No President, Vice President, or Manager shall be eligible for immediate re-election to the same office at the expiration of the term for which he was elected. The term of office shall continue until the adjournment of the meeting at which their successors are elected.

Vacancies in the Council, whether by death, resignation, or the failure for one year to attend the Council meetings, or to perform the duties of the office, shall be filled by the appointment of the Council, and any person so appointed shall hold office for the remainder of the term for which his predecessor was elected or appointed; Provided, That such appointment shall not render him ineligible at the next election.

VII.
DUTIES OF OFFICERS.

All the affairs of the Institute shall be managed by the Council except the selection of the place of holding regular meetings.

The duties of all Officers shall be such as usually pertain to their offices, or may be delegated to them by the Council.

The Council may in its discretion require bonds to be given by the Treasurer, and may allow the Secretary such compensation for his services as they deem proper.

At each annual meeting the Council shall make a report of proceedings to the Institute, together with a financial statement.

Five members of the Council shall constitute a quorum; but the Council may appoint an executive committee, business may be transacted at a regularly called meeting of the Council, at which less than a quorum is present, subject to the approval of a majority of the Council, subsequently given in writing to the Secretary and recorded by him with the minutes.

There shall be a meeting of the Council at every regular meeting of the Institute and at such other times as they determine.

IX.
ELECTION OF OFFICERS.

Any five members not in arrears, may nominate and present to the Secretary over their signatures, at least thirty days before the annual meeting, the names of such candidates as they may select for offices falling under the rules. The Council, or a committee thereof duly authorized for the purpose, may also make similar nominations. The assent of the nominees shall have been secured in all cases.

No less than two weeks prior to the annual meeting, the Secretary shall mail to all members not in arrears a list of all nominations made and the number of officers to be voted for in the form of a letter ballot. Each member may vote either by striking from or adding to the names upon the list, leaving names not exceeding in number the officers to be elected, or by preparing a new list, signing the ballot with his name, and either mailng it to the Secretary, or presenting it in person at the annual meeting.

In case nominations are not made thirty days prior to the date of the annual meeting for all the offices becoming vacant under the rules, nominations for such offices may be made at the said meeting by five members, not in arrears, and an election held by a written or printed ballot.

The ballots in either case shall be received and examined by three tellers appointed at the annual meeting by the presiding officer; and the persons who shall have received the greatest number of votes for the several offices shall be declared elected. The ballot shall be destroyed, and a list of the elected officers, certified by the tellers, shall be preserved by the Secretary.

X.
MEETINGS.

The annual meeting of the Institute shall be held at such time as may be designated by the Council. The Institute may at regular meeting select the place for holding the next regular meeting. If no place is selected by the Institute it shall be done by the Council.

Special meetings may be called whenever the Council may see fit; and the Secretary shall call a special meeting at the written request of twenty or more members. No other business shall be transacted at a special meeting than that for which it was called.

Notices of all meetings shall be mailed to all members at least thirty days in advance, with a statement of the business to be transacted, papers to be read, topics for discussion and excursions proposed.

No vote shall be taken at any meeting on any question not pertaining to the business of conducting the Institute.

Every question that shall properly come before any meeting of the Institute, shall be decided, unless otherwise provided for in these rules, by the votes of a majority of the members then present.

Any member may introduce a stranger to any regular meeting; but the latter shall not take part in the proceedings without the consent, of the meeting.

XI.
PAPERS AND PUBLICATIONS.

Any member may read a paper at any regular meeting of the Institute, provided the same shall have been submitted to and approved by the Council, or a committee duly authorized by it for that purpose prior to such meeting. All papers shall become the property of the Institute on their acceptance, and with the discussion thereon, shall subsequently be published for distribution. The number, form and distribution of all publications shall be under the control of the Council.

The Institute is not, as a body, responsible for the statements of facts or opinion advanced in papers or discussions at its meetings, and it is understood, that papers and discussions should not include personalities, or matters relating to politics, or purely to trade.

XII.
AMENDMENTS.

These rules may be amended by a two-thirds vote taken by letter ballot in, the same manner as is provided for the election of officers by letter ballot; Provided, That written notice of the proposed amendment shall have been given at a previous meeting.

THE SIXTEENTH ANNUAL MEETING, AUGUST 22d, 23d, 24th, 1911.

LOCAL COMMITTEES.

Transportation Committee, Dining Cars and Sleepers.

C. H. Watson, Wm. Kelly, O. C. Davidson.

Committee on Automobiles.

Iron Mountain—J. H. Karkeet, Geo. J. Eisele. Vulcan—F. H. Armstrong. Norway—J. B. Knight. Crystal Falls—Frank Scadden, Arvid Bjork. Iron River—G. L. Woodworth, Frank Youngs, W. H. Jobe.

Committee on Reception.

Norway—Doctor Miller, Gordon Murray, Capt. Wm. Bona, G. A. Hellberg, F. A. Janson. Iron Mountain—E. F. Brown, Martin Goldsworthy. Vulcan—A. W. Thompson. Loretto—C. H. Baxter, H. McLaughlin. Crystal Falls—Thos. Conlin, M. B. McGee, Arvid Bjork, Chas. W. Hughes, R. G. Whitehead, Captain Edwards, W. H. Fraser, J. S. Jacka, Herman Ruwitch, John Tufts, Capt. E. Pengilly, F. D. Ball, E. J. Oswald, Capt. E. Jacka, John Parks, E. S. Bridges, Chas. Neugebauer, W. H. Rezin, John Erickson, Sam Jacobs, Herman Holmes, Michael H. Moriarty. Iron River—E. S. Coe, J. S. Wall, I. W. Byers, M. S. McDonough, Victor D. Laing, J. H. Nettell, Wm. H. Bengry, H. E. Duff, John Looney, D. H. Campbell, Rudolph Erikson, W. H. Jobe, G. L. Woodworth, J. A. Monroe, O. P. Doty, Lowe Whiting, G. W. Youngs, S. D. Klinglund, F. A. Morrison, P. O'Brien, F. A. Dixon, W. H. Seldon, Walter L. Scanlan.

Committee on Finance.

W. H. Jobe, Chairman, E. W. Hopkins, J. D. Vivian, E. F. Brown, Rudolph Erikson, G. L. Woodworth.

ITINERARY.

The following itinerary has been arranged by the Committee in charge for the Sixteenth Annual Meeting to be held on the Menominee Range. This is subject to changes as circumstances may require.

Tuesday, August 22nd.

A. m. arrival and reception of visitors at Crystal Falls.

1:00 p. m. visit to Hollister Mine, inspecting new ore dryer, Tobin and Bristol Mines.

6:00 p. m. entertainment and luncheon by Crystal Falls Commercial Club.

8:00 p. m. business session at Court House.

Wednesday, August 23rd.

8:00 a. m. leave Crystal Falls in automobiles en route to the iron River District, visiting the Chicagoan Lake, Swanson, Baltic, Caspian, James, Davidson, and other mines. At the Swanson, concrete shaft sinking will be seen.

Intermission for dinner at 12.

2:00 p. m. business session at Opera House; election of Officers for ensuing year.

6:00 p. m. entertainment and luncheon by Iron River Commercial Club.

Thursday, August 24th.

7:00 a. m. leave Iron River for Dickinson County points.

9:00 a. m. arrive Loretto. View changes in river course, and mining in the old river bed.

Automobile trip to Hydro-Electric Plant at Sturgeon Falls. Electric equipment and concrete lined shaft at Vulcan.

12:00 noon dinner.

1:00 p. m. automobile trip from Vulcan to Norway and Iron Mountain, visiting Chapin Mine, construction of dam at Twin Falls, and other points of interest.

5:00 p. m. disbandment.

HISTORICAL SKETCH OF MENOMINEE RANGE.

BY THOMAS CONLIN AND P. O'BRIEN.

DICKINSON COUNTY.

The Dickinson County end of the Menominee Range, being its easterly division, which also may be termed "the port of entry," was the first to be explored and developed, either for timber or iron ore. When the discovery of iron ore had been made on the Marquette range, and shipments begun some twenty odd years previous to the discoveries on the Menominee range, it was generally taken for granted that the ore already found limited the mineral resources of this part of the upper peninsula.

Some have also attributed the belated discovery of merchantable ore on this range to Indian superstition, thus keeping secret its known presence.

The opening of the Menominee range may be stated as being in 1870, when the first logs were cut, and floated down the Menominee river in 1871. Also in 1871, John L. Buell in company with John Armstrong made the first reported discovery of iron ore, and in 1872 the first exploring party entered this region under the guidance of Dr. N. P. Hulst, representing the Milwaukee Iron Company. The results of Dr. Hulst's discoveries were not made known. In 1873 the discovery made by Buell and Armstrong was explored and developed. In 1874 fifty-five tons of this ore was hauled to Menominee and smelted, the results being most satisfactory and gratifying. The first mining of iron ore and its smelting was followed by numerous explorations and the rapid development of mines in this county. The extending of the Menominee River Railroad in 1877 from Powers to Quinnesec the entering wedge of this development era, and while explorations and discoveries have been going on from 1871 shipments cannot really be stated as having started prior to 1877. This railroad was extended to Iron Mountain in 1880 and thence in successive stages to the westerly division of the Menominee range, Iron County, becoming a branch of the Chicago & Northwestern system.

The following is a list of the earlier mines, date of discovery and date of first shipment:

	Discovery.	First Shipment.
Breen	1872	1877
Vulcan	1873	1877
Quinnesec	1877	1878
Emmett	1877	1878
Stephenson	1878	1879
Norway	1878	1879
Saginaw	1878	1878
Cyclops	1878	1879
Curry	1878	1879
E. Vulcan	1879	1879
Cornell	1879	1880
Kiel Ridge	1879	1880
Chapin	1879	1880
Indiana	1879	1880
Millie	1880	1881

It is not necessary to- bring the above list down to date in this sketch as practically all the later day mines are to be found in statistical reports published in connection with the Institute proceedings.

Explorations for iron ore are still being carried on in Dickinson County but not on as extensive scale as at present in Iron County. The known iron ore resources on the easterly end of this range insures mining enterprises of magnitude for future generations.

A more extended sketch of Dickinson County could be written, but as this was covered in a previous Menominee Range meeting* it is deemed advisable to give the westerly end of the range most of the available space at this time.

*Menominee Range—By John L. Buell, Vol. XI, 1905.

IRON COUNTY.

Crystal Falls gets its name from the falls in the Paint river, located close to the center of Sec. 20, 43-32.

The story is that in the middle seventies a crew of woodsmen, engaged in looking over and locating timber for a Menominee lumber company, was camped on Lot 3 of Section 20 a short distance above the falls. One morning in early October the sun arose bright after a sleet storm and as one of the cruisers looked out of his tent the sun's rays were reflected from the crystals that were suspended from the dense shrubbery that overhung the chasm about the falls. He remarked upon the crystal like appearance, and suggested that they call the rapids "Crystal Falls." That day the work was close to the falls and the men got to calling the place "the crystal falls in the Paint" which was afterwards abbreviated to "Crystal Falls."

At the falls in the Paint river the ore bearing rocks are exposed and the surveyors and cruisers made note of that fact. As the Menominee range was developed northwest from Waucedah, an advance guard of explorers penetrated the wilderness, like the skirmishers preceding an army, testing the earth by light test-pits. Among this advance body was "Jack" Armstrong, the first man to turn a shovel of dirt in the search for iron ore in the Crystal Falls district. Mr. Armstrong started his work on the banks of the Paint river a few feet from the edge of the cliff where the action of the water had exposed the formation. He was rewarded by meeting with some ore, the property being the same Lot 3, Sec. 20, 43-32 that has been explored by the International Harvester interests during the past two years. Armstrong was pressed closely by the Maltby brothers, who began operations on the lands adjoining his to the west in the vicinity of the Bristol mine and they were really the discoverers of the Bristol-Youngstown deposit.

At this time the C. & N.-W. railroad was surveyed to Florence to which point it was being built to tap the ore district in that section. Among the contractors who were doinir the grading was George Runkle and in his employ was S. D. Hollister. Mr. Runkle was closely connected with some of the Northwestern officials. He and Mr. Hollister visited Crystal Falls locality and Mr. Runkle at once became convinced of its worth and induced Marvin Hughitt to personally visit this section to see for himself the possibilities of the locality and the advantage which the Northwestern would derive by extending its line right on through to Crystal Falls. Mr. Runkle was successful in his efforts and that winter the end of the road was pushed on to the Brule river instead of resting at Florence, a survey having been completed and adopted through to Crystal Falls.

In the meantime Messrs. Runkle, Hollister and others had secured options on the explorations and formed the Crystal Falls Iron company. The properties they took over were the Armstrong exploration on Lot 3, the Fairbanks, Kimball and others. While the road was being extended here more men were put at work in the pits and stories of the fabulous wealth of the section attracted other explorers, among them the Sheldons and Jacob Shafer who discovered the big deposit at the old Shafer. Another company headed by Mr. Hollister had discovered a big deposit on the N.-E. ¼ of S.-W. ¼ of Sec. 21, 43-32, the forty east of the Fairbanks. This discovery, taken along with the Fairbanks, led the Crystal Falls Iron company to believe that the big ore deposits existed to the east of the Paint river.

The Crystal Falls Iron company felt that the locality warranted the building of a town and began to look about for a site. They decided upon one of the banks of Runkle lake, close to the west line of Sec. 22, 43-32, and the original survey for the railroad contemplated the running of the main line to the shores of Runkle lake. In the meantime Mr. Shafer, operating on Sec. 31, had sold his find to the Union Steel company and right here comes the story of how Crystal Falls comes to be located on a side hill instead of upon the level plain about Runkle lake.

When the Union Steel company learned that the Crystal Falls people intended locating the town so far away from their mine they entered a protest which finally resulted in the threat of platting another town on Section 31—only 2½ miles away—in case the original idea of platting Crystal Falls on the banks of Runkle lake was carried out. The Crystal Falls people would not consent to locate the town on Sec. 31 and the Union Steel company refused to co-operate with the project if it was located on Sec. 21. The outcome was a compromise and the nearest piece of property that could be purchased just then was the S.-W. ¼ of N.-E. ¼ Sec. 29, 43-32. So, the property was purchased and the town platted on the side hill amidst inconveniences that were very hard to overcome. Before the controversy was settled the railroad grade had approached the locality and a portion of the approach to the proposed townsite on Runkle lake was graded and may be seen today near Railroad lake. The survey was changed, the road run to the new site and harmony reigned to the inconvenience of later generations.

Crystal Falls had the tips and downs experienced by the other iron districts during the 86's and 90's. The ore being of a lower grade than that of other sections, the explorers and operators attracted to this section were not as strong financially as in other sections and much hardship was experienced because of the irresponsibility of the mining companies during those days. The panic of 1893 acted as a cathartic to clear out the business system. Every property in the district was closed by that financial catastrophe and when they re-opened the ownership had passed to stronger hands.

The connection of the present operators dates from the renaissance of 1897 and subsequent years. Corrigan-McKinney & Co. was known in a small way previous to the panic under the old firm name of "Corrigan, Ives & Co." They were sales agents for some of the companies then operating mines in this section, principally the Mansfield mine under the old regime. In 1897 the new firm of "Corrigan, McKinney & Co." acquired the Crystal Falls mine which until that time had been in the hands of the Butlers of Youngstown, Ohio, and was not regarded as of much worth. They did but little further exploratory work before encountering the large ore deposit which extended to within a few feet of the surface. They immediately stripped the ore body and were enabled to produce ore very economically, a very necessary requisite in the stormy commercial period following the panic. With this property as a nucleus they extended their operations by the acquisition of the Great Western and Lamont mines; optioned and explored the Tobin, which they later developed into the magnificent property it now is. The Dunn they reopened by entirely new workings, made necessary by the caving of the old shaft. The Armenia, Fairbanks and Kimball were each in turn reclaimed by them, the old workings having been worked out or not warranting further work at the time they were abandoned. This company is today the owner of the major portion of the working properties in the district and won its position by banking its faith on the district when it was passed up by others.

Oglebay, Norton & Co., the owners of the Bristol mine, came here in 1898. They acquired a lease on the old Brier Hill which Schlesinger in his palmy days had stripped of its sand overburden at a great cost and which work was regarded as a marvel in those days. The Bristol people developed the property and made it the biggest producer in the district.

The Oliver Mining company came here first through the purchase of the old Columbia mine in 1902. Later on they acquired the Mansfield and Michigan by purchase and the Hilltop through the amalgamation of the American Steel & Wire company. The Youngstown they acquired in fee through the Illinois Steel Co. Of their properties, only the Mansfield is now being operated at Crystal Falls and the Michigan at Amasa.

The M. A. Hanna people were induced through the efforts of Frank Scadden to take hold of the Hollister mine in 1907. They have operated continuously at that property since and in 1909 they took options to explore the Merry lands, one tract lying west of the Bristol where they are opening up the Ravenna mine, and the other tract, the old Monongahela, west of the Columbia. Recently they acquired the Harlow lands lying south of the Monongahela and are in position to become a large factor in the district.

The Youngs people were induced to take an option on a forty north of the Armenia three years ago and since then they have developed the MacDonald mine on that property.

In 1889 the Pickands-Mather interests were exploring the old Walpole at Iron Mountain. The outlook was not promising enough to them at the time so they came to this section and purchased an exploration on the banks of the Hemlock river in Sec. 4, 44-33. They transferred their equipment from the Walpole and succeeded in opening up the Hemlock mine which has been a steady producer since 1891 with the exception of a year or two during the panic of 1893. They platted a portion of their lands and called the place "Amasa."

Two years ago the Longyear & Hodge people began operations in this section, opened an office and later on organized the Nevada land company which has taken over several valuable properties upon which ore has been shown up by means of the diamond drill.

The Breitung people commenced exploratory work here last April and have mapped out an extensive program of exploration with a promise of success.

IRON RIVER-STAMBAUGH.

The Iron River-Stambaugh district, or as it is generally called, the Iron River district, first became known in 1878 when Donald C. and Alexander Mackinnon arrived in the district from Negaunee, walking through the woods from Commonwealth, Wisconsin, the then terminal of the C. &

N. W. Ry. These two hardy pioneers, believing that the district was eventually to prove a valuable one, located Section 26, 43-35, now known as the Village of Iron River. They also located the lands now known as the Kinney, Baltic and Youngs mines, and did some test pitting on these properties, but not sufficient to prove that they really contained the large bodies of ore which have since been shown up.

A recent geological report, published by Mr. R. C. Allen, director of the Michigan State Geological Survey, is authority for the statement that "the first discovery of iron ore in the Iron River district is accredited to Mr. Harvey Mellen, a United States land surveyor. The field notes of Mr. Mellen's under date of August 8th, 1851, describe the occurrence of an outcrop of iron ore five feet high on the west face of Stambaugh hill, 52 chains north of the southwest corner of Section 36, T. 43 N., R. 35 W., and this outcrop was recorded on the original United States Land Survey plat of the township. While the occurrence of ore was thus early made known mining did not begin until 31 years later, when Mr. Mennen's discovery became the site of the Iron River mine," now known as the Riverton.

The Mackinnons explored the N. W. ¼ of the S. W. ¼ Section 36, 43-35, and opened up what is now the Beta mine. As there were no railway facilities the opening up of the property was necessarily slow. The ore was a low grade, running about 58.00 in iron and .25 in phosphorus. Following the development of the Beta came' the opening up of the Nanaimo mine, after which the Village of Iron River was first named.

Following the Mackinnon brothers came R. L. and W. If Selden in 1880 or 1881, as civil engineers of the C. & N. W. Ry. The latter gentleman, becoming imbued with the great future of this district, concluded that no better place for a home could be found, and together with his brother located lands in Section 35 and 36, 43-35, and immediately commenced active exploratory work, opening up the Iron River, Isabella, Selden and Hiawatha mines. The Iron River and Isabella mines were opened up and actively worked until 1888 or 1889, with Tod Stambaugh as general manager and J. N. Porter as general superintendent. In honor of the work done by Mr. Stambaugh, the Village and Township of Stambaugh was named after him.

In 1882 the district became prominently known to the outside world by the extending of the C. & N. W. Ry. from Commenwealth to Iron River, which remained its terminus for four years when it was extended to Watersmeet and the Gogebic range. Immediately on the extension of the railroad into Iron River ore shipments were made from the Iron River and Nanaimo mines.

Shortly after this time John S. MacDonald of Fond du Lac, Wisconsin, but now of Minneapolis, believed that a charcoal furnace would be a success in Iron River, as there appeared to be an unlimited quantity of iron ore and hardwood. Accordingly, in 1885, the work of erecting a sixty ton furnace was commenced and in 1886 was ready for operation. A number of charcoal kilns were erected near the furnace and also along the county road, on the farm now owned by M. B. Waite. The furnace from the start did not prove a paying proposition and in two or three years was forced into idleness, in which condition it remained until 1905 or 1906, when it became the property of Paul N. Minckler, who dismantled it and made it into a sawmill.

The Nanaimo and Iron River mines continued to ship ore until 1891, when the Nanaimo was closed down and remained closed until 1904. It was then reopened by the Mineral Mining Co. The Iron River mine shipped 1,176 tons of ore in 1892, was closed down and remained closed until 1903, when it was taken over by the Oliver Iron Mining Co., and has become a large producer.

For several years after the closing down of the above mentioned mines no operations were conducted in the Iron River district, particularly from 1893 to 1898 inclusive, owing to the low grade of the ore and the prevailing hard times.

The homestead law was also a determining factor in preventing the development of the district. As the question of title was at stake no mining company cared to expend any money in exploratory work without knowing in whom the title to the land rested. As rapidly as the ownership to the land was settled exploratory operations became more numerous until at present there is not another district in the entire Lake Superior region of similar area that can boast of so many mining companies in operation.

Following the opening of the Nanaimo and Iron River mines, came the developing and opening up of the Sheridan, Hiawatha, Dober, Baltic, Caspian, James, Young, Baker, Fogarty, Berkshire, Chathams, Zimmerman, Chicagoan, and Davidson mines. Besides there are a number of promising explorations which will within the next year or so be added to the shipping list.

The following well-known companies are now actively engaged in the Iron River district:

Oliver Iron Mining Co.	Republic Iron & Steel Co.
Verona Mining Co.	Davidson Ore Mining Co.
Corrigan, McKinney & Co.	Jones & Laughlins Co.
Oglebay, Norton Co.	Mineral Mining Co.
Rogers Brown Ore Co.	Florence Iron Co.
Youngs Mining Co.	Wickwire Steel Co.
Cleveland-Cliffs Iron Co.	Michigan Iron Co.

Iron River Ore Co.

Of these fifteen companies, seven are already shippers and have been for a number of years. The future of the Iron River district never looked brighter than at present.

DESCRIPTION OF MINES ON THE MENOMINEE RANGE.

THE OLIVER IRON MINING COMPANY.

CHAPIN MINE.

The Chapin Mine is located in Iron Mountain, Michigan, and is a property of the Oliver Iron Mining Company, and has been in operation since 1879.

The Chapin has three shafts, the "B" Chapin, No. 2 Hamilton and "C" Ludington. "B" Chapin is at this time, idle on account of alterations being made to its hoisting plant. No. 2 Hamilton, since the sinking of "C" Ludington was completed, has been used for hoisting and lowering men and timber only. Pumps are also located on the 12th and 16th levels of this shaft, which, until the Cornish pumping plant was placed in operation, were used for pumping all the coming water in the Chapin Mine.

Since the date of the last meeting of the Institute on the Menominee Range (1905), a few changes have taken place in the way of equipment at the Chapin, which might here be briefly described. The sinking of "C" Ludington shaft has been completed. At this shaft the entire product of the mine is hoisted, and here, also, the greater portion of the pumping from this property is carried on "C" Ludington shaft is 10' 4" by 21' 3"; is steel lined and has a depth of 1,522 feet, or is down to what is known as the 17th level. The shaft has two skip compartments, each 5'x6'; one cage, 5'x10' 4", and one compartment 9' 3"x10' 4", used for ladderway, pump columns, air lines, electric wires, etc. Two five ton skips are operated in this shaft; the product of the mine being hoisted from what is termed the 14th, or main working level, and which is located 1,201 feet from the surface. The equipment at "C" Ludington shaft consists of one 34x72 inch single duplex first motion Corliss hoisting engine, operating single drum, 12' diameter, 10' face, grooved for 1⅜" rope and is used as a skip hoist, and one 30x60 inch simple reversible Corliss hoisting engine, geared to one 12' drum, 10' face, grooved for 1⅜" rope, and used as Cage hoist. Electric generator plant for operating underground electric haulage consists of one 100 K. W. direct current, 250 volt, 400 ampere belt driven generator, driven by 14"x36" Corliss engine, and one two unit, three bearing induction motor generator set, 200 K. W. 250 volt, 800 ampere. The boiler plant consists of four 72"x15' horizontal tubular boilers. As all the machinery described above is operated with compressed air, this plant is used only in case of emergency.

At this shaft there has also been installed, and is now in operation, a Cornish pumping plant, which, some 15 years ago, was located in "D" shaft Chapin Mine. This plant may be described as a Steeple Compound engine with high pressure cylinders 50 inches diameter, low pressure 100 inches diameter, stroke 120 inches and fly wheel 40 feet in diameter, weighing 160 tons. The pump is of eight-lifts construction, six sets each 192 feet apart and two sets each 170 feet apart. Plungers and discharge column 28 inches diameter, pump rods 7" and 8" diameter. Capacity of pumping plant 3,000 gallons per minute from depth of 1,500 feet. For operation of the pumping plant, there have been installed six 72"x18' horizontal tubular boilers. The building containing these boilers is one of the standard type of the Oliver Iron Mining Company.

CHAPIN MINE COMPRESSOR PLANT.

Mention might also here be made of the Chapin Mine air compressor plant, located at what is known as the Upper Quinnesec Falls, on the Menominee River, about three miles southeast of the mine. This plant was installed in the year 1882. During the years 1903 and 1904, and subsequent to this time, some changes were made in the plant, one of which consisted of building a steel flume to replace the wooden flume originally built. This new flume has a length of 382 feet, is 16 feet deep and 22 feet wide and is supported by 72 concrete piers.

New air cylinders of the Corliss valve type, have also been installed, three pair being 34"x60" and one pair 38"x60" in size, replacing three pair 34"x60" and one pair 36"x6o" of the old poppet valve type. Each pair of the cylinders are driven by 50" special double horizontal turbines. A pipe line 24" in diameter, conveys the compressed air to the mine a distance of 16,665 feet. This pipe is built in lengths of 58 feet each, the material being riveted wrought plates ¼" thickness. At the present time, all machinery at the Chapin Mine, with the exception of the Cornish pumping plant, is operated by compressed air.

ARAGON MINE.

The Aragon is another of the Oliver Iron Mining Company's properties, and is located in the City of Norway, Michigan. This mine is operated by two shafts, Nos. 4 and 5.

No. 4 shaft has a depth of 991 feet. It has three compartments, two for skips and one for pipes, ladderway, etc. The equipment at this shaft consists of one 20"x42" simple duplex first motion, hoisting engine, operating two drums each 6 feet in diameter with 9 foot face. One Corliss cross-compound steam, single-acting, four stage air compressor, steam 12"x 22"x30", air 20"x12"x7¼"x4¼"x30", providing air for pneumatic haulage plant in use at this mine. One simple steam, three stage tandem air compressor, steam 14"x16", air 10½"x7¾"x3⅝"x16", first installed for furnishing air for pneumatic haulage, now used as relay only. One 17½ K. W. direct current, 125 volt, belt driven generator for lighting purpose on surface. The boiler plant at No. 4 consists of three 264 H.P. Babcock & Wilcox water tube boilers.

No. 5 shaft has a depth of 1,052 feet and has four compartments, two compartments for skips of five-ton capacity each, one for cage and one for pipes, ladderway, etc. On the 11th level at this shaft are located two 18"-28"-47"-12"x24" triple expansion pumps. The equipment on surface here consists of one 28"x60" simple duplex, first motion Corliss hoisting engine, connected to two 12 foot drums—each 9 foot face and used for operating two five-ton skips. One 24"x42" simple Corliss hoisting engine, geared to one 12 foot drum, diameter of face 5½ feet and used for operating cage. There are also located at No. 5 shaft two compressors, one tandem compound, two stage, steam 18"x36", air 20"x32"x36". One straight line simple two stage air compressor, steam 20"x26", air 22"x14"x26". The boiler plant consists of two 264 H. P. and one 400 H. P. water tube boilers.

Since the last meeting of the institute, a new machine, blacksmith and carpenter shop has been built in close proximity to No. 5 shaft. A new laboratory, a changehouse with capacity for 350 men, saw mill, oil house and captain's office have also been erected. Old buildings of same nature as those mentioned, were formerly located near what was known as No. 2 shaft. This shaft has been abandoned on account of the ground caving, which also made necessary the construction on a permanent site for the buildings above noted.

MANSFIELD MINE.

The Mansfield is the property of the Oliver Iron Mining Company located at Mansfield, Iron County, Mich., about seven miles east of Crystal Falls.

Geologically, the Mansfield ore body stands alone. It is not of the same age as the Amasa, Crystal Falls or Iron River ore bodies nor the ore bodies at Iron Mountain and east. It lies in a thin slate formation, above and below which is greenstone. There are other slates east of the Mansfield mine which are of the same geological age as the Mansfield slate, but they are not so enclosed by greenstone. The ore body strikes nearly north and south and dips west at a high angle. It is about eleven feet thick, and very uniform, and is fairly persistent with depth. It is spoken of by many as a true fissure vein, and looked upon as an eruptive, but the ore was concentrated in exactly the same way as were the oilier iron ore bodies of Michigan. Elsewhere the Mansfield slates have not produced ore.

The mine is operated by one shaft, known as No. 2, and has a depth of 1,390 feet. It is vertical and has three compartments, two for skips and one for ladderway, pipes, etc. The skips in this shaft are suspended from single deck cages, which are used for hoisting and lowering men. The equipment here consists of one 28"x48" simple reversible Corliss hoisting engine, geared to two drums, each 10 feet in diameter with 6½ foot face. One simple duplex slide valve, two stage air compressor, steam 18"x24", air 28¼"'x17¼"x24". The boiler plant consists of three 72"x18 ft. horizontal tubular boilers.

MICHIGAN MINE.

The Michigan is located at Amasa, Iron County, Mich., and is operated by the Oliver Iron Mining Company.

This property is in the same geological formation as is the Dober. To the East, which would be in its footwall, is a magnetic slate which can be readily traced with the magnetic needle, though the magnetic dip is not large. This slate is in the footwall of the Hemlock and Gibson also. East of the magnetic slate is the Hemlock greenstone. The Michigan formation clips west at a high angle and the strike is nearly north and south. The ore is high in phosphorus, as are the other ores of the same formation. The mine is operated through one shaft, known as No. 2. This shaft is incline and has three compartments, two for skips and one for ladderway, pipes, etc. The equipment at this shaft consists of the following: One 12"x14" simple duplex slide valve reversible hoisting engine, geared to drum 6 feet in diameter with face 4' 8", one straight line, simple steam, single stage air compressor, steam and air cylinders 12"x30" and one 250 H. P. water tube boiler.

DOBER MINE.

The Dober mine is operated by the Oliver Iron Mining Company and located at Stambaugh, Iron County, Michigan.

The Dober formation strikes west of south and is nearly vertical. It has a black slate footwall, as have all the other mines of the Iron River area. It is separated from the Isabella ore body adjoining the Dober on the north by a black slate. It is, however, possible that future work will show that the Isabella and Dober formations are really one, and that their present apparent relations are due to folding. The Dober ore body lies in a formation which is geologically younger than the slates, in which are found the ore bodies at Iron Mountain and east. Like other ore bodies of the Iron River area, the Dober is high in phosphorus. It is difficult to say what part the black slate footwall played in the concentration of ore, but since every mine in the area has black slate, either in foot or hanging wall and sometimes both, it is quite evident that the presence of black slate is almost a necessary condition for a mine in the Iron River area.

There are two shafts in operation at Dober mine: Nos. 1 and 2. No. 2 is incline, has three compartments and is down to a depth of 685 feet. Two four-ton skips are operated in this shaft. The equipment at this point consists of one 18"x48" simple single reversible Corliss hoisting engine, geared to two drums each 8 ft. in diameter with 5 ft. face and one simple duplex Corliss, two stage air compressor, steam 18"x30", air 28"x18"x30". No 1 shaft has one compartment only and is down to a depth of 800 feet, equipped with cage for hoisting and lowering men. The cage is also used for hoisting some ore with car. The hoist for operating this cage is described as one 18"x24" simple duplex slide valve reversible engine, geared to one drum 6 ft. in diameter with 6 ft. face. One boiler plant provides steam for equipment at both shafts above described, and consists of three 250 H. P. water tube boilers.

CUNDY MINE.

The Cundy is the property of the Oliver Iron Mining Company and is situated at Quinnesec, in Dickinson County, Michigan. This mine is located in what is generally known as the Curry member of the Vulcan iron hearing formation, despite the fact that most of the ore bodies east of Iron Mountain are in the Traders' member. The dip of the ore body is about 70 to 80 degrees toward the south, which is away from the dolomite, although the Chapin dips to the north toward the dolomite. The ore is hard and lean, and shows the fragmental nature more plainly than is common along the range. The ore body carries a considerable amount of magnetite.

Two shafts are located on this property; one known as the "Gray," and the other the "Foote," the former 495 feet and the latter 615 feet in depth. The equipment at the Cundy mine consists of one 24"x48" simple, non-reversible, Corliss hoisting engine geared to two drums, each 8 feet in diameter with 6½ foot face, and three 72"x20' horizontal tubular boilers. This property was closed down in October, 1903, and has not been in operation since that date.

O. C. Davidson, Iron Mountain, Mich., is general superintendent of the properties operated by the Oliver Iron Mining Company.

THE MUNRO IRON MINING COMPANY.

THE ROGERS MINE.

The Rogers Mine, located on the N. E. ¼, Section 29, 43-34, is under lease to the Munro Iron Mining Company. The property has been partially explored by diamond drilling. A concrete shaft sunk by the Foundation Company is now down to ledge and the active development of the property will soon be started. The concrete part of the shaft has a circular exterior with 16' 6"x11' 0", rectangular interior, which will be divided into two skip roads, a cage road and pipe and ladder compartment. No permanent equipment has yet been installed.

THE CHICAGOAN MINE.

The Chicagoan Mine is located on the Northeast quarter of Section 26, 43-34 about seven miles east of Iron River and is operated by the Munro Iron Mining Company. Although first explored in 1881, the property was not brought to the shipping stage until this season. The old exploring shaft has been sunk to a total depth of 540 feet and the ore measures explored by three main levels, the 2nd, 3rd and 5th. The sub-level stoping system of mining is used. The mine is equipped with three 150 H. P. boilers; one No. 8 crusher, and temporary air compressors and hoist. Total shipments to August 1st 70,000 tons.

THE HIAWATHA MINE.

The Hiawatha Mine, located on the S. W. ¼ of the S. E. ¼, Section 35, 43-35 is owned in fee by the Munro Iron Mining Company who began work on the property in 1906. The shaft has been sunk to a total depth of 790 feet with levels approximately one hundred feet apart, the seventh or bottom level being at a depth of 757 feet. The sub-level stoping system of mining is used to a large extent. The surface equipment consists of four return tubular boilers, 22"x48" Allis Chalmers first motion hoist with 7 ft. drum, 2,000-ft. Nordberg cross compound air compressor, McEwen D. C. generator, and a No. 8 McCully crusher. Tramming is done by electricity. The mine is provided with a one 1,200 gallon Prescott crank and fly wheel pump and one 1,000 gallon Prescott triple expansion pump. The yearly output is about 130,000 tons. Total production previous to 1911, 614,496 tons.

THE MUNRO MINE.

The Munro Mine located one and one-fourth miles west of Norway on Section 6, 39-29 is leased by the Munro Iron Mining Company. Mining is by the open pit milling system. Owing to the low grade of the ore, only a limited product is desired. Total production to date, 298,578 tons. Equipment consists of two 150 H. P. return tubular boilers, geared hoist and straight line air compressors, and a No. 7½ crusher.

G. L. Woodworth, Iron River, Mich., is in charge of the several properties of this company.

THE DESSAU MINING COMPANY.

This company operates the Millie Mine located on the N. E. ¼ of the N. W. ¼ and the N. W. ¼ of the N. E. ¼ of Section 31, Town 40, Range 30. This mine was first opened in the early eighties and has shipped to January first 368,267 tons. This product with the exception of 113,650 tons, mined from an open pit at the west end of the property, was a high grade Bessemer ore. The Main shaft is 350 feet in depth.

S. J. McGregor, Iron Mountain, Mich., is in charge of the property.

LORETTO MINE.

Located in Section 7, T. 39 N., R. 28 W., between the northern and southern belts of dolomite. Operated by the Loretto Iron Company. As the Sturgeon River formerly passed over the ore body, mining was conducted by the room and pillar system to a depth of 800 feet. In 1908 the course of the river was diverted to the west of the ore body and operations since that time have consisted of mining out the pillars by the top slicing system. There are two shafts in use, No. 1 hoisting shaft 6x12 feet, 800 feet deep and No. 3 timber shaft 8x10 feet, 300 feet deep. The boiler plant consists of two 76"x20' and 72"x20' horizontal tubular boilers, and one 10' 6"x12' 6" Scotch marine boiler. The mechanical equipment consists of one Bullock 21"x36" direct acting flat rope hoist, one Webster, Camp & Lane 10"x14" geared hoist, one 16"x30" and 30"x19"x42" cross compound Rand compressor and a 10"x18" and 11½"x7"x5½"x3⅜"x12" Laidlaw-Dunn-Gordon high pressure air compressor.

APPLETON MINE.

Operated by the Loretto Iron Company and included in the description of the Loretto Mine. J. Ward Amberg of Chicago is manager.

CORRIGAN, McKINNEY & CO.

Several of the mining companies operating on the Menominee range, particularly in Iron County, are under the control of Corrigan, McKinney & Co. The active mines at the time of the Institute meeting were the Tobin, Dunn, Armenia and Tully; the idle mines were the Great Western, Crystal Falls, Kimball, Fairbanks and Baker. The operations are under the charge of Wm. J. Richards, general superintendent, Crystal Falls, Mich.

TOBIN MINE.

The Tobin Mine has been opened to a depth of 1,100 feet, mining now to the eleventh level. From this level a winze has been sunk another 125 feet and crosscutting is now in progress to the shaft, thus making the twelfth level. This mine is electrically equipped, having electric haulage on the stockpile and underground. The main shaft is 6' 6"x22' inside measurements, and four compartments. The main hoist is a twin Corliss Nordberg 20"x48", first motion. The man and timber hoist is a Marinette 16"x20", geared. The compressor is the Rand Imperial type of twenty-five drill capacity. The boilers are horizontal return tubular, four in the battery, with a total of five hundred horse power. At this plant the Green Fuel Economizer has been installed. Underground the water is handled by a Prescott triple expansion pump of 750 gallons capacity, with a Prescott compound of 500 gallons capacity as a relay. All the ore hoisted is crushed.

DUNN MINE.

The Dunn is one of the oldest mines in Iron County. The bottom level is the eleventh, at a depth of 1,420 feet. The shaft is three compartment, 6' 4"x16' 4" inside. All ore hoisted is crushed before going on the stockpile or into the cars. The hoist is of the Sullivan Corliss type 20"x48", first motion. A new compressor made by the Chicago Pneumatic Tool Company was recently installed, and is a Corliss two stage design, 20"x34" steam, 17"x28" air, with piston stroke of 36", or a drill capacity of about 25 machines. This mine has underground electric haulage and also electric haulage for stocking on surface. The boiler battery consists of horizontal return tubular boilers, three of 150 horse power each and one of 125 horse power. The underground water is handled by a Prescott compound pump of 500 gallons capacity.

ARMENIA MINE.

The Armenia mine is now working on the seventh level or a total depth of 690 feet. The shaft is 6' 4"x16' 4" inside, four compartments. The main hoist is a Fraser Chalmers, 22"x48", geared type. The man and timber hoist is a Marinette 18"x24". This mine has a crusher equipment and all its ore is crushed. A Rand duplex two stage compressor furnishes air for twelve machines. The boiler plant consists of three 150 horsepower horizontal return tubular boilers. The mine water is handled by a Prescott triple expansion pump with a capacity of 1,000 gallons at 1,000 feet. The haulage equipment at this mine, both underground and on top, is electrical.

GREAT WESTERN MINE.

Although the mine is at present idle considerable activity prevails on surface. At this mine is located the general shops of the Corrigan, McKinney & Co. group, the general store house, and the general office. Hence, a fair force is kept continually engaged here.

TULLY MINE.

The work at the Tully consists in sinking a shaft from surface through the overburden of 160 feet to the ledge. This work is almost finished, after sinking through 80 feet of hard pan, then through 80 feet of quicksand and handling 1,200 gallons of water per minute. This mine, as well as all the idle mines of the Corrigan, McKinney & Co. control, has complete surface equipment.

THE FLORENCE MINE.

Located on a hill northwest of the village of Florence, Wisconsin, covering the N. E. ¼ of S. E. ¼ and S. E. ¼ of N. E. ¼ of Section 20 and the N. W. ¼ of S. W. ¼ of Section 21 in Township 40 North, Range 18 East.

The ore is a medium hard, red hematite. The formation is very wide; slightly bowed and folded. The ore occurs in large lenses of irregular shape. It is mined by the underhand stoping system, milling into raises from below. Floor pillars are left every second level which are afterwards blasted out. This leaves very large stopes some of which are 250 feet long, from 50 to 150 feet wide, and 200 feet high. In the old part of the mine, these stopes are being filled with sand in order to mine the pillars which contain a large amount of good ore. The sand filling is done with a Bagley Steam Grader operated by three men. This grader handles more dirt in twenty-four hours than would be possible with a steam shove' working under similar conditions. The tramming underground is done by three electric motors working on 500 volts, direct current. The deepest level is 670 feet.

The main items of interest at the mine is the crusher plant which is a No. 7 Gates, set on a concrete foundation. The ore being elevated by means of a belt elevator and trammed to the stockpile with an electric motor in the winter time, in the summer time, the ore is emptied directly into the pockets from the elevator. The mine has been closed since the first of June, this year.

Felix A. Vogel, 25 Broad street, New York city, is the general manager; E. S. Dickinson, superintendent, and Edward Larson, assistant superintendent.

BRISTOL MINE.

The Bristol mine is located in the E ½ of the S ½ of Section 19-43-32 about 1½ miles from the city of Crystal Falls. The mine was originally called the Claire, but was leased in 1889 by the Bristol Mining Co. and renamed the Bristol. The first shaft was 960 feet deep and is being replaced by a steel lined 4-compartment shaft, which will be put down to a depth of 1,000 feet. A Webster, Camp & Lane hoist and a Norwalk tandem compound compressor are the equipment at the old shaft. Two grades of ore are shipped; the Manganate ore containing over 3 per cent, manganese, and the Bristol 1 running higher in iron and lower in manganese. Total output 1 to January 1st, 1911 is 2,456,109 tons.

E. W. Hopkins is General Manager and Arvid Bjork, Superintendent.

BUCKEYE MINE.

The Buckeye mine is located in Section 33-40-18 in the Wisconsin portion of the Menominee Range, in the Town of Commonwealth. It is worked by the Reserve Mining Co. under a lease from the Commonwealth Iron Co. and was opened in 1908. The shaft is down 495 feet and four levels have been opened up. The hoisting plant is the Sullivan automatic slide-valve type, the compressor a Sullivan straight line corliss. During the last year the mine buildings have been rebuilt and the equipment is very complete. The total production to date is 187,775 tons.

E. W. Hopkins is general manager and Frank J. Smith, superintendent.

BRULE MINING COMPANY.

CHATHAM MINE.

The Chatham Mine is located in the N. E. ¼ of the S. E. ¼ of Section 35, 43-35 in the village of Stambaugh in the Iron River district, and is operated by the Brule Mining Company. A Sullivan automatic slide valve hoist has been recently installed. The compressor is a Sullivan straight line corliss. The mine is operated from two shafts, one on each side of the Iron River; No. 1 having a depth of 700 feet and No. 2 a depth of 300 feet. A great deal of pumping is necessary owing to its close proximity to the river.

BERKSHIRE MINE.

The Berkshire Mine is located in Section 6, 42-34 in the village of Stambaugh in the Iron River district. The mine was opened in 1908 by the Brule Mining Company. The workings are operated from a single shaft which has a depth of 365 feet. A Sullivan automatic slide valve hoist has been recently installed, and air for drills is furnished by a Sullivan straight line corliss compressor. Total production to date is about 200,000 tons.

E. W. Hopkins, Commonwealth, Wis., is general manager and F. D. Klinglund, Stambaugh, Mich., superintendent.

GROVELAND MINING COMPANY.

In 1881 exploring was begun on what is known as the Groveland Mine, located in the N. E. ¼ of S. W. ¼ and N. W. ¼ of S. E. ¼, Section 31, 42-29, Dickinson County, by the Felch Mountain Mining Company, a subsidiary of the Old Menominee Mining Company, and continued by them until 1885 when it was abandoned. The work consisted of pits, trenches and shallow drill holes. In 1887 W. H. Rand of Chicago organized the Groveland Mining Company, and equipped the property for active mining. A small shipment of ore was made to Joliet, Ills., in 1888 and again in 1889. The ore being too low grade to be disposed of at this time, shipments were stopped and exploratory work carried on until 1892 when the company suspended operations. It remained closed until 1901 when it was reopened by Corrigan, McKinney & Co., and abandoned by them in 1905. In 1907 it was again opened by G. W. Youngs who organized the present Groveland Mining Company, the present operators. Shipments of ore have been made for the past four years without interruption and to date the mine has shipped about 140,000 tons. The equipment consists of four 60 H. P. boilers, one 12"x16" Lake Shore Engine Works geared hoist, one 20"x16½"x28"x 24" Franklin compressor and one No. 7½ Gates crusher. F. W. Youngs of Iron River is superintendent.

McDONALD MINING COMPANY.

The McDonald Mine is located in the S. E. ¼ of the N. E. ¼ Section 23, 43-32 in the Crystal Falls district and lies north of the Armenia Mine. The property is in its development stage, a 12'x8' shaft is being sunk its present depth being 318 feet. Work was started in 1908, and in 1909 a small cargo was shipped. Ore lenses of a very encouraging nature have been found above the 300 foot level which are widening with depth. The equipment consists of two 150 H. P. horizontal boilers, one 12"x14" geared hoist and one 16"x14"x24"x18" Franklin air compressor. F. W. Youngs, Iron River, is superintendent.

HURON IRON MINING COMPANY.

The Youngs Mine is located in the E. ½ of Section 12, 42-35 in the Iron River district and adjoins the Baltic Mine on the west and the Fogarty on the south. The property was opened in 1905 by G. W. Youngs and 11,000 tons were shipped that year. In 1907 it was sold to the Huron Iron Mining Company, the present operators. It has one working shaft 425 feet deep, through which a four-ton skip is operated. The equipment consists of three 150 H. P. horizontal boilers, one 15"x20" Lake Shore Engine Works geared hoist with 6 foot drums, one Ingersoll Rand 15 drill compressor and one No. 7½ Gates crusher. F. W. Youngs is superintendent.

PEWABIC COMPANY.

This company operates the Pewabic Mine near the City of Iron Mountain. It is one of the oldest companies on the Menominee Range, and in point of total shipments is the third largest producer. The Pewabic includes the old Walpole and Keel Ridge Mines. The local office of the company is at Iron Mountain. Mr. E. F. Brown is manager and W. G. Munroe assistant superintendent.

MINERAL MINING COMPANY.

The general mine office of this company is at Iron Mountain, Michigan, and E. F. Brown is secretary and general manager. The operations of this company at the present time consist of the following mines:

WAUSECA MINE—N. ½ of N. E. ¼, Section 23-43-35.

OSANA MINE—S. W. ¼ of N. E. ¼ and S. E. ¼ of N. W. ¼, Section 23-43-35.

NANAIMO MINE—N. W. ¼ of S. W. /4 and S. W. ¼, of S W. ¼, Section 26-43-35.

BREEN MINE—N. W. ¼ of N. E. ¼, N. W. ¼ of N. W. ¼ and N. E. ¼ of N. W. ¼, Section 22-39-28.

ANTOINE ORE COMPANY.

This company is operating the Clifford-Traders Mine, located on Sections 17 and 20, Town 40, Range 30, near Iron Mountain. The mine is worked open pit and the present depth of the shaft is 135 feet. The ore is crushed before being shipped, a No. 7½ Gates crusher handling the product as mined. Frank Carbis of Iron Mountain is superintendent.

PICKANDS, MATHER & COMPANY.

The operations of this company in the Lake Superior district, are under the charge of C. H. Munger, general manager, Duluth., Minn. The Menominee Range properties, under the charge of Charles E. Lawrence, general superintendent, Iron Mountain, consists of the following mines:

BALTIC MINE.

The Baltic mine is located on the W. ½ of the N. W. ¼ of Section 7, Town 42, Range 34. The ore is a brown hematite, and is mined by the sub-stoping method. The mine is thoroughly equipped with machinery, has forty-four dwellings and a modern fireproof dry house, equipped with steel lockers, baths, toilets and emergency hospital. It also has a club house for the benefit of the Company's employees, which is equipped with bowling alleys, baths, barber shop, pool and billiard room with a large and well lighted reading room, is stocked with papers and magazines, together with a graphophone and pianola. The mine is opened to the 7th level, 585 feet vertical depth, and is operated through two shafts, one being used for ore and the other for the handling of men and timber. The first shipment of ore was made in 1901 and the mine is the pioneer of the district around Palatka.

FOGARTY MINE.

The Fogarty mine is located on the S. E. ¼ of the S. E. 34 Section 1, Town 42, Range 35. The ore is a brown hematite, and like the Baltic is mined by the sub-stoping method. The property is .fully equipped with machinery and has a fireproof dry house with steel lockers, baths and emergency hospital. The mine is opened to the 3rd level, at a depth of 265 feet vertical, and is operated through two shafts, one for the handling of ore and the other for the handling of timber and men. The first shipments were made in 1907.

CASPIAN MINE.

The Caspian mine is located on the N. E. ¼ of Section 1, Town 42, Range 35. The ore is a brown hematite, and the method of mining is the slicing or caving system. The property is thoroughly equipped with machinery. It has sixty-eight dwellings, and the company is at present erecting a handsome and modern club house for the use of its employees. The mine is opened to the 3rd level, being 292 feet deep, vertically, and is operated through three shafts, one being for the handling of ore and the other two for men and timber. The first shipment was made in 1903.

BENGAL MINE.

The Bengal mine is located on the N. ½ of the S. E. ¼ of Section 36, Town 43, Range 35. The ore is a brown hematite. This property at present has merely an exploring shaft with an equipment of exploring machinery and buildings on surface. A new shaft is being sunk, which, when completed, will be equipped with modern machinery. The work of exploring to date has been confined to one level.

W. H. Jobe is superintendent of the Baltic, Fogarty, Caspian and Bengal mines, all of which are located near Palatka, in the Iron River district.

HEMLOCK MINE.

The Hemlock mine is located on the W. ½ of the S. W. ¼ of Section 4, Town 44, Range 33, near Amasa. The ore is a red hematite, extremely hard, and the back-stoping system is here applied. The property is thoroughly equipped with machinery and mine buildings, among the latter being a modern fire-proof dry house, with steel lockers, baths and emergency hospital. The Company has twenty-seven dwellings for the use of employees. The product is secured from one shaft, the mine being opened to the 14th level, at an angle of 65 degrees, depth, 1,200 feet. The first shipments were made in 1891. C. W. Hughes is superintendent.

CHANNING MINE.

The Channing mine is located on the S. E. ¼ of Section 20, Town 45, Range 33, north of Amasa. The ore is a red hematite. The property has never been worked as a mine, although the ore body has been developed, ready for mining, but is of low quality. The mine is closed down at present. The equipment is of an exploratory nature. R. G. Whitehead is superintendent.

VIVIAN MINE.

The Vivian mine is located on the S. W. ¼ of Section 34, Town 40, Range 30, near Quinnesec. The product is a silicious ore, and the mode of mining is back-stoping. The ore is secured through one shaft and the mine is opened to the 4th level, at a vertical depth of 310 feet. The first shipment was made in 1902. The mine is equipped with necessary machinery and mine buildings, together with five dwellings for employees. The property is closed at present.

CALUMET MINE.

The Calumet mine is located on the N. E. ¼ of Section 8, Town 41, Range 28, south of the Metropolitan district. The ore is silicious and the mode of mining is back-stoping. The product is secured through one shaft, and the mine has been opened to the 3rd level, at a vertical, depth of 215 feet. The property is equipped with the necessary machinery and has twenty-four dwellings. The mine is closed at present. The first shipment was made in 1906.

PENN IRON MINING COMPANY.

The Penn group of mines were developed in 1879-81 by the Menominee Mining Company and acquired by Penn Iron Mining Company in 1882. The total production to December 31st, 1910, is 8,845,135 tons. The operations of the company are divided into three departments—East Vulcan, West Vulcan and Norway.

EAST VULCAN MINE.

At the East Vulcan there are two shafts, No. 4, 1,450 feet deep, and No. 3, 1,150 feet deep, and the East Central adit which reaches some small ore bodies near the surface at the west end of the operations. The largest of these has been connected below with drifts from No. 3 shaft. In this ore body the top stoping and caving method, from sub-levels, about fifteen feet apart, is used, but in most other parts of the mine where the ore body is very irregular in shape the ore is taken out in over-hand stopes with square sets or stull pieces and generally filled with waste rock. In some cases the stoping is in the form of rooms and pillars. The mine makes from 700 to 800 gallons of water per minute which is pumped from the bottom of No. 4 shaft. This property at the present time is producing at the rate of from 80,000 to 100,000 tons of ore a year.

WEST VULCAN MINE.

The West Vulcan department includes, from east to west —-No. 7 shaft, 265 feet deep; C shaft, 1,500 feet deep; Curry shaft, 1,350 feet deep, and Brier Hill shaft, 810 feet deep. Brier Hill shaft is circular in section, 14 feet in diameter, and lined throughout with concrete with steel dividers to hold the runners. The constructon of this shaft is described in the Proceedings of 1909, Vol. XIV, pages 140-147. This department is producing at the rate of between 200,000 to 250,000 tons of ore a year. About 30 gallons per minute of water is pumped from the bottom of the Brier Hill shaft and 900 gallons per minute from the bottom of C shaft. There are steel head-frames over Curry and Brier Hill shafts and a fire-proof changing house with lockers and toilet arrangements at Brier Hill.

The ore on the lower levels east of C shaft is being taken out by top slicing. In most of the other parts of the mine the system is by rooms and pillars, using square sets with rock filling in the rooms, and square sets, sometimes in side slices with filling, or top slicing in the pillars. The timber system is used where it is necessary to hold up the surface or where the rock over the ore will not cave. The irregularity of some of the ore shoots is such that no caving plan will apply. Where the walls are very strong shrinkage stoping is sometimes used. The square set methods are described in a paper by F. L. Burr in another part of these Proceedings. The workings connecting the four shafts at different levels extend for over a mile from east to west. At both East and West Vulcan there are geologically two ore formations with slate of varying thickness up to four hundred feet between. In some cases the formations have been so folded as to appear in crosscuts to be duplicated. The ore is sometimes found in major folds, but sometimes the folding is of minor importance. Continuous exploring underground is required to trace the known ore bodies or discover new ones. Even in the larger ore bodies their continuance in depth is very uncertain.

NORWAY MINE.

The old Norway mine was idle for a number of years, but the pillars and floors are now being taken out and this will not take very long. Exploring by drifting underground and diamond-drilling from surface is being prosecuted. The old Cyclops pits are worked on an open pit milling system for silicious ore in the summer time.

HYDRO-ELECTRIC PLANT.

In 1905 and 1906 a hydro-electric plant was constructed at the Sturgeon Falls of the Menominee River, and practically all of the mine machinery is, or soon will be, driven electrically. The steam pumps which were installed before the electrical pumps were put in are still in place and the engines of two of the hoists can still be connected, but the steam machinery is now only for emergencies. No new steam engines have been installed since the electrical equipment was first started, except a steam turbo-generator to supplement the hydro-electric plant during low stages of water. The hydro-electric plant was described in a paper by T. W. Orbison and F. H. Armstrong in the Proceedings of 1908, Vol. XIII, page 177, and the machinery equipment of the mines is the subject of a paper by Mr. Armstrong which appears in another part of these Proceedings. No attempt has been made to tram with electric trolleys underground, as the ore is scattered between so many shafts and different levels that electric equipment for this purpose would not be justified.

William Kelly, Vulcan, Mich., is general manager of the properties operated by the Perm Iron Mining Company.

HOLLISTER MINE.

This is what may be called one of the re-claimed mining prospects of the Crystal Falls district. At present mining is being done at a depth of 750 feet through a two-compartment exploratory shaft six feet by ten feet inside. The hoist is a duplex Webster Camp and Lane, with six-foot drum. The air is supplied by a Hall compressor, capable of running seven drilling machines. The surface is equipped with shops, etc. At the present time experimenting is being done with a dryer, for the purpose of eliminating as much moisture from the ore as possible. This dryer has a capacity of 300 tons per day. Frank Scadden, of Crystal Falls is in charge of the property which is operated by M. A. Hanna & Co.

EXPLORATIONS.

The following is a list of explorations being carried on at the time of the Institute trip through the district:

THE REPUBLIC IRON & STEEL CO.—Operating two drills on the Sherwood, south of the James mine, section 23, 43-35.

JONES & LAUGHLIN CO.—One drill west of the James, on section 15, 43-35.

POWERS & GARY EXPLORING CO.—Operating one drill on the Aronson property, on section 23.

THE MUNROE MINING CO.—Operating one drill on the Minckler property, also on section 23.

THE IRON RIVER ORE CO.—Two drills on section 22, 43-35.

THE CORRIGAN-MCKINNEY CO.—Operating one drill on the Carlson property, east of the Baker mine, section 31, 43-34.

THE WICKWIRE STEEL CO.—Operating one drill on the Greig property, section 33, 43-35, one on the Purcell, section 14, 43-35, and one on the McDonald property, section 24, 43-35.

THE CLEVELAND-CLIFFS IRON CO.—Three drills in operation on sections 21, 22 and 23, 43-34.

THE OLIVER IRON MINING CO.—Operating one drill on section 25, 43-34, east of the Chicagoan mine.

THE BLAIR & GIBBS EXPLORING CO.—Two drills in operation, one on section 35, 44-36; one on 35, 43-34, and a test-pit crew on section 3, 43-36.

THE MICHIGAN MINING CO.—Two exploratory shafts. Section 36, 43-35 and section 6, 42-34.

PRODUCING MINES OF IRON COUNTY.

Name of Mine.	Operator.	Location.	Manager.	Address.
Great Western	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Tobin	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Dunn	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Armenia	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Baker	Corrigan, McKinney & Co.	Stambaugh	W. J. Richards	Crystal Falls
Tully	Corrigan, McKinney & Co.	Stambaugh	W. J. Richards	Crystal Falls
Bristol	Ogleby, Norton & Co.	Crystal Falls	E. W. Hopkins	Commonwealth
McDonald	Huron Iron Mining Co.	Crystal Falls	G. W. Youngs	Iron River
Hollister	M. A. Hanna & Co.	Crystal Falls	Frank Scadden	Crystal Falls
Baltic	Verona Mining Co.	Palatka	C. E. Lawrence	Iron Mountain
Caspian	Verona Mining Co.	Palatka	C. E. Lawrence	Iron Mountain
Fogarty	Verona Mining Co.	Iron River	C. E. Lawrence	Iron Mountain
Hemlock	Verona Mining Co.	Amasa	C. E. Lawrence	Iron Mountain
Mansfield	Oliver Iron Mining Co.	Mansfield	O. C. Davidson	Iron Mountain
Michigan	Oliver Iron Mining Co.	Amasa	O. C. Davidson	Iron Mountain
Dober	Oliver Iron Mining Co.	Iron River	O. C. Davidson	Iron Mountain
James	Mineral Mining Co.	Iron River	E. F. Brown	Iron Mountain
Konwinzki	Mineral Mining Co.	Iron River	E. F. Brown	Iron Mountain
Chatham	Oglebay Norton & Co.	Iron River	E. W. Hopkins	Commonwealth
Berkshire	Oglebay Norton & Co.	Iron River	E. W. Hopkins	Commonwealth
Gibson	Rogers-Brown Ore Co.	Amasa	T. H. Martin	Amasa
Hiawatha	Munroe Mining Co.	Iron River	G. L. Woodworth	Iron River
Chicagoan Lake	Munroe Mining Co.	Iron River	G. L. Woodworth	Iron River
Zimmerman	Spring Valley Iron Co.	Iron River	O. P. Doty	Iron River
Bates	Bates Iron Co.	Iron River	Felix A. Vogel	Florence
Gleason	Davidson Ore Mining Co.	Iron River	R. Erickson	Iron River

IDLE MINES.

Name of Mine.	Operator.	Location.	Manager.	Address.
Lot 3	Wisconsin Steel Co.	Crystal Falls	Geo. Darlington	Crystal Falls
Crystal Falls	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Fairbanks	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Kimball	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Youngstown	Oliver Iron Mining Co.	Crystal Falls	O. C. Davidson	Iron Mountain
May	Oliver Iron Mining Co.	Crystal Falls	O. C. Davidson	Iron Mountain
Youngs	Huron Iron Mining Co.	Crystal Falls	G. W. Youngs	Iron River

PRODUCING MINES OF DICKINSON COUNTY.

Name of Mine.	Operator.	Location.	Manager.	Address.
Chapin	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain
Aragon	Oliver Iron Mining Co.	Norway	O. C. Davidson	Iron Mountain
Millie	Dessau Iron Co.	Iron Mountain	S. J. McGregor	Iron Mountain
Traders	Antoine Ore Co.	Iron Mountain	C. T. Fairbairn	Duluth
Pewabic	Pewabic Co.	Iron Mountain	E. F. Brown	Iron Mountain
Walpole	Pewabic Co.	Iron Mountain	E. F. Brown	Iron Mountain
Norway	Penn Iron Mining Co.	Norway	Wm. Kelly	Vulcan
Curry	Penn Iron Mining Co.	Norway	Wm. Kelly	Vulcan
Vulcan	Penn Iron Mining Co.	Vulcan	Wm. Kelly	Vulcan
Vivian	Verona Mining Co.	Quinnesec	C. E. Lawrence	Iron Mountain
Calumet	Verona Mining Co.	Calumet	C. E. Lawrence	Iron Mountain
Loretto	Loretto Iron Co.	Loretto	J. W. Amberg	Chicago
Munro	Munro Mining Co.	Norway	G. L. Woodworth	Iron River
Few	Few Mining Co.	Norway	E. C. Eastman	Marinette
Groveland	Groveland Mining Co.	Randville	G. W. Youngs	Iron River

IDLE MINES.

Name of Mine.	Operator.	Location.	Manager.	Address.
Cundy	Oliver Iron Mining Co.	Quinnesec	O. C. Davidson	Iron Mountain
Quinnesec	Corrigan, McKinney & Co.	Quinnesec	W. J. Richards	Crystal Falls
Saginaw	Saginaw Mining Co.	Norway	E. W. Jones	Iron Mountain
Breen	Mineral Mining Co.	Waucedah	E. F. Brown	Iron Mountain
Forest	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain
Cuff	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain

MENOMINEE RANGE MINES IN WISCONSIN.

Name of Mine.	Operator.	Location.	Manager.	Address.
Florence	Florence Iron Co.	Florence, Wis.	E. S. Dickenson, Supt	Florence, Wis.

[Shipments from Lake Superior Mines Since 1855, Summary]

MENOMINEE RANGE.

Iron Ore Shipments (Gross Tons) for 1910 and Total to Date.

Name of Mine.	1910.	Total to Date.
Alpha		1,370
Antoine (Clifford)	91,081	1,548,499
Aragon	241,046	6,077,327
Armenia	65,473	377,081
Baker	39,417	84,420
Baltic	171,930	1,340,593
Berkshire	97,999	135,734
Breen		75,425
Bristol (Claire)	270,742	2,456,109
Calumet		121,354
Chapin (Ludington)	465,543	17,649,477
Caspian	171,334	699,305
Chatham	51,988	181,427
Columbia		942,703
Commonwealth	89,116	2,600,900
Crystal Falls		1,735,251
Cuff		58,419
Cundy		721,321
Dober (Riverton)	84,269	2,195,146
Dunn	136,144	1,658,015
Eleanor (Appleton)		18,719
Fairbanks (P't. R.)		379,789
Florence	239,161	2,957,180
Fogarty	51,071	168,936
Forest		11,988
Genesee (Ethel)	66,185	537,624
Gibson	45,202	102,353
Great Western	80,709	1,952,937
Groveland	26,462	100,554
Hemlock	115,407	1,705,225
Hiawatha	128,884	614,496
Hilltop		20,229
Hollister	49,434	96,416
Hope		28,530
James	78,388	231,359
Keel Ridge		93,101
Kimball		16,224
Lamont (Monitor)	3,183	558,524
Lincoln		241,627
Loretto	116,048	1,311,068
Mansfield	114,357	1,217,355
McDonald	6,022	7,166
Michigan	17,922	171,719
Millie (Hewitt)		368,267
Monongahela		9,310
Munro	20,022	298,578
Nanaimo		373,765
Northwestern		35,810
Pennsylvania Iron Mining Co.	344,760	8,845,135
Pewabic	380,376	7,317,165
Quinnesec	744	627,215
Saginaw (Perkins)		502,985
Sheridan		116,299
Tobin	235,812	1,630,549
Tully	2,726	2,726
Verona		130,975
Vivian	14,827	420,239
Youngs	98,399	473,784
Zimmerman	25,555	37,690
Miscellaneous		1,057,306
Total	4,237,738	75,450,793

[From Iron Trade Review]

LAKE SUPERIOR IRON ORE SHIPMENTS FROM THE DIFFERENT RANGES FOR 1905, 1906, 1907, 1908, 1909 AND 1910, AND GRAND TOTAL FROM 1855 TO 1910, INCLUSIVE.

(Compiled from Tonnage as Published by Iron Trade Review).

		1905.	1906.	1907.	1908.	1909.	1910.	Grand Tot.
Marquette Range	(Tons	4,210,522	4,057,187	4,388,073	2,414,632	4,256,172	4,392,726	96,309,304
	(Per cent	12.2	10.5	10.3	9.3	10.0	10.1	19.5
Menominee Range	(Tons	4,495,451	5,109,088	4,964,728	2,679,156	4,875,385	4,237,738	75,433,492
	(Per cent	13.1	13.3	11.8	10.3	11.4	9.9	15.3
Vermilion Range	(Tons	1,677,186	1,792,355	1,685,267	841,544	1,108,215	1,203,177	29,938,362
	(Per cent	4.9	4.7	4.	3.2	2.6	2.6	6.2
Gogebic Range	(Tons	3,705,207	3,641,985	3,637,907	2,699,856	4,088,057	4,315,314	65,210,569
	(Per cent	10.8	9.4	8.6	10.4	9.5	10.0	13.3
Mesabi Range	(Tons	20,153,699	23,792,882	27,492,949	17,257,350	28,176,281	29,201,760	224,870,949
	(Per cent	58.7	61.7	65.1	66.3	66.1	67.2	45.6
Miscellaneous	(Tons	111,391	128,742	76,146	122,449	82,759	91,682	698,562
	(Per cent	.3	.4	.2	.5	.2	.2	.1
Total tons		34,353,456	38,522,239	42,245,070	26,014,987	42,586,869	43,442,397	492,461,338
		Increase over 1904 57.4%	Increase over 1905 12.1%	Increase over 1906 9.8%	Decrease from 1907 38.5%	Increase over 1908 63.6%	Increase over 1909 2.0%	

THE SIXTEENTH ANNUAL MEETING.

TUESDAY, AUGUST 22, 1911.

The Westerly end of the Menominee Range has, during the past few years, shown perhaps greater extensions in ore bodies, particularly in the so-called Iron River District, than any other of the iron ranges in the Michigan field. Many new mines have been added to the list of producers and there is at the present time, much new exploratory work in progress. Diamond drilling and exploring shaft are found in new territory, some of which are very promising, while others have not progressed sufficiently to determine the ore measure. The State Geological Survey has given the Iron River District much attention and its work has been of great benefit to the explorer. The attendance at the meeting was assured, as the mining men have been following the progress of this district with interest. Large sums have been expended in the exploration and opening of new properties, which were to be visited during this meeting. The attendance numbered 250 members and guests.

The first stop made by the special train after lunch was at the Hollister, operated by M. A. Hanna & Co., Frank Scadden. Manager. Much interest was shown in the ore-dryer in operation at this mine. The plant is of an experimental kind, and is 6 by 35 feet in size, made by the Atlas Company of Cleveland, Ohio. The moisture is reduced from 15 per cent to 6 per cent and 150 tons per day is being treated. The next stop was at the Tobin Mine of Corrigan-McKinney & Company, of which W. J. Richards, President of the Institute, is General Manager. The Tobin is one of the largest mines in Iron County, is fully equipped and produced 235,812 tons in 1910. From here the party was taken by automobiles to "Idlewild," the beautiful summer home of W. J. Richards, on the shore of Fortune Lake. A barbecue was the feature, prepared by the Commercial Club of Crystal Falls.

EVENING SESSION.

At eight o'clock the members met at the Court House where the business session was held. The meeting was opened by W. J. Richards, President, who extended a most cordial welcome on behalf of the Citizens of the Menominee Range. Mr. Richards stated that it was most gratifying to their local committee to have such a large attendance, considering that a number of the mines were at present idle, owing to the dullness in the iron and steel market. He called attention to the development in the Western end of the Range and spoke with much encouragement of the future prospects of the district. Mr. Richards then introduced Charles H. Watson of Crystal Falls, who delivered the address of welcome. Mr. Watson spoke in part as follows:

Mr. President and Members of the Lake Superior Mining Institute:

The citizens of Crystal Falls appreciate in the fullest measure the high honor of being permitted to the best of their limited ability, to entertain this convention of men who, in a large measure, are furnishing the brawn and brain for the development and operation of the greatest mining- region upon and in the surface of the globe. I have referred to the limitations under which my fellow citizens strive to this end, for it must be recognized that in a village of the size of our Crystal Falls, many limitations of necessity hamper the possibilities for the adequate accommodation and entertainment of a gathering of the proportions of the present meeting. We must ask you, therefore, to permit the breadth of our spirit of hospitality to compensate for any shortcomings along the line of our ability to demonstrate. We hope that during your visit to this part of the Menominee Range you will note that we have been contributing our fair share toward the development of this portion of the great Lake Superior basin. The very favorable conditions which have existed in the iron ore market during the years recently passed have induced capital to explore for and develop some of the iron ore bodies which in prior years had been considered worthless. An abandoned field of a few years ago, through these market conditions, the energy of our local mining men and the business daring of those whom they represent, has been turned into an active and productive district. The value of many of these properties, however, remains for the future to prove. We, who live beside some of these properties, for divers reasons have been inclined to doubt their ultimate value under anything but the most favorable conditions, and really have never appreciated how highly important we were in dollars and cents until very recent expert advices have been received from Lansing. Seriously, however, even these advices we fear will have to stand the test of time and experience.

Again, I desire to say, that we are under deep obligation to the Lake Superior Mining Institute. In the first place, we are indebted to you for having selected, last year, our well beloved fellow citizen, William John Richards, as your President. This feeling was demonstrated at that time by a sumptuous banquet which was tendered to Captain Richards to celebrate his election to the presidency of this important body, I want, at this time, on behalf of the citizens of Crystal Falls and Iron County, to personally thank you for this honor.

Stepping aside for the moment, from my capacity as a representative of the citizens of Crystal Falls, I think it should be considered a fitting tribute to those not at all connected with the mining industry or the Lake Superior Mining Institute, who have contributed so liberally to the preparation for this meeting, to say on behalf of your president and those of us who are members of the Mining Institute and connected with the mining industry, that we appreciate their efforts in this behalf in the highest measure.

It was the custom of the ancients when friendly hosts approached the gates of a city to cause the mayor or other executive head thereof to render up the keys to the city in token of the hospitality of the citizens toward the visitors. Something symbolical of this has been the custom from time immemorial. On behalf of the mayor and the citizens of Crystal Falls, at this time, however, it is my high privilege to say to you that we have no keys to deliver—the keys have been deposited in the deepest well within the city, the gates and doors have been unbarred and thrown wide open and in welcome to you we bid you enter and help yourselves.

The first paper of the evening was by A. M. Gow of Duluth, Minnesota, on “Some Safety Devices of the Oliver Iron Mining Company.” In introducing this subject, Mr. Gow spoke as follows:

Mr. President and Gentlemen of the Institute: In the matter of Safety Devices, we, in this country are about fifty years behind lime. The Steel Corporation woke up to this fact several years ago and since that time, the General Safety Committee has been waking up the subsidary Companies. This General Committee consists of ten men and appoints all the subcommittees which visit the various works and mines of the Corporation to make recommendations and point out where conditions can be improved. There have been in the neighborhood of seven thousand recommendations made by the examining committee, looking to safety plans and over go per cent of these recommendations have been accepted without any question. It is not to be expected that safety devices will prevent accidents altogether. Accidents will happen around a mine, even with the best protection to safeguard the men. I don’t think you care to have me make any extended remarks on the rules and devices which have been put in, so I will show in a few pictures some of the plans and devices which have been put into effect for the safety of our employes.

Mr. Gow’s further remarks were in explanation of the various devices for shops, mills and mines, which were displayed by stereopticon views, and were followed with close attention by the members. A more detailed, description accompanies the views selected for publication.

The next paper for the evening was by C. E. Lawrence of Iron Mountain, Michigan, on “Social Surroundings of the Mine Employe.” This is a subject which is receiving very careful attention by mine managers in this section, and Mr. Lawrence has followed closely the results of the efforts of Pickands, Mather & Company, with which firm he is engaged as Superintendent of their Menominee Range properties. This concluded the reading of papers for this session.

On motion, the President appointed the following Committees, the same to report at the next session:

COMMITTEE ON NOMINATIONS—W..H. Johnston, Ishpeming, Mich.; W. H. Jobe, Palatka, Mich.; Graham Pope, Houghton, Mich.; D. E. Sutherland, Ironwood, Mich.; J. D. Ireland, Duluth, Minn.

AUDITING COMMITTEE—J. B. Cooper, Hubbell, Mich.; C. E. Lawrence, Iron Mountain, Mich.; W. J. West, Hibbing, Minn.

WEDNESDAY, AUGUST 23RD.

Promptly at nine o'clock the party was conveyed by two special trains from Crystal Falls to the Iron River-Stambaugh district, stopping at the Baltic mine of Pickands, Mather & Co., which is briefly described on page 32. The Club house, erected and maintained for the benefit of the employes of this company, was inspected. The building is complete in its equipment for a social club and is much enjoyed by the employes. It is well patronized and has proven very successful, as it has attracted a desirable class of miners to the immediate locality. The village of Palatka, where the club is located, contains many attractive buildings and the grounds and streets present an appearance of neatness.

The Youngs and Caspian mines were next visited, after which the party returned to Iron River where the James mine of the Mineral Mining Co. was inspected. This is a, new property and is being equipped with substantial buildings and a steel head frame. Returning to Iron River, where luncheon was served on the trains, the members later met at the Opera House where a business session was held at 2 o'clock.

The first paper presented was on the "Block Caving and Sub-Stoping System at the Tobin Mine." This paper, prepared by Fred C. Roberts, was read by Professor Sperr of the Michigan College of Mines. This was followed by a paper on "Top Slicing and Caving Systems in the Stambaugh District," by W. A. MacEachern, of Iron River, Mich. E. E. White of Ishpeming, Mich., read a paper on "Surveying and Sampling Diamond Drill Holes," which was illustrated by drawings showing curvatures in drill holes. The last paper was by T. B. Wyman of Munising, Mich., Secretary-Forester of the Northern Forest Protective Association, the title being "The Relation of Mining Interests to the Prevention of Forest Fires." Mr. Wyman presented important facts in connection with the supply of timber available for mining and strongly urged the necessity of reforestation.

The following papers were read by title:

Accidents in the Transportation, Storage and Use of Explosives, by Charles S. Hurter, Duluth, Minn.

Square Set Mining, by Floyd L. Burr, Vulcan, Mich.

Check System of Time Keeping, by James D. Vivian, Crystal Falls, Mich.

Boiler Setting and Coal Handling, by J. S. Jacka, Crystal Falls. Mich.

Electrical Operating Plants of Penn Iron Mining Company, by Frank H. Armstrong, Vulcan, Mich.

A Diamond Drill Core Section of the Mesabi Rocks—No. IV., by N. H. Winchell, Minneapolis, Minn.

Some Practical Suggestions for Diamond Drill Explorations, by A. H. Meuche, Houghton, Mich.

Recording and Signalling Device for Mines, by John M. Johnson, Ishpeming, Mich.

Time Keeping System and Labor Distribution at the Newport Mine, by G. L. Olson, Ironwood, Mich.

Raising Shaft on Timber at the Armenia Mine, by S. J. Goodney, Crystal Falls, Mich.

Cornwall Ore Banks of Lebanon County, Pennsylvania, by E. B. Wilson, Scranton, Pa.

At the conclusion of the reading of papers, the Council presented its report for the fiscal year ending August 22, 1911.

REPORT OF THE COUNCIL

The Secretary's report of Receipts and Expenditures from August 26th, 1910, to August 22nd, 1911, is as follows:

RECEIPTS.

Cash on hand August 24th, 1910........			$5,076.55
Entrance fees for 1910..................	$ 215.00		
Dues for 1910	2,025.00		
Back dues	180.00		
Advance dues, 1911	65.00		
Sale of proceedings	57.30		
Sale of Institute badges................	8.00		
Total		$2,550.30	
Interest on deposit		171.24	
Total receipts			2,721.54
Grand total			$7,798.09

DISBURSEMENTS.

Stationery and printing	$ 58.85		
Postage	139.16		
Freight and express	13.81		
Telephone and telegraphing.............	3.91		
Secretary's salary	750.00		
Stenographic work	82.44		
Total		$1,048.17	
Publishing Proceedings XV.............	$ 732.50		
Photographs, maps, etc.................	57.50		
Advance papers, 1910	188.75		
Total		978.75	
Total disbursements			2,026.92
Cash on hand August 19, 1911...........			5,771.17
Grand total			$7,798.09

MEMBERSHIP.

	1911.	1910.	1909.
Members in good standing.....................	467	465	475
Honorary members	4	4	4
Life members	2	2	2
Members in arrears (2 years, '09-'10)............	44	36	36
Total	517	507	517
New members admitted	46	45	72
New members not qualified....................	3	1	1
New members added	43	44	71

TREASURER'S REPORT.

The Treasurer's report from August 26th, 1910, to August 22d, 1911, is as follows:

Cash on hand August 26th, 1910...................	$5,076.55	
Received from Secretary.........................	2,550.30	
Interest on deposits	171.24	
Paid drafts issued by Secretary..................		$2,026.92
Cash on hand August 22d, 1911....................		5,771.17
	$7,798.09	$7,798.09

Your committee appointed to examine the books of the Secretary and Treasurer, beg leave to report that we have carefully examined same and find that the receipts and expenditures shown therein to be in accordance with the above statement for the fiscal year ending August 22nd, 1911.

JAMES B. COOPER,
WILLIAM J. WEST.
CHAS. E. LAWRENCE.

The following applications for membership, received since the last annual meeting, are approved by the Council:

Boss, Clarence M., Mining Engineer, Duluth, Minn.

Bowers, E. C., Secretary Wickwire Mining Co., Iron River, Mich.

Burnham, R., Commercial Salesman, Westinghouse Mfg. Co., Minneapolis, Minn.

Cory, Edwin N., Mining Captain, Negaunee, Mich.

Deacon, John, Superintendent, Cambria and Lilly Mines, Negaunee, Mich.

Fox, M. J., Lumberman, Iron Mountain, Mich.

Gish, John R., Commercial Salesman, Beaver Dam, Wis.

Goodney, S. J., Mining Captain, Crystal Falls, Mich.

Hampton, H. C., Salesman, Chicago, Ills.

Hovland, Joseph T., Mining Engineer and Drill Contractor, Houghton, Mich.

Huhtala, John, Superintendent, Richmond Mine, Palmer, Mich.

Imhoff, Wallace G., Geological Engineer, Y. M. C. A., Ishpeming, Mich.

Jacka, Edwin, Mining Captain, Armenia Mine, Crystal Falls, Mich.

McDonald, James A., Salesman, Advance Packing & Supply Co., Hancock, Mich.

Morgan, E. Robins, Resident Engineer, Robins Conveying Belt. Co., Chicago, Ills.

Myers, Albert J., Mining Engineer, Iron Mountain, Mich.

Newby, Wm., Assistant Mining Captain, Puritan Mine, Ironwood, Mich.

Pengilly, Ed., Mining Captain, Crystal Falls, Mich.

Rowe, Wm. C, Mining Captain, Bessemer, Mich.

Ryan, John A., Chief Clerk, O. I. M. Co., Iron Mountain, Mich.

Trevarthan, W. J., Mining Captain, Bessemer, Mich.

Trudgeon, John, Mining Captain, Wakefield, Mich.

Uhler, Fred Walter, Mining Engineer, Buhl, Minn.

Vilas, Royal L., Sales Manager, Pluto Powder Co., Ishpeming, Mich.

Vivian, David L., Mill Superintendent, Gay, Mich.

Walker, Robert L., Superintendent, American Mine, Diorite, Mich.

Warne, Edw. S., Mill Superintendent, Point Mills, Mich.

Wheelwright, O. W., Geologist, Florence Iron Co., Florence, Wis.

Worden, E. P., Chief Engineer, F. M. Prescott Steam Pump Co., Milwaukee, Wis.

Yates, William H., Sales Engineer, Allis-Chalmers Co., Negaunee, Mich.

Zapffe, Carl, Mining Geologist, Brainerd, Minn.

On motion duly carried the report of the Council was accepted and the Secretary instructed to cast a ballot for the election of the applicants to membership.

The committee on nominations presented its report as follows:

Your committee on nominations beg leave to submit the following names for officers of the Institute for terms specified:

For President (one year):
Frederick W. Denton, Painesdale, Mich.

For Vice Presidents (two years):
George H. Abeel, Ironwood, Mich.
Graham Pope, Houghton, Mich.
Wm. H. Jobe, Palatka, Mich.

For Managers (two years):
M. H. Godfrey, Coleraine, Minn.
Jas. E. Jopling, Ishpeming, Mich.

For Treasurer (one year):
E. W. Hopkins, Commonwealth, Wis.

For Secretary (one year):
A. J. Yungbluth, Ishpeming, Mich.

W. H. JOHNSTON,
D. E. SUTHERLAND,
JAMES D. IRELAND,
WILLIAM H. JOBE,
Committee,

The report of the committee was on motion adopted and the Secretary instructed to cast a ballot for the election of the officers as presented by the committee.

William Kelly, of Vulcan, Mich., offered the following resolution, which was on motion adopted:

Resolved, That the Council be authorized to appoint from time to time special committees to consider and report upon to the Institute through the council such subjects as changes in mining laws, safety devices, the securing and editing of papers on mining methods, definition of mining terms, affiliations with other societies, and such other subjects as the Council shall deem it desirable to inquire into, such reports not to be binding on the Institute except in action is taken by the Institute in accordance with the Constitution and By-Laws.

John M. Bush, of Ironwood, Mich., offered the following resolution, which was on motion adopted:

Resolved, That a vote of thanks be extended to the Mining Companies of the Menominee Range and their local officials for the entertainment offered on the occasion of this visit; also to the citizens of the range as a whole for their cordial reception; to the Railway Companies for the exceedingly good service given in the movement of the members in special trains and the many courtesies and privileges shown our members and guests.

MR. KELLY—I would like to say a word before we adjourn. There has been some consideration by the governing body of the American Institute of Mining Engineers to extend the scope of its influence, and it is possible that some plan for affiliation with the Lake

Superior Mining Institute and other similar organizations may be suggested. I would not advocate any proposition that would result in giving up the automatic existence of this Institute, but still it is possible that our publications could obtain a wider circulation if they were incorporated with the publication of the American Institute of Mining Engineers. We have the President of the American Institute of Mining Engineers with us and as it will only take up two or three minutes' time, and you may be willing to hear something on that subject, I ask the privilege of the floor for Mr. Kirchhoff.

MR. KIRCHHOFF—This is an era of co-operation, and team work and we have been much encouraged in seeing how it has developed in engineering fields in recent years. We are now installed in a building, through the munificence of Mr. Carnegie, which represents a cost of about $1,800,000. Mr. Carnegie gave us $1,050,000 of this amount. Since the erection of this building, we have been able to bring together the different branches of engineering into co-operation and good-fellowship. We now have a library of some 50,000 volumes which has grown out of the collections of the Mechanical Engineers, the Electrical Engineers and the Mining Engineers. It is now under the management of an expert librarian and an adequate staff, thus realizing to an extent, hitherto impossible, the benefits of co-operation.

I have been very much struck by the proposal just made before the meeting to unify mining nomenclature, and in behalf of the Institute offer you our cordial co-operation in the work, in which no doubt such organizations as the Canadian Mining Institute, the Mining and Metallurgical Society, the Institute of Mining and Metallurgy, the South African Society and others would probably gladly join. It is through co-operation along such lines that much good can be accomplished.

Upon the conclusion of the business session, the members and guests were taken by automobiles to Sunset Lake, where the Iron River Commercial Club had prepared a clambake and other entertainment for the visitors. An orchestra furnished music during the evening and an enjoyable time was had by all.

THURSDAY, AUGUST 24TH.

Promptly at eight o'clock in the morning the party left Iron River, arriving at Loretto at ten, where the Loretto mine was visited. A trip was made up to the dam which was constructed when the course of the Sturgeon river was changed, and the new channel was followed to the point where it again took the original course. The changing of the river was made necessary as it crossed directly over the ore formation, making it impossible to remove the ore with safety even by leaving large pillars to support the surface. A brief description with map is published elsewhere in this volume.

The party next visited the clam and power plant of the Penn Iron Mining Co. at Sturgeon falls on the Menominee river. Seventy automobiles were brought into service and the four-mile trip was made in quick time. This plant is fully described in Vol. XIII, 1908, page 153. The next stop was at the Company's mines at Vulcan where the East and West Vulcan and Brier Hill Shafts were visited, also the Aragon mine of the Oliver Iron Mining Co. at Norway. The electrically-driven machinery at the Penn Iron Co.'s mines was very carefully inspected, being the first plant of its kind in the district, and considerable time was spent here.

Many of the visitors took the opportunity of going clown in the Vulcan shaft to see the electrically-driven pumps, provision having been made by enclosing the cage so that the trip could be made without the necessity of special clothing. The route to be taken in inspecting the surface plant was indicated by arrows placed at various points which avoided confusion and kept the crowd from scattering. Guides accompanied the party giving such information as was desired by the visitors.

Continuing the trip by automobiles to Iron Mountain, the new plant of the Peninsular Power & Development Co, under construction at Twin Falls on the Menominee river, was next visited. This plant will develop 5,000 horsepower, ample to supply all the mines in the vicinity. It is expected that the work will be completed during the summer of 1912. Returning to Iron Mountain, the Ludington shaft of the Oliver Iron Mining Co. was the next stop. The Cornish pumping plant which was formerly installed at "D" shaft of the Chapin is now in operation at "C" Ludington. A visit was also made to the Pewabic mine, after which the party disbanded.

A brief description of the mines visited, also many of the others, in both Iron and Dickinson counties, may be found on pages 17 to 40.

The beautiful roads on the Menominee Range, especially through Dickinson county, where the country is more level than in Iron county, made the automobile trips a very interesting and enjoyable feature throughout, Special trains, in addition to the regular, were provided where necessary to take the members home with the least possible delay. Congratulations were freely extended to the local committees for the admirable manner in which the arrangements were carried out, and the meeting proved both profitable and enjoyable. Credit is also due to the members for their generous response with papers on many interesting subjects.

The following is a partial list of those in attendance:

ABEEL, GEO. H............................Hurley, Wis.
ADGATE, F. W.............................Chicago, Ills.
ALLEN, R. C.............................Lansing, Mich.
AMBERG, J. W.............................Chicago, Ills.
ARCHIBALD, R. S....................Crystal Falls, Mich.
ARMSTRONG, F. H........................Vulcan, Mich.

BACON, F. A. .... Princeton, Mich.
BARBER, G. S. .... Bessemer, Mich.
BAXTER, C. H. .... Loretto, Mich.
BENGRY, W. H. .... Palatka, Mich.
BERTLING, J. F. .... Chicago, Ills.
BJORK, ARVID .... Crystal Falls, Mich.
BOND, WILLIAM .... Iron River, Mich.
BOSS, C. M. .... Duluth, Minn.
BOYLE, O. F. .... Crystal Falls, Mich.
BREWSTER, E. E. .... Iron Mountain, Mich.
BREWER, L. C. .... Ironwood, Mich.
BRIDGES, E. S. .... Crystal Falls, Mich.
BRIGHAM, E. D. .... Chicago, Ills.
BROOKS, F. G. .... Stambaugh, Mich.
BROWN, E. F. .... Iron Mountain, Mich.
BURNHAM, R. .... Minneapolis, Minn.
BURNS, A. L. .... Crystal Falls, Mich.
BUSH, J. M. .... Ironwood, Mich.

CARBIS, FRANK .... Iron Mountain, Mich.
CARBIS, W. J. .... Iron Mountain, Mich.
CARLSON, WM. .... Crystal Falls, Mich.
CARPENTER, A. B. .... Los Angeles, Cal.
CASWELL, L. C. .... Crystal Falls, Mich.
CHAMPION, JOHN .... Loretto, Mich.
CLIFFORD, J. M. .... Escanaba, Mich.
COE, E. S. .... Iron River, Mich.
COLE, W. T. .... Ishpeming, Mich.

CONLIN, THOMAS .... Crystal Falls, Mich
CONOVER, A. B. .... Chicago, Ills.
COOPER, J. B. .... Hubbell, Mich.
CORIA, J. W. .... Ashland, Wis.

DAVIDSON, C. J. .... Milwaukee, Wis.
DAVIDSON, D. W. .... Iron Mountain, Mich.
DAVIDSON, O. C. .... Iron Mountain, Mich.
DAVIDSON, W. F. .... Crystal Falls, Mich.
DAVIS, J. M. .... Green Bay, Wis.
DEACON, J .... Negaunee, Mich.
DICKENSON, E. S. .... Florence, Wis.
DIXON, F. A. .... Stambaugh, Mich.
DUNCAN, M. M. .... Ishpeming, Mich.
DUPRES, NAPOLEON .... Stambaugh, Mich.

EDWARDS, J. P. .... Mansfield, Mich.
EISELE, L. G. .... Iron Mountain, Mich.
EISELE, G. J. .... Iron Mountain, Mich.
ELDRIDGE, P. C. .... Milwaukee, Wis.
ERICSON, JOHN .... Crystal Falls, Mich.
ERICSON, RUDOLPH .... Iron River, Mich.
ESTEP, H. COLE .... Chicago, Ills.

FISHWICK, E. G. .... Milwaukee, Wis.
FLANCHER, F. A. .... Crystal Falls, Mich.
FLODIN, N. P. .... Marquette, Mich.
FLOOD, J. R. .... Crystal Falls, Mich.
FRASER, W. H. .... Crystal Falls, Mich.

GISH, J. R. .... Beaver Dam, Wis.
GODFREY, M. H. .... Coleraine, Minn.
GOLDSWORTHY, M. .... Iron Mountain, Mich.
GOODNEY, S. J. .... Crystal Falls, Mich.
GOODSELL, B. W. .... Chicago, Ills.
GORDY, SHEPARD B. .... Derby, Conn.
GOUDIE, JAMES, JR. .... Ironwood, Mich.

HAMPTON, H. C. .... Chicago, Ills.
HANSON, W. J. .... Palatka, Mich.
HARDENBURG, L. M. .... Hurley, Wis.
HASTINGS, E. .... Green Bay, Wis.
HEARLEY, M. T. .... Cleveland, Ohio
HEGGATON, WM. S. .... Negaunee, Mich.
HELMER, C. .... Escanaba, Mich.
HELMER, W. S. .... Escanaba, Mich.
HICKS, B. W. .... Vulcan, Mich.
HILL, W. D. .... Crystal Falls, Mich.
HINE, S. K. .... Girard, Ohio
HODGSON, JOSEPH .... Ishpeming, Mich.

HOLMAN, J. WINCHESTER .... Chicago, Ills.
HOLMES, HERMAN .... Crystal Falls, Mich.
HOPKINS, E. W. .... Commonwealth, Wis.
HOVLAND, J. T. .... Houghton, Mich.
HUEY, GEO. T. .... Minneapolis, Minn.
HUHTALA, JOHN .... Negaunee, Mich.
HURTER, CHAS. S. .... Duluth, Minn.

IMHOFF, W .... Ishpeming, Mich.
IRELAND, J. D. .... Duluth, Minn.

JACKA, E .... Crystal Falls, Mich.
JACKA, J. S. .... Crystal Falls, Mich.
JACKSON, I. H. .... Crystal Falls, Mich.
JACOBS, SAM .... Crystal Falls, Mich.
JAYNE, WM. .... Crystal Falls, Mich.
JEWELL, SAMUEL .... Ishpeming, Mich.
JOBE, W. H. .... Palatka, Mich.
JOHNSON, O. R. .... Michigamme, Mich.
JOHNSON, J. M. .... Ishpeming, Mich.
JOHNSTONE, O. W. .... Ironwood, Mich.
JOHNSTON, W. H. .... Ishpeming, Mich.
JONES, JOHN T. .... Iron Mountain, Mich.
JORY, WM. .... Princeton, Mich.

KEATING, W. G. .... Escanaba, Mich.
KEELEY, E. D. .... Chicago, Ills.
KELLY, WILLIAM .... Vulcan, Mich.
KENNEDY, J. S. .... Ashland, Wis.
KERN, WM. .... Crystal Falls, Mich.
KIRCHOFF, CHARLES .... New York
KITTS, T. J. .... Houghton, Mich.
KLINGLUND, F. D. .... Iron River, Mich.
KONWINSKIN, JOE .... Iron River, Mich.
KRETZ, W. C. .... Trenton, N. J.
KROGDAHL, S. J. .... Ishpeming, Mich.
LARSON, C. F. .... Crystal Falls, Mich.
LAWRENCE, CHAS. E. .... Iron Mountain, Mich.
LETZ, J. F. .... Milwaukee, Wis.
LINSLEY, W. B. .... Escanaba, Mich.
LUKEY, FRANK .... Ironwood, Mich.
LUNDIN, OLE .... Stambaugh, Mich.

MACE, R. E. .... Duluth, Minn.
MATTHEWS, A. .... Crystal Falls, Mich.
MEAD, D. W. .... Madison, Wis.
MEUCHE, A. H. .... Houghton, Mich.
MEYERS, W. R. .... Princeton, Mich.
MINER, A. B. .... Ishpeming, Mich.

MITCHELL, W. A. .... Chicago, Ills.
MONROE, J. A. .... Iron River, Mich.
MORGAN, E. R. .... Chicago, Ills.
MORRISON, M. B. .... Stambaugh, Mich.
MYERS, A. J. .... Iron Mountain, Mich.
M'BERNEY, WM. .... Stambaugh, Minn.
M'DONALD, D. B. .... Duluth, Minn.
M'GEE, M. B. .... Crystal Falls, Mich.
M'GONAGLE, W. A. .... Duluth, Minn.
M'GREGOR, S. J. .... Iron Mountain, Mich.
M'GREGOR, J. P. .... Milwaukee, Wis.
M'LEAN, J. H. .... Duluth, Minn.
M'LEAN, J. H., JR. .... Duluth, Minn.
M'NAMARA, THOS. B. .... Ironwood, Mich.
M'NEIL, E. D. .... Virginia, Minn.

NEELY, BENJAMIN ....Crystal Falls, Mich.
NETTLE, J. H.........................Stambaugh, Mich.
NEUGERLAUER, C..................Crystal Falls, Mich.
NEWBY, WM ....Puritan, Minn.
NEWETT, WILLIAM ....Ishpeming, Mich

O'BRIEN, P............................Iron River, Mich.
ORR, F. D.................................Duluth, Minn.
OSWALD, E. J.......................Crystal Falls, Mich.

PARKER, E. W.......................Washington, D. C.
PASCOE, P. W..........................Republic, Mich.
PEARCE, E. L..........................Marquette, Mich.
PENGILLY, E.. ....Crystal Falls, Mich.
PENGLASE, THOMAS ....Crystal Falls, Mich.
PHILLIPS, W. G.........................Calumet, Mich.
POPE, GRAHAM ....Houghton, Mich.
POTTER, E. F.......................Minneapolis, Minn.

QUIGLEY, G. J.............................Antigo, Wis.
QUINE, J. T............................Ishpeming, Mich.

RAISKY, F. H..........................Ishpeming, Mich.
RALEY, R. J.............................Duluth, Minn.
REEDER, E. C.............................Chicago, Ills.
REIGART, J. R.........................Princeton, Mich.
REYNOLDS, W. J...................Crystal Falls, Mich.
RICHARDS, W. J.......................Painesdale, Mich.
RICHARDS, W. J....................Crystal Falls, Mich.
RICHARDS, W. A..........................Chicago, Ills.
RICHARDS, ALVIN ....Chicago, Ills.
ROBERTS, H. C.....................Crystal Falls, Mich.
ROBERTS, E. S........................Iron River, Mich.
ROBERTS, FRED C..... ....Crystal Falls, Mich.

ROBERTSON, H. J......................Escanaba, Mich
ROGERS, C. M......................Crystal Falls, Mich.
ROSE, WM. T..........................Ishpeming, Mich.
ROSS, D. M.........................Crystal Falls, Mich.
ROUGH, J. H...........................Negaunee, Mich.
ROWE, W. C...........................Bessemer, Mich.
RUNDLE, A. J....................Iron Mountain, Mich.
RYAN, J. A.........................Iron Mountain, Mich.

SAMPSON, JOHN ....Ashland, Wis.
SANDS, T. E.........................Minneapolis, Minn.
SCADDEN, FRANK ....Crystal Falls, Mich.
SCANLON, W. L.......................Iron River, Mich.
SCHIEBLER, W.......................Iron River, Mich.
SHAW, PHILLIP ....Crystal Falls, Mich.
SHERRERD, J. M.............................New York
SHOVE, B. W..........................Ironwood, Mich.
SILLIMAN, A. P.........................Hibbing, Minn.
SKINNER, M. B...........................Chicago, Ills.
SPEAR, J. H............................Ironwood, Mich.
SPERR, F. W............................Houghton, Mich.
STEWART, H. E.......................Houghton, Mich.
STOLLBERG, J. R..................Crystal Falls, Mich.
SUTHERLAND, D. E....................Ironwood, Mich.

TALLON, P. M.........................Milwaukee, Wis.
TARR, S. W...............................Duluth, Minn.
THOMPSON, N. W..........................Albany, N. Y.
THOMPSON, N. W., JR...................Albany, N. Y.
TRAVER, W. H.............................Chicago, Ills.
TREBILCOCK, JOHN ....Ishpeming, Mich.
TREBILCOCK, WILLIAM ....North Freedom, Wis.
TREPANIER, H... ....Iron Mountain, Mich.
TREVARROW, H.. ....Negaunee, Mich.
TREVARTHEN, W. J....................Bessemer, Mich.
TREZONA, CHAS ....Ely, Minn.
TRUDGEON, JOHN ....Whitefield, Minn.
TUFTS, JOHN ....Milwaukee, Wis.
TUPPER, C. A..........................Milwaukee, Wis.
TYLER, W. E..............................Mendota, Ills.
TYLER, E. S..........................Stambaugh, Mich.

VILAS, R. L............................Ishpeming, Mich.
VILAS, P. N.........................Minneapolis, Minn.
VIVIAN, JAMES D...................Crystal Falls, Mich.

WALKER, R. S............................Diorite, Mich.
WALL, JOHN ....Crystal Falls, Mich.
WALL, J. S............................Iron River, Mich.

WATSON, CHAS. H.................Crystal Falls, Mich.
WEBB, R. B.........................Crystal Falls, Mich.
WEBB, CHAS. E.......................Houghton, Mich.
WEBB, G. S............................Marquette, Mich.
WELKER, W. F...........................Ashland, Wis.
WENGLER, M. B........................Milwaukee, Wis.
WESSINGER, W. E.......................Duluth, Minn.
WESSINGER, H. J.........................Duluth, Minn.
WEST, W. J.............................Hibbing, Minn.
WHEELWRIGHT, O. W...................Florence, Wis.
WHITE, E. E..........................Ishpeming, Mich.
WHITING, LOWE ....Crystal Falls, Mich.
WILLIAMS, P. S..........................Ramsay, Mich.
WILSON, E. B ....Scranton, Pa.
WINCHELL, W. H....................Minneapolis, Minn.
WINSLOW, FRANCIS ....Washington, D. C.
WORDEN, E. P..........................Milwaukee, Wis.
WYLD, R. H...............................Chicago, Ills.
WYMAN, T. B...........................Munising, Mich.

YATES, W. H...........................Negaunee, Mich.
YUNGBLUTH, A. J.....................Ishpeming, Mich.
YUNGBLUTH, ROY O..................Ishpeming, Mich.
YOUNGS, G. W........................Iron River, Mich.
YOUNGS, F. W.........................Iron River, Mich.

A DIAMOND DRILL CORE SECTION OF THE MESABI ROCKS—IV.

BY N. H. WINCHELL, MINNEAPOLIS.

GEOLOGICAL BEARING OF THE FOREGOING DESCRIBED FACTS.

In the Proceeding's of the Institute for three previous years (1908, 1909 and 1910) the writer has presented evidence to show that in Minnesota volcanic igneous rock composes a large proportion of the strata usually termed "Animikie," which also specifically may be designated *Mesabi*. These results seem to call for a discussion of the bearing which they present on the geological history of the rocks themselves and of the adjacent terranes.

Near the close of the Minnesota Geological Survey (i. e. in 1899) some evidence of this nature of the iron-bearing rocks of the Mesabi range was met with, and it was presented in the final report (Vol. V), where its purport was fully set forth . It was suggested that if a careful examination were to be made of the rocks of the Animikie, it might be found that detritus from igneous rocks was an important element in their composition. Reviewing what he wrote twelve years ago as to the igneous nature of the rock from which the Mesabi ore is derived, the writer is gratified and entirely satisfied with the conclusions to which he came, and desires to re-affirm them and strengthen them, with the new evidence already presented to the Institute.

It was a great surprise, however, to the writer to find so much igneous material in the Mesabi section, extending through a thickness amounting to more than two thousand feet. Throughout that thickness the eruptive material amounts to more than fifty per cent of the whole, at least in the region of present active mining.

Through the kind co-operation of Mr. E. J. Longyear, I writer was furnished with a series of nine drill-core samples taken from S. E. ¼ Sec. 30, T. 58-20, near Hibbing. These also were mounted in thin section, by E. Dominique, Paris, and on examination were found to be so similar to those already described that, while they verify the record of the deeper drill, they afford no important new facts, from a microscopical point of view. They are from a point about thirty-three miles west from the other drill hole.

It is the present purpose to consider some of the consequences of this discovery, for it certainly changes very materially the interpretation which we must put upon the rocks of the Mesabi range. We do not know yet whether the igneous composition of the Animikie prevails throughout the full extent of those rocks, from east to west. We know of it at the eastern end of the range in Minnesota and in the productive western part, and at the point where it strikes the Mississippi. There is, however, an anomalous condition of the geology extending through Lake county and entering somewhat into St. Louis county, and prevailing south of the international boundary in Cook county. Here the geographic area in which the so-called "slates and quartzytes" of the Animikie would be expected to show their full extent and characteristics, is occupied by a group of rocks which are decidedly and distinctly of igneous origin. They are gabbro, and acid "red rock," so-called. The former grades into diabase, and thence into ordinary trap, petrographically. The latter is sometimes granitic, and sometimes is quartz porphyry. It also acted in large areas as an effusive igneous rock and flowed toward the basin of lake Superior in a manner the same as that which characterized the basic trap of the region. The writer has observed and has described numerous instances in which the "red rock" was plainly derived from the slate of the Animikie by contact metamorphism and fusion, apparently by the diabases and gabbro of the region. W. S. Bayley has shown the same on Pigeon point. Now this observation shows two things conclusively:

1. The slates were formed before they were metamorphosed and fused.

2. The metamorphosing agent was co-extensive with the metamorphism and fusion.

If, therefore, the great agent of this metamorphism and fusion was the gabbro and its derivatives, there must have been a long period of volcanic activity earlier than the gabbro outbreak, i. e. assuming that the Animikie in Lake and Cook counties possessed essentially the same volcanic composition as found in St. Louis county and near Gunflint lake, of which there is no known reason to entertain any doubt. The "red rock" is known to extend, with interruptions, from Pigeon point to Duluth. The gabbro does the same. It appears plain, therefore, that the gabbro was not the first, nor among the first of the basic eruptives to make its appearance but that probably it was nearer the close than the beginning of the Keweenawan age. It is also plain that the epoch of the Animikie, consisting, as shown, largely of basic igneous materials, formed as such before the gabbro, was a great igneous age, characterized by volcanoes and probably by surface lavas. The gabbro, and its product, the "red rock" were much later than this volcanic age.

The writer has heretofore shown reason to divide the Keweenawan into two parts, viz: The *Cabotian*, the older, and the Manitou, the younger, and be placed the gabbro and the "red rock" in the earlier member; but it appears to be necessary to remove them to the later. The Cabotian was an age during which were accumulated enormous quantities of volcanic sand and other debris, forming, as it appears, the Mesabi portion of the Animikie, as now known, and doubtless embracing many layers of surface trap. After these strata were laid down, mainly in the presence of oceanic waters, which contributed an acid, sedimentary element, they suffered the action of the great gabbro attack and this was accomplished and followed by other surface lavas.

While removing the gabbro and the "red rock" to the Manitou section, it is necessary to note carefully an important distinction, viz: the materials which when fused, produced the Manitou red rock, prior to fusion constituted the Animikie slates, and, as seems to be reasonable in the light of recent developments, are to be considered the chronological equivalent of that part of the Keweenawan which has been named *Cabotian*. Basic, at first, having the form of volcanic ejecta, when mingled with the acid ingredients which it received by immersion and distribution in the waters of the ocean, it becomes frequently an acid rock when fused, forming the widespread ‘‘red rock" with all its variations, and as such it takes its place in the Manitou member of the Keweenawan.

It seems, from some points of view, a violent suggestion to associate the Animikie (Mesabi) with the Keweenawan, for it brings into a later age those strata which have by some been put into the "upper Huronian" and by some into the Archean because (ignoring the Taconic) they lie in places non-comformably below what is by them believed to be the sole representative of the ‘‘Cambrian." But in reality such an adjustment of the new facts satisfies not only a reasonable demand of petrologic resemblances, but also of stratigraphic association. The petrologic resemblance between the Keweenawan and the Mesabi rocks has been the burden of my later papers. It is imperative, in considering the stratigraphic association, to call to mind the duplicate structure of the Keweenawan, as described in the final report of the Minnesota survey; for either the Keweenawan consists of two great members, as there described, or there exists a distinct, and separate, great igneous formation not hitherto discovered—one which has the thickness of over two thousand feet and which must have required for its sedimentary accumulation a great length of time, and which is by all geologists, who have studied the Keweenawan of Lake Superior, considered to be immediately below the well-known traps of the well-known Keweenawan. To link the Mesabi with the Keweenawan stratigraphically alleviates another anomaly, which the writer has elsewhere alluded to, viz: The top of the Animikie, as hitherto defined, has never been observed, although its highest strata, where locally exposed, as at Thunder Bay, have been seen to be overlain by a conglomerate of the "Upper Cambrian," there having been some kind of a break, and accompanying degradation of the Animikie, separating them. But if the Animikie (Mesabi) be only the downward extension of the Keweenawan, it is reasonable to assume that no definable stratigraphic summit exists, but that the Mesabi rocks upwardly blend stratigraphic-ally and structurally into the igneous rocks of the Keweenawan, the beds of passage being simply such conglomerates and sandstones as are well-known parts of the Keweenawan. Not only so, but the red shales, the conglomerates, the sandstones (volcanic sands largely) which are well-known integral parts of the Mesabi, although often changed to iron ore, are identifiable, at least comparable, with similar strata of the Keweenawan.

If we seek for the extension of the igneous Mesabi further east, in Ontario east of Gunflint lake, we have not much field evidence to depend on. At Gunflint lake the writer found the lower beds of the Animikie to contain much flint and this character extends, according to the Canadian geologists, many miles further east; but the very lowest strata at Gunflint lake consist of contorted and handsomely colored jaspilyte, lying on the uneven surface of the Archean granite. The flint and the jaspilyte are essentially of the same composition, chemically deposited micro-granular silica, but differ in structure, one being horizontally stratified and more or less thinly interbedded with black slate such as on the Mesabi range in Minnesota consists largely of igneous debris. The conditions all indicate that there was a period of igneous activity at Gunflint lake, at the opening of the Animikie, that the heated ocean was charged with soluble silica, that this was precipitated along with the sediments of volcanic sand and breccia and that the lava that outflowed was suddenly consolidated as volcanic glass, (obsidian), and was at once permeated by the prevailing soluble silica without losing its fluidal structure, forming the jaspilyte of the region. There could be no nicer and clearer demonstration of the nature and origin of the Mesabi jaspilyte—and the same origin is perfectly applicable to the Archean jaspilyte of the Vermilion range.

When it is once apprehended that igneous agencies were chiefly operative in the production of the parent rock from which the iron ores of the Lake Superior region have been derived by alteration *in situ*, both the Archean and the Taconic, several corollary conclusions follow:

1. Not all the igneous rock can be assumed to have been changed to iron ore, but much of it, especially that which lay on land surfaces, maintained its original composition.

2. It was when the action of the ocean was immediate and direct that the great alterations were produced.

3. The red shales so common in the Keweenawan and occasionally seen in the Mesabi, consisted originally of volcanic and other igneous debris. They sometimes constitute a low-grade iron ore, as at Baraboo, Wis., and at the Mahoning mine at Hibbing, Minn.

4. As these red shales form a great thickness of rock that extends under the eastern and southern part of Minnesota, read ling two or three thousand feet, it follows not only that the oceanic currents of the Taconic age in the Lake Superior region carried their sediments far from the volcanic centers toward the southwest, but that the volcanic activities of the whole Keweenawan age, including the Mesabi, are cotemporaneously represented by that vast thickness of red shale.

It has already been shown in Part III of this series, that while the igneous fragmental character extends throughout the Mesabi section of over two thousand feet, the alteration which resulted in the localization of the beds of iron ore is confined essentially to the bottom of the Mesabi strata. That points clearly to. the origination of the ore about cotemporary with the rocks in which it exists—at least it precludes the agency of later, or it might be said *present*, atmospheric or ground water currents. It cannot safely be presumed that causes acting later than the date of the Mesabi formation could so affect the bottom beds everywhere and leave the rest of the two thousand feet practically intact. If there be any iron in the Mesabi rocks, so far as known, it is always at or near the bottom, and, as shown by the foregoing descriptions, if iron ore be lacking in commercial quantities at its wonted stratigraphic place, still the original rock has been profoundly changed at that horizon and the changes are the same as those that are met with where iron ore exists in large amounts. The inference is inevitable that the cause of the ore acted while the bottom beds which contain it were being accumulated. That is, it originated in an epoch of early volcanic activity, and was dependent in a large measure, if not entirely, on the contact of the heated waters of the ocean on the lavas and volcanic ash of the immediate vicinity. At a later date, when the igneous violence had subsided locally or abated, the earlier igneous centers were buried under vast thicknesses of sediment and igneous debris, and this later part of the Mesabi has never been altered. Still, if similar conditions co-existed at some later date within the Animikie age, it is reasonable to suppose that iron ore would have been formed, and hence that it is not impossible that iron ore horizons considerably later than that which is now worked may be discovered, not only in the Mesabi strata but in any other part of the Keweenawan.

If, now, we re-capitulate briefly the results of this investigation, we shall find the following:

1. The mines of the Mesabi range show nearly all the grand, igneous structures seen in the Keweenawan. These were enumerated and in part illustrated in the proceedings of the Institute of 1908.

2. The black slates, so-called, of the Mesabi range consist largely of basaltic igneous material and of volcanic glass the result of sudden cooling of erupted matter, the average proportion being more than 50 per cent.

3. This igneous matter is usually in the form of more or less rounded pellets, and these can be seen by the naked eye, more or less mingled with quartz which is likewise rounded by beach action, the quartz being most abundant near the bottom of the section.

4. This igneous material has suffered a profound alteration at the horizon of the iron ore, but the greater part of it is simply consolidated, forming with other kinds of sediment, the “black slates” of the region.

5. This alteration has been accompanied by more or less localization of the substances produced, sometimes being beds of so-called chalcedonic quartz, sometimes of kaolin, sometimes of limestone and sometimes of iron ore.

6. Besides actinolite, occasional mica and tourmaline, there was formed a soft, light green mineral which is practically isotropic, which has been called glauconite and greenalite.

7. This green substance serves sometimes as a general matrix for all the other substances, and sometimes retains the round shape of the original pellets.

8. All the other secondary minerals, such as hematite and quartz in particular, and occasionally the actinolite and calcite, also show by their manner of distribution in the thin sections examined, the rounded form of the original pellets.

9. No one of these secondary products, and especially not the greenalite, can be said to be the source of any of the others but they are all co-ordinate and co-temporary products of alteration of the original igneous rock.

10. The beds at, or near, the bottom of the black slates are the only ones, so far as known, which show such profound alteration, and they were probably so changed prior to the deposition of the overlying mass of black slate.

11. The chief agent of this alteration was the heated water of the ocean which covered the region.

12. The volcanic vents of the region, as they became extinct, or as they shifted from the west toward the east, were buried under the sediments that were formed by later vents, such sediments drifting mainly from the northeast toward the southwest.

The geological bearing of these facts may be summarized briefly as follows:

1. This great igneous formation is the *Cabotian* so named by the writer 1899, and called the lower member of the Keweenawan.

2. While as an igneous formation it appeared as lavas with their varieties, it also gave rise to thick beds of sediments, both tuffs, breccias, conglomerates and red sandstones, as well as red shales.

3. The so-called “red rock” series of rocks, extending from Duluth to Pigeon Point, is due to the metamorphism and even the fusion of this igneous sediment by the outbreak of the great gabbro mass.

4. This event seems to separate the Cabotian from the Manitou lavas, and brings the gabbro and the red rock series into the Manitou.

5. The gentler effects of this great volcanic age, including both the Cabotian and the Manitou, were carried by the prevailing currents of the cotemporary ocean, far toward the southwest, and are seen in a vast thickness of red shale which underlies the upper Cambrian in southern and southeastern Minnesota.

TIME KEEPING SYSTEM OF THE CRYSTAL FALLS IRON MINING COMPANY.

BY JAMES D. VIVIAN, CRYSTAL FALLS, MICH.

In the employment of the number of men necessary to operate a mine, the employer is compelled to introduce a system of time-keeping which will insure accuracy in the work, not only as to the distribution of the labor cost to the proper account, but also as to the correctness of the time credited to each employe for the work performed. Many different systems are used at the mines in the Lake Superior district, each of which has some good points, and it is with the idea of bringing out a discussion of the various systems that this paper is presented at this meeting. The best method is one by which a check can be had on the person keeping the time, to provide safeguards against carelessness and dishonesty.

An employe is liable to be mistaken in the number of shifts that he claims to have worked during the month, and should, he claim more than the time-keeper shows, a check system against the time-keeper will prove or disprove his claim. The same system would be equally effective should an employe think he had worked less time than his due bill called for. It would not be just to deduct a certain number of shifts, when a checking system might show that the employe had not kept his own time correctly.

In order to provide as many safeguards as possible, the time-keeping system adopted by the Crystal Falls Iron Mining Company, as explained herein, will show that the system has a tendency to keep not only the time-keepers in line, but also the several foremen or bosses, by whom the time is kept.

The men on going to work in the morning, report their brass check numbers to the time-keepers (at our mines this is done verbally), who records the same as the men present themselves at the window. The time-keeper, in taking the numbers in this manner, sees each man, and knows that the man has gone to work, whereas, if the numbers were to be deposited by the men themselves one man could deposit more than one number, and later in the shift, those for whom he deposited could slip into their working places. On returning from work-at the close of a shift, our men report again in the same manner to the time-keeper.

During the shift (we are working two shifts of ten hours each and have a time-keeper for each shift), the time-keeper sees every man at his work. On surface he makes two rounds each day, once on each half shift. Underground the timekeeper makes only one round each shift, and as he meets the men he records the place in which they are working. This ambles him to classify the time according to the accounts kept or classification required for cost reports, etc. The time-keeper at the close of the shift has a good check on his own work, and taking for granted that he has faithfully performed his duties as required, the possibility of an error is remote.

MINE

DAILY LABOR AND PRODUCT REPORT

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Surface	Total	Underground	Day	Night	Total
1 Office, Time. Shipping and Supply Clerks.		1 Mining Captain and Ass'ts			
2 Mining Engineer, Chemist and Ass't,		2 Mine Foreman,			
3 Master Mechanic,		3 Miners, Company Acc't,			
4 Machinists and Helpers,		4 " Contract,			
5 Engine House Floorman,		5 Trammers, Company Acc't			
6 Brakemen,		6 " Contract,			
7 Firemen,		7 Car Dumpers and Skip Tenders,			
8 Pumpmen,		8 Trackmen.			
9 Pipemen.		9 Timbermen,			
10 Carpenters,		10 Ditching & Cleaning Tracks			
11 Carpenters' Helpers,		11 Underground Laborers,			
12 Blacksmiths,		12 Mule Teamsters,			
13 Blacksmiths' Helpers,		13 Car Brakemen,			
14 Drymen and Janitor,		14 Chutemen,			
15 Landers, Pocketmen and Rock Pickers....,		15 Wheelers,			
16 Stock Pile Trackmen,		16 Motormen,			
17 " " Motormen,		17 Motor Brakemen,			
18 " " Laborers,					
19 Barn Boss and Helper,					
20 Teamsters-Swampers-					
21 Crushermen-Crusher Engineers,					
22 Surface Foremen,					
23 " Laborers,					
24 Painters,					
25 Wood Choppers,					
26 Steam Shovel Operators.					
27 " " Laborers,					
28 Masons,					
29 Electrician,					
30 Boiler Makers and Helpers					
33 Total Men,		21 Total Men,			
		22 Product per Man,			

23	Total Number Men Employed	
24	Product per Man	
	Number Cars Trammed	
	Number Skips Hoisted	
	Number Tons Hoisted	
	Total Product to Date for Month ...Days	
	Average Daily Product for Month	
	Estimate for Month ...Days	
	Cars Shipped from Stockpile	

Summary of Hoist		Day	Night	Total
25 Number Cars Trammed	No. 1 Shaft			
	No. 2 Shaft			
	No.........			
26 Number Skips Hoisted	No 1 Shaft			
	No. 2 Shaft			
	No.........			
27 Number of Skips Rock Hoisted.				
28 Tons Ore Hoisted				

(Reduced from the Original.) FORM "A"

We show herewith the form of daily report made by the time-keeper (Form A) and transmitted to the general office. This is here given to show the similarity of the checking report made out by the different foremen (Form C) and explained later.

This now leads up to the checking system other than that employed by the time-keeper. The surface foreman takes the time of the men employed on surface, regardless of what his employment or connection with any particular branch of the organization may be. The shift boss takes the time of the men underground, likewise regardless of the work they are doing. These several bosses, therefore, take the time of all men employed around the mine.

Each foreman makes out a report for his shift, the surface foreman being obliged to get the time of the few men employed at night, when no regular night surface foreman is employed. He takes each man's number orally, and at the close of the shift fills out the blank here shown (Form B), making a cross (X) after the number corresponding to the brass check number of every man whose time he has taken.

On the reverse side of this report, as shown by Form C, he makes a general classification of the men working on his shift. This classification we consider merely incidental to the real purpose of the report, i. e., getting a check on each man who worked on that particular shift.

1301	1355	1409	1463	1517	1571
1302	1356	1410	1464	1518	1572
1303	1357	1411	1465	1519	1573
1304	1358	1412	1466	1520	1574
1305	1359	1413	1467	1521	1575
1306	1360	1414	1468	1522	1576
1307	1361	1415	1469	1523	1577
1308	1362	1416	1470	1524	1578
1309	1363	1417	1471	1525	1579
1310	1364	1418	1472	1526	1580
1311	1365	1419	1473	1527	1581
1312	1366	1420	1474	1528	1582
1313	1367	1421	1475	1529	1583
1314	1368	1422	1476	1530	1584
1315	1369	1423	1477	1531	1585
1316	1370	1424	1478	1532	1586
1317	1371	1425	1479	1533	1587
1318	1372	1426	1480	1534	1588
1319	1373	1427	1481	1535	1589
1320	1374	1428	1482	1536	1590
1321	1375	1429	1483	1537	1591
1322	1376	1430	1484	1538	1592
1323	1377	1431	1485	1539	1593
1324	1378	1432	1486	1540	1594
1325	1379	1433	1487	1541	1595
1326	1380	1434	1488	1542	1596
1327	1381	1435	1489	1543	1597
1328	1382	1436	1490	1544	1598
1329	1383	1437	1491	1545	1599
1330	1384	1438	1492	1546	
1331	1385	1439	1493	1547	
1332	1386	1440	1494	1548	
1333	1387	1441	1495	1549	
1334	1388	1442	1496	1550	
1335	1389	1443	1497	1551	
1336	1390	1444	1498	1552	
1337	1391	1445	1499	1533	
1338	1392	1446	1500	1554	
1339	1393	1447	1501	1555	
1340	1394	1448	1502	1556	
1341	1395	1449	1503	1557	
1342	1396	1450	1504	1558	
1343	1397	1451	1505	1559	
1344	1398	1452	1506	1560	
1345	1399	1453	1507	1561	
1346	1400	1454	1508	1562	
1347	1401	1455	1509	1563	
1348	1402	1456	1510	1564	
1349	1403	1457	1511	1565	
1350	1404	1458	1512	1566	
1351	1405	1459	1513	1567	
1352	1406	1460	1514	1568	
1353	1407	1461	1515	1569	
1354	1408	1462	1516	1570	

(Reduced from the Original.) FORM "B"

This report as made out each day by shift boss or foreman, is then placed in an envelope, sealed, addressed to the superintendent, and mailed to the general office. The bosses and time-keepers are, under no consideration, to compare notes on the time, under penalty of dismissal. These reports as received at the general office, are checked against the report of the time-keepers, and at the end of the month, against the total days of the pay roll. In all cases they must agree.

Assuming that a discrepancy should occur between the time-keepers and foremen, we have provided a blank (Form D) to be used in checking, to find where the error was made. This blank, when filled out, is referred by the general office to the captain of the mine, whose duty it then is to take the books of the time-keeper and shift boss or foreman, and in their presence check the same to locate the error. This is a very easy matter and quickly done. The blank is then filled out as directed and returned to the general office and filed with the reports.

All men are paid by the cashier of the general office, the time-keepers not doing any paying. It has been found that men who were generally classed as the "habitual kickers" on pay days are not now heard from, as they know that when they get their due bills their time is correct, and there is no further cause for a complaint.

__________ Mine, __________ 191__

Surface	Total	Underground	Day	Night	Total
Office, Time, Shipping and Supply Clerks		Mining Captain and Ass'ts			
Mining Engineer, Chemist and Assistants		Mine Foreman			
Master Mechanic		Miners, Company Acc't			
Machinists and Helpers		Miners, Contract			
Engine House Floorman		Trammers, Company Acc't			
Brakeman		Trammers, Contract			
Firemen		Car Dumpers and Skip Tenders			
Pumpmen		Trackmen			
Pipemen		Timbermen			
Carpenters		Ditching and Cleaning Tracks			
Carpenters' Helpers		Underground Laborers			
Blacksmiths		Mule Teamsters			
Blacksmiths' Helpers		Car Brakemen			
Drymen and Janitor		Chutemen			
Landers, Pocketmen and Rock Pickers		Wheelers			
Stock Pile Trackmen		Motormen			
" Motormen		Motormen Brakemen			
" Laborers					
Barn Boss and Helper					
Teamsters—Swampers—					
Crushermen—Crusher Engr's—					
Surface Foremen					
" Laborers					
Painters					
Wood Choppers					
Steam Shovel Operators					
Steam Shovel Laborers					
Masons					
Electrician					
Boiler Makers and Helpers					
Total Men		Total Men			
		Grand Total Men			

(Reduced from the Original.) FORM "C"

CRYSTAL FALLS IRON MINING CO.

.... 191......

Captain ....

.... Mine

Dear Sir:

The following discrepancies appear on the Daily Report of .... 191..

	DAY	NIGHT	REMARKS:
Daily Report	....	....	....
Shift Boss	....	....	....
Sur. Boss	....	....	....
....	....	....	....
....	....	....	....

Please locate the discrepancies and return this slip with your findings.

W. J. Richards, Gen. Sup't.

....

REPORT:

....

Captain

FORM "D"

The method above described has been in actual use since the early part of 1902, and has proven very effective. At the time the reports were first introduced at the older operating mines, the shift bosses objected to the clerical work involved, but once fairly started, it has had no drawbacks and is in general favor.

SOME PRACTICAL SUGGESTIONS FOR DIAMOND DRILL EXPLORATIONS.

BY A. H. MEUCHE, HOUGHTON, MICH.

The volumes of the Lake Superior Mining Institute contain many articles on diamond drilling. Most of these papers deal with the curvature of drill holes and methods of observing the true angle of dip. As a result of these papers the diamond drill operators are supposed to test the angle of their holes at frequent intervals and then the angle etched on the bottle is corrected for capillarity. I am heartily in accord with this survey of bore holes but often wonder, inasmuch as no attempt is made to determine their lateral deflections, if these surveys and corrections are really worth while.

Besides these there are many matters which should be considered by anyone having lands explored by means of diamond drills. Two of the most important are the preserving of the bore holes and the preserving of the records. In the Copper Country, where I have had most of my experience, the usual practice is to pull out the stand pipe when the hole is completed, thus making it impossible to reopen the hole and continue it to a greater depth, if the occasion should ever arise when it might be advisable to do so. Of course, this question must be answered separately for each and every drill hole, as it becomes necessary to consider the policy of the parties having the drilling clone, the cost of leaving the casing compared to the total cost of the hole, and whether or not for geological reasons it is definitely known whether any occasion may ever arise for deepening the hole. By this I mean that you know definitely that ore does not lie at any greater depth.

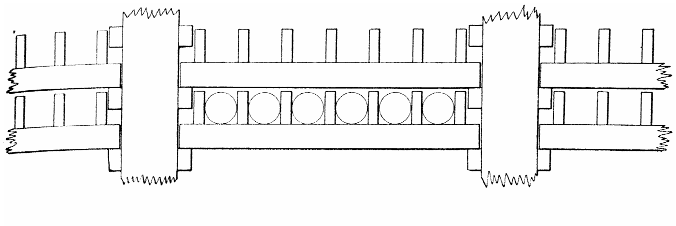
In the Copper Country geological conditions answer the question many times. Here, as most of you know, the beds usually have a pretty steep dip and cross-sections are made by drilling a series of holes in a line at right angles to the strike and placing these far enough apart so that the bed exposed in the bottom of one hole is also found in the top of the adjacent hole.

There are two methods in which cross-sections are drilled. The most logical is to start at the extreme eastern limit of your property or at the limit of the copper bearing range, and work west. In this method it is necessary to bore the holes until you are positive of having a lap. The objection to the method is that it is not always possible to bore the holes as deep as you wish to go and then it is necessary to put down an intermediate hole. The other method is to start from the west and drill your hole as deep as yon can, or desire to, compute the horizontal distance covered by the hole, deduct a little for lap and locate your hole to the east. This method works fairly well, especially for two drills, but is open to many objections. Suppose you find a fairly rich copper bearing lode, near surface, in one hole and would like to examine it at depth. It may only be a few feet below the bottom of your preceding hole, but if it has been discontinued and the pipe pulled out, these examinations would necessitate a new hole, duplicating largely work which has already been done. Again you may make a mistake in your computations, or the clip may be steeper than you thought it was. Under these circumstances you may have a gap in your section. Another trouble lies in the fact that even though the holes do lap, you may not be able to recognize them.

All these objections and troubles occur quite frequently and have come within my own observations. Ordinarily the first method is the better one to follow, but there are many times when it is advisable and sometimes necessary to use the second. If the latter method is used, I strongly advise leaving the stand pipe.

Another matter which has become a sort of hobby of mine is the care and preservation of drill cores. Perhaps this is due to the fact that I have examined in the neighborhood of a hundred thousand feet of drill cores during the last few years. I have seen cores kept in a limited number of boxes-when these boxes became full the cores were dumped out and the boxes refilled. I have seen core boxes kept in a cold wet cellar, one box piled on top of another, forming a high stack. Often the lids are nailed down tighter than the bottom is nailed to the box, so that in trying to pry off the lid the box falls to pieces. I have climbed upon racks, pulled out boxes (not having covers) that were slipped in sideways, balanced them on my finger tips and tried to get down. Once or twice the boxes turned up side down.

With these experiences you can readily perceive why the method used by the Victoria Mining Company and later adopted, with some minor changes, by the Mass Consolidated Mining Company, appeals to me. In both cases they have rigged up a sort of cabinet, using the core boxes without lids as drawers. The boxes slide lengthwise into a rack or cabinet. The boxes or trays are stacked so close together that the bottom immediately above acts as its cover. At the Victoria, a strip the full length of the box is nailed on either side forming the slides for the drawer. A drawer-pull and a label giving the number of the hole and the depths of the hole from which the core was taken is fastened to one end of the box. At the Mass they have overcome the necessity of nailing strips to the sides of the box by allowing the bottom of each box to extend about half an inch on either side. The boxes are made about five feet long, which is a convenient length to handle, and holds enough core for ordinary purposes. The cabinet itself is made very similar to any ordinary cabinet, holding drawers, except that it is not necessary to put a piece of wood under each drawer as a stiffener. If the sides are made of two inch material, a stiffener need only be introduced about every ten boxes. Sides or partitions are made for each stack of core boxes and as high as desired. These had better be made pretty heavy as they must support the entire weight of all the boxes in each stack, and in order to make the construction as slow burning as possible, I would suggest a tight partition. Strips are nailed on both sides of these partitions to catch the strips on the boxes, thus supporting them. These strips should be placed just far enough apart to allow easy and free sliding of the boxes.



SKETCH SHOWING BOXES IN RACK

The accompanying sketch will explain the construction fully. The advantages of this system are the convenience in referring lo the cores at any time and small amount of space required. Each box occupies a space of 10⅞x23-16 inches. Allowing one stiffener for every ten boxes, thirty boxes can he stored in a stack five feet nine inches high. As each box holds thirty feet of 1⅛ inch core, which represents approximately forty feet of drilling, one stack would represent 1,200 feet of drilling. Ten such stacks representing 12,000 feet of drilling, would only occupy a space six feet high, ten and one-half feet long and five feet deep. I do not believe that the same number of boxes with covers screwed on could be gotten into the same space, and I question if the lumber and screws used for a cover would cost as little as would this scheme. The only objection to the scheme is the trouble involved in transporting the boxes from the drill. The Mass Mining Company solved this by making boxes with hinged covers and locks which would just hold one core box. The core box was then placed in the box, which was then locked and sent to the mine office. For shipping the core boxes could he crated readily enough.

I wonder, with such a convenient method as this of storing cores, if as much core would be thrown away as is now done. After so much money has been spent in obtaining the records it seems too bad to see the true records destroyed. I often encounter the argument "Of what good are they?" They usually are no longer of any use to you, but someone else may examine them and see something of great scientific or practical value. There is some excuse for a person holding merely an option on a piece of land to throw away the cores, as he may not have any place to store them, but in those cases I truly believe that the Geological Survey should make an attempt to preserve the records.

STANDARD BOILER HOUSE AND COAL HANDLING SYSTEM OF THE CRYSTAL FALLS IRON MINING CO,. MENOMINEE RANGE.

By J. S. Jacka, Crystal Falls, Mich.

One of the first questions to be decided in the construction of the power plant is its location. This depends largely upon the location of the shaft, the ease with which coal may be brought to the boiler, and means of storing the coal, especially in the winter.

The first factor, the location of the shaft, is one that has an important bearing upon the location of the engine house. The building must be so situated that the cable will have as few sharp bends as possible, and still be comparatively close to the shaft. The cost of handling the coal and ashes is usually the largest item in the operating charges. In plants as found at some of the smaller mines, the amount of fuel and ash handled does not warrant the expense of an elaborate conveyer system, which would be justifiable in larger plants. In whatever way the fuel is supplied provision must be made for storing a quantity sufficient to operate the plant for some time, in case supply is interrupted, to guard against an enforced, shut down.

The type of building should next be considered. It must be as near fire proof as possible, cheap in construction, and should be flexible enough in the design to make it conform to the various local conditions found at the mines and still retain the same general shape or plan. This has been the aim in all of the installations at the Crystal Falls Iron Mining Company's properties. One set of drawings has been made and they have been used in the building of all boiler houses, with only slight variations as were necessary at the mine. For lack of a better word this has been called the "standard" coiler house of the Crystal Falls Iron Mining Company. The term is not used to imply that one boiler house is the exact counterpart of another, but that certain features of its construction and details have been so standardized that as a whole it may be termed a "standard" boiler house.

The boiler should be of a type such that its first cost will be low, and still give a maximum efficiency with a minimum amount of expense for its upkeep. As affecting fuel economy the boiler equipment is by far the most important part of the power plant and involves the largest share of the operating expense. It matters little how elaborate, modern, or well designed it may be, skill, good judgment and continued vigilance are required on the part of the operator to secure the best efficiency.

Of the various types and grades of boilers on the market experience shows that most of them are capable of practically the same evaporation per pound of coal, provided they are designed with the same proportions of heating and grate surface and are operated under similar conditions. They differ, however, with respect to space occupied, weight, capacity, first cost, and adaptability to particular conditions of operation and location. The boiler used by the Crystal Falls Iron Mining Company is of the fire tube type. This boiler is simple, inexpensive, and when properly operated is found to be durable and economical. The installation and removal of this type of boiler gives it an advantage over the water tube boiler, especially in mining work, where the life of the plant is comparatively short. The number of boilers installed at any one plant in no case exceeds six boilers, and as there is always plenty of floor space the addition of extra boilers would only involve the cost of installing the boilers themselves. For low pressure and small power the return tubular boiler has advantage of affording a large heating surface in a small, space, and large overload capacity, a condition to be desired in furnishing steam for hoisting engines. The first cost of this boiler is low, which gives it another advantage over the water tube boiler.

The boiler shown on plate I practically conforms to the specifications of the Hartford Steam Boiler Inspection & Insurance Co. The "standard" is a 72"x18' horizontal return tubular boiler having 68 four-inch tubes. The shell is made of open hearth flange steel plate ½" in thickness. The heads are 9-16" in thickness. The longitudinal seams in the shell are the butt joint double covering strip type triple riveted. The firth seams are single riveted lap joint. These riveted seams are proportioned so as to secure the strongest possible joint. The braces in each case, together with their rivets, have been carefully calculated for the pressure they are to bear, and are so distributed that all parts of the surface braced may be sustained. The boiler has a 11"x15" manhole cover in the front end below and in top shell above tubes. The front is the full arch flush type. The flush front costs a little more than the extended front for brick and setting, but it is more convenient to operate and the boiler is less expensive.

Plate I shows longitudinal section of the boiler setting. This setting is the same regardless of the number of boilers, and is made of hard red brick laid in lime (or cement) mortar and the entire setting is lined with fire brick up to the center line of the boiler, as shown in the drawing. Every fifth course is laid with headers, so that any part that might become damaged can be easily renewed without taking out the entire lining. In the drawing the grate width is six inches less than that of the boiler, and the side wall is battered so as to leave a space at the level where the setting closes into the boiler. The top of the bridge wall is 12" from the bottom of the shell and the space behind is left empty. Curving this combustion chamber to conform with the shell only reduces its size, which is a disadvantage with bituminous coal. The rear wall is 30" back of the rear head, which makes the chamber larger. The back connection, i. e., the connection between the rear wall and the head, is a source of more or less trouble on account of the expansion and contraction of the boiler, and the difficulty of making a joint that will remain tight. One method is to spring an arch across having one end resting on the wall and the other upon an angle fastened to the back head of the boiler. The arch consists of brick resting in an iron frame work. Another method used is to place steel rails across the setting latterly and fill in the spaces between the rails with brick.

It is sometimes difficult with low grade fuels and natural draft to burn sufficient coal in the grates of a horizontal tubular boiler to produce the evaporization needed. For this reason it is necessary that the grate surface be as large as possible, and have the maximum rate of combustion per square foot of grate surface for the draft obtained.

The suspended support is used as this seems to be the best method. The boiler, being independent of the walls does not get out of alinement with the settling of the walls which is almost sure to occur. When the boiler is set on the lugs the settling of the walls often throws the support of the boiler on two lugs thus setting up severe torsional strains in the boiler shell. The boiler is set high in front in accordance with general practice. The expansion and contraction of the fire brick causes the boiler to settle in front and it invariably gets lower than the rear end; this necessitates the raising of the front end.

While this setting has been very satisfactory and has given good service it was thought advisable to try some other type of boiler in order to eliminate, if possible, the settling and cracking of the walls. With this in view a Casey-Hedges patented standard steel setting was installed after carefully considering several different types. This setting appears to present means of overcoming the defects in the all-brick setting and still retains the good features of the old setting. This setting does away with the heavy brick work walls. It is lined first with a layer of asbestos, then a layer of red and a layer of fire brick. There is a notable absence of heavy foundations, the only ones of any consequence being beneath the supporting columns from which the boiler is suspended. The barrel of the casing is semi-circular in shape, being practically an inverted Dutch Oven, holding the heat to the boiler as the hot gases pass from the furnace over the incandescent fire brick into the combustion chamber. This setting is cheaper to install and requires less brick. The only repairs necessary is the relining of the furnace, thus lowering the cost of maintenance as compared to the brick setting.

In selecting a grate bar that was cheap and would give adequate support to the coal and yet permit the access of sufficient air from below for combustion, it was found that the Wicks rocking grate gives the best service as compared with the stationary grate; while the initial cost is greater the rocking grate out-lasts the stationary grate.

The steam line leading to the shaft is connected to an auxiliary 5" header, or by-pass, besides being connected to the main header. This affords a means of making repairs or additions to the main header without stopping the mine pumps. This auxiliary line also supplies the feed pumps. The Hoppes feed water heater or purifier is used and is the open type of heater. This style of heater has several advantages over the closed type, namely, it is lower in first cost, is more easily accessible for cleaning and repairs, scale and oil do not affect the heat transmission. It has the disadvantage in that the oil becomes mixed with the steam but by keeping them clean and using oil traps this difficulty is reduced to a minimum.

The means by which coal may be placed within reach of the fireman presents a more difficult problem in a plant of this size than it would be in a larger one. The method used is to make a space similar to a stockpile ground. A trestle is built the entire length of this space and the railroad cars are unloaded from it. A narrow gauge portable track is then laid from the coal pile to the boiler house and by means of an inclined track laid on timbers the car is elevated above the coal bunkers. A ton and one-half car is used to convey the coal. The car, designed for this, works automatically. The doors are placed in the bottom and are opened by a system of levers and a spring. A dog engaging a "dump pin," which is fastened to the timbers and is adjustable as to location on the timber, releases a catch letting the doors drop open. When the car starts on its return journey a flat piece of iron attached to the runners, upon which the rails are laid, automatically closes the doors. This car, as shown on plate III, is built low in order to make it easier to shovel into. A small hoisting engine in the boiler house is used to pull the car. This method of handling the coal is very simple and can be adapted to suit almost any condition that may arise in the location of the coal pile. The manner in which the car enters the boiler room is shown in plate II.

RECORDING AND SIGNALLING DEVICE FOR MINES.

JOHN M. JOHNSON, ISHPEMING, MICH., INVENTOR.

The present invention was devised more particularly for making records of mine operations, but undoubtedly many features thereof are useful in connection with other work of a somewhat analogous character.

One of the primary objects is to provide novel and practical mechanism of a comparatively simple nature that will record the operation of elevating mechanism, showing the number of trips or loads, the places from which such loads are taken together with all stops, delays and the like.

Another and important object is to provide means for recording the character or grade of ore or other material transported, and the levels or places from which the same are taken.

Still another object is to provide a signalling system which, while useful *per se*, also combines with the aforementioned means or mechanism to produce a semi-automatic apparatus in which the signal to the operator of the hoisting mechanism effects the operation of the recording means.

Recording Mechanism for the Elevating Means—Taking up this recording mechanism, in detail, a suitable frame is employed, in which are mounted a pair of stationary vertical shafts having gear wheels journaled on their lower ends, said gear wheels being in mesh with an intermediate idler. These shafts are surrounded by skeleton frames, secured to the gear wheels, and on said frames are detachably slipped winding drums, preferably in the form of open ended cylinders. These cylinders have at their lower ends inset lugs that engage in sockets carried by the skeleton frames and consequently the drums and frames are held against relative rotation. One of these drums is designed to carry a record receiving sheet that is unwrapped therefrom, and wound upon the other drum. Said other drum is therefore provided with suitable tines to engage the end of the sheet. For the purpose of removing the record sheet when the receiving drum has the same there-on, said drum is provided at its lower end, with an opening so that the robed sheet can be grasped between the finder and thumb, and withdrawn from the drum or cylinder when said cylinder is detached from the skeleton frame. The drums are operated by a suitable time movement. This time movement may be of any suitable character so that it is absolutely accurate. It is carried by a frame that is hinged to the rear side of the main supporting frame, and has a gear wheel in mesh with one of the gear wheels. By having it hinged, it may be swung downwardly and out of the way, in order to permit the drums to be readily removed and replaced.

By referring to Fig. 2, it will be noted that the record sheet has its main portion divided into two longitudinal spaces and the margins of said spaces being provided with scales indicative of the divisions of time, as will be evident, and it will be clear that as the winding drums are revolved by the time movement, this sheet will be slowly unwound from one drum, and wound upon the other. Interposed between the drums is a vertical platen across which the sheet operates, and co-operating with this platen on the exposed face of the sheet is a vertically movable recording or marking device preferably in the form of a fountain pen having a suitable filling funnel. The pen is slidably mounted in a pair of upstanding ears carried by a supporting arm that is vertically slidable in a guide, and has a threaded engagement with a vertically disposed rotating screw shaft. The marking device has its rear end offset, and mounted on said marking device between the ears, is a yoke. This yoke is ordinarily secured against movement on the marking device by a set screw, and has a depending pintle borne against by one end of a lever that is journaled between its ends on the arm. A spring connected to the other end of the lever and to an adjusting screw, serves to yieldingly maintain the marking device or pen against the record sheet. The adjusting screw is carried by a supporting bracket fastened to the arm.

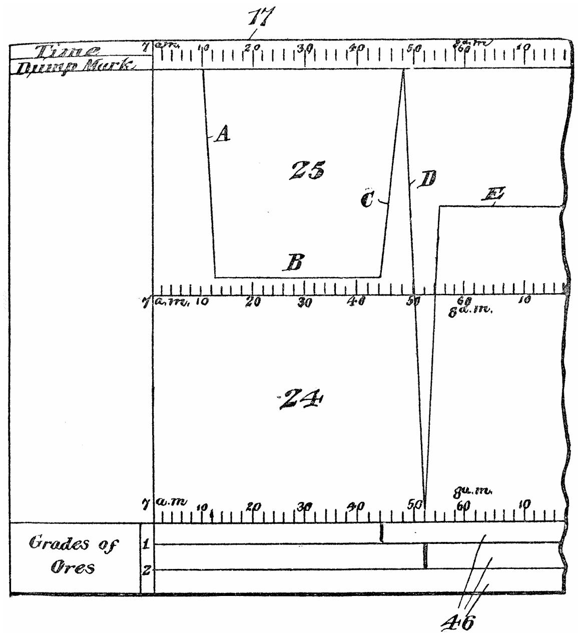


FIG. 2
Face View of a Portion of One of the Record Sheets.

The screw shaft is journaled in two horizontal bars of the supporting frame, and is geared at its lower end to a horizontally disposed shaft. This shaft extends in any suitable direction and projects from the frame. It has secured thereto a sprocket wheel and the sprocket chain, passing around the wheel also passes around a sprocket wheel carried by the hoisting drum. It will be understood that the gearing between said hoisting drum and the vertical screw shaft is such that the operation of said drum from one level to another will rotate the screw shaft sufficiently to carry the marking device across the lower space of the record sheet, and a movement of said drum sufficient to elevate the skip from the level to the dumping point will carry the marking device from the intermediate line of division to the dump mark indicated on said record sheet.

The operation of this portion of the mechanism is believed will now be obvious. The time movement operates at a proper rate of speed, to carry the record sheet past the marking point, according to the time indicated on said record sheet. The said sheet having been properly started, will continuously operate, and therefore the marking device or pen will make a continuous line thereon. If the winding drum is rotated to lower the skip to the first level, a line, as A in Fig. 2, will result, for the screw shaft being simultaneously rotated, will carry the pen downwardly. After reaching the level if a. delay occurs, a horizontal line, as B, will show the length of such delay, and if the skip is now elevated to the dumping mark, another upwardly extending line, as C, will be the result. If for instance, the skip is then lowered to the second level, the line D will clearly show the same, and if a breakdown or other accident occurs, to cause the skip to stop at an intermediate point, a horizontal line, as E, will show the same, and also clearly indicate the length of the delay. Thus a complete record of the operation of the elevating mechanism will be produced.

It will of course be understood that the mechanism may be used in connection with any number of levels, two being shown in the present instance, Fig. 1, for the sake of simplicity. Also these levels may be located at various depths requiring only the change in the arrangement of the record sheet and in the gearing which is interposed between the winding device and the vertical screw shaft. It is also worthy of note that the threads on the screw shaft terminate short of the horizontal bars, in which said shaft is threaded. This is important for the reason that if the winding drum for any reason should be operated beyond the limits of movement of the marking device, said device will merely disengage from the threads and prevent breakage of the parts. It will be understood that a number of the detachable cylinders may be employed in order that no great delay may take place in changing the record sheets, particularly when the mine is operated continuously.

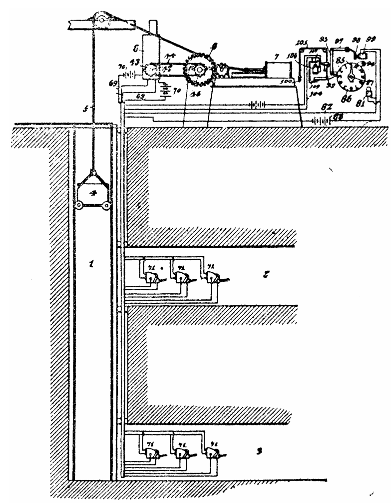
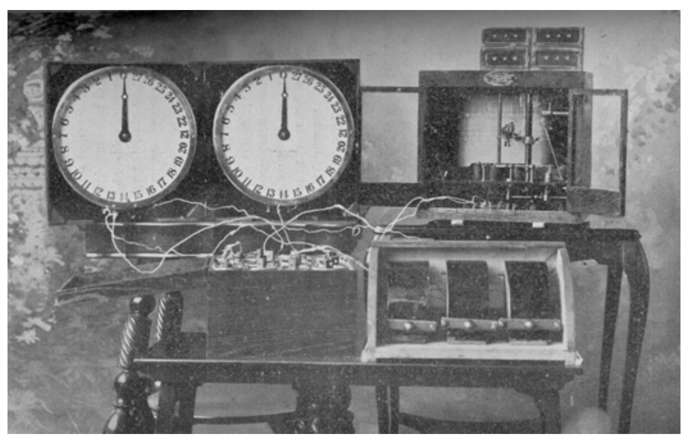


FIG. 1
Diagrammatic View of a Mine, Showing the Recording System Installed.

Grade Recording Mechanism—It will be noted that the lower margin of the record sheet, Fig 2, is provided with longitudinal lines of spaces in which the grades of ores elevated are recorded. This recording mechanism is preferably constructed as follows: Two hammers are employed, though any number may be provided depending on the number of grades of ore or material which it is desired to make record of. These hammers respectively have their heads movable against the different spaces in vertical alinement with the marking device. They are pivoted between their ends, and their lower ends are connected by links to swinging arms that are attached to the armatures of electro-magnets. Interposed between the hammer heads and the record sheet is an inking ribbon that passes around a plurality of rollers and has retaining cords on its margins, which cords engage in grooves formed in the peripheries of the rollers. A step-by-step movement is given to the ribbon in order that a fresh portion will always be located in the paths of movement of the hammers. To this end, one of the rollers has a ratchet wheel secured to its upper end, and a spring-pressed dog carried by a reciprocatory bar, operates on the ratchet wheel. Another spring, pressed dog engaged with the ratchet wheel, prevents the retrograde rotation of said wheel, and consequently a similar movement on the part of the ribbon. The reciprocatory bar has a link connection with a bell crank lever, and this lever in turn has another link connection with a swinging actuating lever. The lever has outstanding cam shoulders, either of which swings into the path of movement of the pen supporting arm when the other is moved out of said path. A spring carried by the lever and operating against a pin serves to hold said lever in either of its two positions. With this construction therefore upon every upward and downward movement of the pen supporting arm, the lever will be caused to rock back and forth, thus through the connections and effecting a reciprocation of the bar, and causing the dog to effect a movement of the ratchet wheel and of the ribbon.

The electro-magnets are in independent circuits that include suitable sources of electrical energy and these circuits extend downwardly to the different levels where they are provided with circuit closers or switches. Each closer comprises side plates to which are attached terminals and a swinging operating lever pivoted to and between the side plates has pivoted thereon a swinging arm that carries a cross bar. This bar operating on the edges of the walls, is movable across the terminal, thus connecting the same, and closing the circuit. A spring serves to yieldingly hold the arm downwardly with the cross bar upon the walls. Brackets are fastened to said wall and have elevating dogs pivoted to their ends and extending over the free ends of the terminals, these dogs being held downwardly upon the edges of the side walls by springs. With this construction therefore, if the cross bar is in its rearmost position in rear of the does, upon the forward movement of the lever the cross bars will operate beneath the dogs and engage the terminals, said cross bar will then pass beneath the free ends of the dogs and consequently upon the return movement of the operating lever, the cross bar will ride upon the dogs and will be bridged thereby from the terminals so that the circuit will not again be closed. Upon the closure of either of the circuits, it will be evident that the electro-magnet in that circuit will be energized. Consequently the armature being operated, will cause the hammer connected thereto to be swung and the head, striking the ribbon, will cause a mark upon the record sheet in one of the spaces intended for recording the grade of ore. The operator therefore in the mine at the desired level, uses this mechanism to indicate the grade of a skip of ore that is about to be elevated, but the circuit closer also constitutes a part of the mechanism for signaling the engineer or operator of the hoisting mechanism, and this signaling mechanism is constructed and associated with the recording means as follows:

Signalling Mechanism—An electric bell of any well known form, located in the engine house or at the proper point with relation to the hoisting mechanism, is included in an electric circuit and also includes a suitable source of electrical energy. This circuit extends down into the mine, and has spaced terminals secured in the circuit closers, and in the path of movement of the cross bars of said circuit closers. It will thus be clearly evident that when a skip is to be hoisted from the mine, the person in control at the level from which it is to be hoisted, has only to operate the proper lever indicating the grade of ore in the skip. Upon the initial movement of said lever, the circuit will be closed to make a record of the grade of ore upon the record sheet, and directly thereafter the cross bar of the circuit closer will connect the terminals of the circuit whereupon the bell will be sounded, and any number of strokes of the bell may be made, provided the arm is not completely turned over the bridges. The record of the grade of the ore therefore also acts as a record against the engineer in charge of the hoisting mechanism, for the mark made by the hammer will indicated in connection with the mark made by the pen, whether or not there was delay in answering the signal to raise the load. There is also preferably employed a visual signal for the engineer, the same comprising a rotary pointer that operates over a dial properly numbered as shown. The pointer is connected to a shaft on which is mounted a ratchet wheel and a pinion. The pinion is in mesh with a gear wheel to which is connected a return spring. An actuating dog operates on the ratchet wheel to effect a step by step rotation thereof and a consequent winding of the spring. The return movement of said ratchet wheel after its movement by the dog is prevented by a swinging dog pivoted at one end, and thus being movable into and out of coaction with the ratchet wheel.



View Showing Complete Recording Machine and Signal Dials

The operating dog is connected to the lower end of a lever fulcrumed between its ends, and having a link connection with the armature of an electro-magnet. This electro-magnet is in the circuit with the bell and therefore every time said circuit is closed, the armature will be actuated. This will cause the movement of the dog, and the consequent rotation of the pointer, the dog preventing the return of said pointer after each movement. However, if the arm or dog is raised, the spring reacting on the wheel and pinion will immediately return the pointer to zero. This movement of the dog is effected by a suitable handle having a cable connection with a lever which in turn has a cable connection with the dog, said handle being disposed in a convenient position to be grasped and, operated by the engineer in charge. To the lever is connected a return spring which normally maintains said lever against a stop. It sometimes may happen, however, that the engineer is not present or for some other reason, it is desired to repeat the signal. It will be evident that the mechanism must be such that a repetition of the signal will not operate the recording mechanism, and also it is necessary that such repetition will not merely advance the pointer. Therefore at each level there is provided an additional circuit closer and constructed exactly the same as those already set forth. The terminals of this circuit closer are a part of a circuit that in, eludes a source of electrical energy and an electro-magnet. This magnet has an armature co-operating therewith, and a link connected to the armature is connected to a lever. The lever has one end disposed beneath the end of the dog. The other terminals of the circuit closer, are connected to the circuit. Bridge dogs are mounted over the terminals. An actuating lever forms a part of the circuit closer and has attached thereto the usual cross bar corresponding in all respects to the cross bar of the above described circuit closers. Assuming therefore that a signal has been given to the engineer at the top of the shaft, and it is desired from any cause to repeat the same, the operator at the level from which the load is to be taken, operates the circuit closer. As the cross bar moves over the terminal the circuit will be closed, thus energizing the magnet which draws its armature. As a result the lever will be operated; which will raise the dog so that the pointer will return to its original or zero postion. The movement of the lever of the circuit closer, being continued, the cross bar will strike the terminals, thus closing the circuit and the signal can be repeated. The return of the lever and cross bar to its original position will not effect the operation of the dog, as said cross bar will be bridged from the terminals by the dogs.

Registering Mechanism for the Loads—Besides recording the number of loads of different grades of ore on the record sheet, registering mechanism is also provided so that the number of loads can be ascertained at any time at a glance without the necessity of an inspection of the complete record sheet. To this end, there is mounted upon the supporting frame, a plurality of registers the number of such registers depending on the number of grades of ores to be recorded and registered. Thus it will be evident that any number can be employed. These registers may be of any well known type. In the present form, each consists of three number wheels, each of those having the lower orders of digits, being provided with means for effecting an increment of movement of the next upon each complete rotation. Operating on the teeth of the wheel having the lowest order of digits, is a swinging yoke that is carried by a vertically reciprocating actuating bar. These bars have pivoted to their lower ends, abutment blocks that are located in the path of movement of the supporting arm of the marketing device or pen. The actuating bars furthermore have notches in their rear sides, and holding dogs pivotally mounted between their ends on the supporting frame, engage in the notches. The dog have their free ends upturned, as illustrated and these ends are located in the path of movement of the offset terminals of levers, fulcrumed between their ends upon the platen. Reciprocating yokes horizontally disposed and embracing the hammers are mounted in hangers and have their rear ends pivotally connected to the levers. These yokes are urged forward by springs.

Assuming now that the actuating bars are in their elevated positions and are locked by the dogs, and also assuming that a loaded skip at one of the levels is about to be elevated, one of the switches is operated, and as already explained, one of the hammers is actuated to record the load upon the record sheet. The hammer in turn operates one of the yokes, causing the movement of the lever and of the dog, which thus releases the actuating bar, and permits it to fall. The yoke therefore drops beneath the lower tooth of the number wheel, and as the skip reaches the dumping point, the pen carrying arm will strike the depending block of the depressed actuating bar, causing the same to move upwardly and rotating the number wheel one increment. Thus the operation of the register is dependent upon the load properly reaching the surface. It will thus be seen that the mechanism disclosed, records the operation of the elevating mechanism, produces a record of the grades of ore, the number of loads and the levels from which they are taken, besides recording the time at which the different loads are ready to be hoisted, and maintaining a check against those in charge of the hoisting mechanism. Both oral and visual signals are provided for the operator in charge of the hoisting mechanism, with means for repeating signals without causing confusion and without effecting improper operations of the recording mechanism, while registering mechanism, dependent on the recording means, is provided for showing the number of loads of the different grades actually elevated, preventing mistakes or fraud in the operation of the recording means.

From the foregoing, it is thought that the construction, operation and many advantages of the herein described invention will be apparent to those skilled in the art, without further description, and it will be understood that various changes in the size, shape, proportion, and minor details of construction, may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

SURVEYING AND SAMPLING DIAMOND DRILL HOLES.

BY E. E. WHITE, ISHPEMING, MICH.

Diamond drilling is expensive work, costing rarely less than $2.50 per foot in the Lake Superior iron district, and often reaching $5.00 per foot in hard ground, or even more if any of the many difficulties known to drillmen are encountered. Yet up to a few years ago little attention was paid to determining the actual course of holes underground, to accurate sampling and analysis, or to scientific location of drill holes. A description of the methods which have been developed in the course of extensive explorations by the Cleveland-Cliffs Iron Company in the Lake Superior district will perhaps be interesting to the members of the Institute.

It has now been common practice for several years to test the inclination of drill holes by etching glass tubes with hydrofluoric acid and the apparatus used by the Cleveland-Cliffs Iron Company has been described by Mr. J. E. Jopling in a paper read before the Institute in August, 1909. In an article which appeared in the Engineering and Mining Journal of September 17th, 1910. I described how the curvature of a diamond drill hole can be controlled and gave an example where it had been done successfully. Although the hole kept to the desired course, it failed to intersect the ore encountered in a previous hole because the direction of deviation from the vertical of the previous hole had not been determined, although the amount of deviation had been determined by the usual hydrofluoric acid tests.

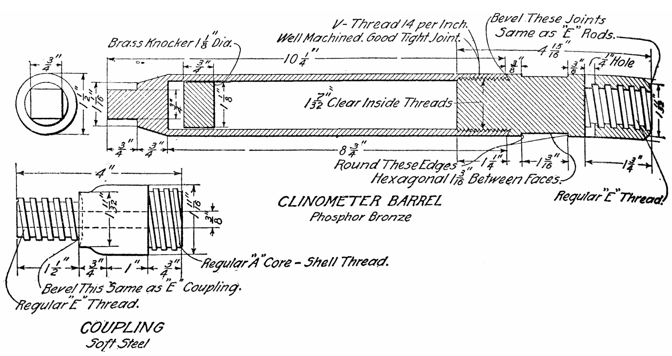


FIG. 1

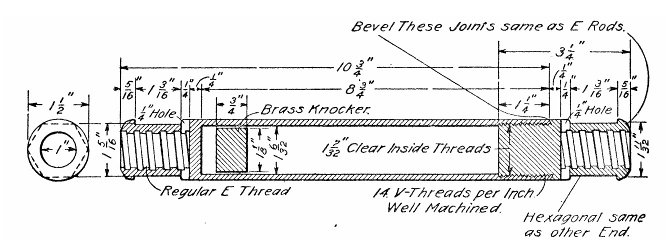


FIG. 2

This failure to secure results led to my investigating the question of determining the course, as well as the inclination, of drill holes. After considering several methods two were chosen for trial, one of which has proved satisfactory, the other moderately so. In non-magnetic rock formations the old method of a compass suspended in gelatine is successfully used with improvements worked out by Mr. George Maas and myself. Mr. Maas has patented his improved compass and his idea of using a thermos bottle in connection with the compass and gelatine. In magnetic formations a method of marking the drill rods is used in connection with hydrofluoric acid tests. This method was described to Mr. J. E. Jopling by Mr. John Deacon, superintendent of the Republic Iron & Steel Company's properties at Negaunee, who used it in testing diamond drill holes at the Cambria mine. We did not find it as successful as using a compass, but it is the only method which I know of that is practicable in magnetic formations

SURVEYING IN NON-MAGNETIC FORMATIONS.

Figures 1 and 2 show the cases used to test for inclination and course. The latter shows the case used when it is desired to make more than one test at the same time, as it may be inserted at any point in the drill rods at the same time that the first case is used at the end of the rods. As it is desired to use as large a glass tube in the case as possible, and as the outside diameter is limited by the size of an "E" hole, a material was selected which combined the greatest possible toughness and tensile strength with non-magnetic properties. Phosphor bronze was chosen, which is entirely non-magnetic and for which the manufacturers guarantee a tensile strength of 70,000 pounds and elastic limit of 55,000 pounds per square inch. By using a case of dimensions given in Figure 1, a glass tube 1⅛" outside diameter can be used and according to Nystrom's formula for the collapsing strength of small tubes $P = \frac{4Tt^2}{fd\sqrt{L}}$, using a factor of safety of 4, this case should be safe in a hole 3,300' below water level. A little wicking is used to make a perfectly tight joint.

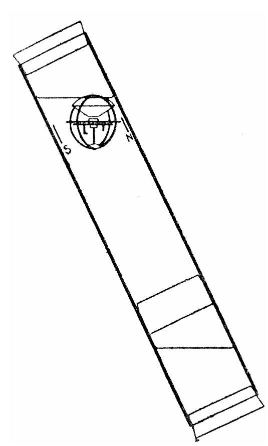


FIG. 3

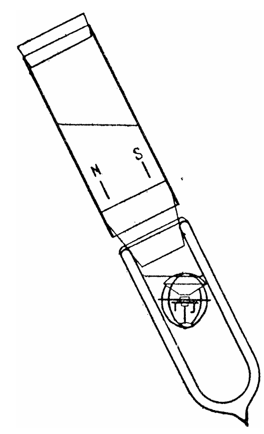


FIG. 5

The compass invented by Mr. Maas is shown in Figure 3. Its advantage over the old forms of compass used for this purpose lies in the fact that it is pivoted in a cage which prevents its coming in contact with the glass tube and insures its swinging freely in the gelatine. The cage is below and rigidly attached to the float, which is made of cork. The most accurate and satisfactory method of testing the course of a hole is to use the compass in a glass tube open at each end and about 6" long. A section of rubber stopple is forced into the tube, leaving about 1½" for acid at one end and 4" for gelatine at the other. A small weighed portion of dry gelatine is carried to the drill and dissolved, on the ground in a certain quantity of water, care being taken that the water has no chance to evaporate while dissolving the gelatine. The proportions are so chosen that when dissolved the solution will keep liquid as long as possible after being lowered in the drill hole and yet will become perfectly solid when cold. For instance, using Nelson's Improved Brilliant Gelatine we use 5-6 gram and dissolve it in 50 cc of water. In a hole where the rods can be lowered in twenty minutes or less a 1⅛" tube is used with paper wrapping. When it takes from twenty to thirty minutes to lower the rods a 1" tube is used with several wrappings of paper. If deeper than this a thermos bottle is used and by using a paper wrapper the gelatine may thus be kept liquid fifty minutes. The time the gelatine remains liquid was determined by tests in ice-water at 43° Fahrenheit, which is the temperature of the underground water.

In the first two cases when the thermos bottle is not necessary the dissolved gelatine is poured into the tube and heated as hot as possible by immersing the tube in water heated to boiling by live steam. When hot the compass is dropped in and a stopple placed in that end, then about 1" of dilute hydrofluoric acid is poured into' the other end and that end closed. The tube is then wrapped in paper and placed with gelatine end up in the bronze case, which is attached to the bottom of 20' of brass "E" rods and lowered into the hole, losing as little time as possible. The brass rods are screwed to the bottom of the regular drill rods, an "A" to "E" reducting coupling being used if the hole is being drilled with "A" rods. The bronze case and brass rods are made for an "E" hole so that they can be used in either case. If two tests are to be made at the same time another tube and compass are placed in the case shown in Figure 2 and inserted in the drill rods at the proper point, using 20' of brass rods on each side.

The tube is left stationary in the hole fifty minutes after the rods are lowered, giving the gelatine time to cool and set and the acid time to etch a good line. It is found that acid diluted with 12 parts of water gives best results. It is diluted in the office and carried to the drill in hard rubber bottles with screw tops, which are much more convenient than the paraffine bottles used at first.

When the tube is brought to surface the positions of the North and South ends of the needle are marked on the glass with a diamond point and the tube washed out and the compass dried to prevent rusting. This tube forms a permanent record of the inclination and course of the hole at the depth where the test was taken.

The thermos bottle is 1⅛" outside diameter and consists of two clear glass walls with a vacuum between as shown in Figure 5. When it is necessary to use this the hot gelatine and compass are placed in the bottle and the bottle closed by a rubber stopple. The stopple also closes one end of a 1⅛" tube 3" long, serving to connect the bottle and tube and preserve them in the same relative position, as shown in Figure 5. Dilute acid is placed in the tube, the other end closed, and the tube and bottle placed in the bronze case and lowered into the drill hole. It only takes the gelatine 1½ hours to solidify in the thermos bottle so that it is usually left in the hole only fifty minutes after the rods reach the bottom, just-long enough to get a good etching. It may be left in the hole over night, however, but in that case the acid is diluted more. When the tube is brought to surface the North and South points are marked on it, corresponding to the position of the compass needle in the thermos bottle. The tube then forms a permanent record of course and inclination just as the 6" tube does.

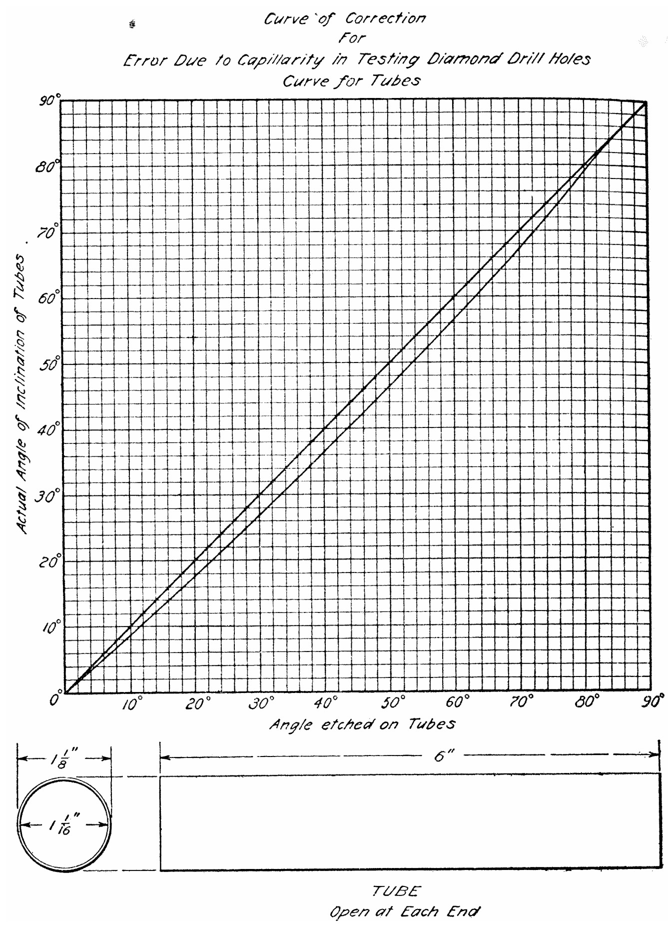


FIG. 4

In either case the inclination is read in the goniometer described and shown by Mr. J. E. Jopling in the Transactions of the Institute for 1909, and is corrected for capillarity according to a curve which is prepared for each size of tube, by testing tubes at known angles according to the method described by Mr. Jopling. Figure 4 shows a curve for 1⅛" tubes It will be noted that for these larger tubes the correction is only 3¾° at 45°, which is the maximum. The angle can be read to ½° and I feel certain that the results of tests for inclination can be relied upon within 1°.

To determine the course of the hole the tube is placed in the goniometer with the graduated circle set at 0° so that the tube is vertical. If the inclination of the hole is steep the tube is twisted until the etching shows the dip to be either directly toward or away from the eye; that is, until the cross-thread bisects the ellipse etched on the glass. If the inclination is shallow it is more accurate to twist the tube so that the dip to be the right or left of the observer and in the plane of the graduated circle. The goniometer is next placed on a protract or so that the tube comes vertically over the center, and by sighting clown over a straight edge placed in line with the North and South points marked on the tube the point of the compass towards which the hole dips may be determined. Figures 3 and 5 show tubes with acid, gelatine, compass, and North and South points marked, just as they are taken from the drill hole. I intend to have another goniometer made with horizontal circle to measure the course as well as vertical circle for the inclination, but have not bad an opportunity to do so as yet.

We have found the method described above very successful, and two tests at the same point almost always agree. When this is not the case more tests are made and so far we have always been able to ascertain which are wrong. We have made tests at a depth of 2000', but it would probably be difficult to go much deeper without using more insulating wrapping around the thermos bottle than is possible with a bottle and ease of dimensions now used.

The precautions to be taken are three in number: first, that the compass swings perfectly freely, that is, that it docs not catch on the cage and that the gelatine keeps liquid long enough; second, that there is no local magnetic attraction in the rock formation; and third, that the compass is not affected by the steel drill rods or casing or by other iron in the hole. The first precaution is easily taken; the second can only be judged by a knowledge of the formation and by taking tests at different depths. If these are concordant there is probably no appreciable magnetic attraction. The third precaution is important. We use 20' of brass rods and so have no iron within 20' of the compass. Tests with 10', 20', 30' and 40' of brass rods at the same depth gave the same reading in a hole dipping 500 North 45° East so that 20' is conservative. The results of a second test with shorter lengths of brass rods at another point are given below:

Length of Brass Rods.	Inclination.	Apparent Course.
1'	62°	N 6° E
2'		N21°E
3'		N39°E
4'		N35°E
5'		N42°E
6'		N42°E
7'		N41°E
8'		N23°E
10'		N48°E
12'		N50°E
20'		N47°E

SURVEYING IN MAGNETIC FORMATIONS.

When the rock formation is known to be magnetic, or when several tests with the compass do not agree, there seems to be no way of determining the course of a hole but by lowering the rods in such a way that the test tube can be oriented at any point in the hole. We have done this by the method suggested by Mr. Deacon. The rods are first screwed together in one or two long lines on surface just as they- will be lowered into the hole, with the bronze case at the end, all the joints being made as tight as usual. Great care is necessary that no twist be left in the rods when screwing them together on the ground. This trouble is not experienced when there is snow as the rods slip easily on the snow and no torsion can be introduced. When the ground is bare it may be avoided by placing level planks at short intervals for the line of rods to rest upon and not allowing them to touch the ground at any point. If not over 500' in length the rods will turn on grass without leaving any twist in the rods.

When all connected, each joint that is to be broken, usually every second joint, is marked with a chisel so that it can he screwed up again to exactly the same place. They are marked exactly on top as they lie on the ground so that when the rods are in the hole the marks will point in exactly the same direction. The joints are then broken, being careful not to disturb any joints which are not marked.

Dilute hydrofluoric acid is poured into a glass tube and the tube marked with a diamond and placed in the bronze case so that the mark on the tube corresponds with that on the case. The tube is then lowered into the hole, being careful to exactly match the marks at every joint. The mark on the last rod is placed directly in front of the drill and this direction determined, which is the direction of the mark on the glass tube. The tube is left stationary at the bottom of the hole for about fifty minutes when acid diluted 12 to 1 is used and then withdrawn and washed. To determine the course of the hole another mark is made exactly on the opposite side of the tube and the course found by using the goniometer and protractor as described in connection with the gelatine test.

This method of course only gives accurate results when the rods turn easily in the hole so that there is no twist in the rods when lowered. This is usually the case except in very deep holes or in holes where the inclination is low or where the curvature is excessive. In these cases, unless the hole is rifled, the twist may probably be removed by raising and lowering the rods several feet a few times after the rods are in the hole. Precaution should be taken that the tube cannot turn in the bronze case, either by wrapping with paper or by using a stopple which fits the case snugly. Our tests by this method do not always agree and are apt to be 10° or 20° anti-clockwise from the course as determined by compass in a non-magnetic formation. One reason for this seems to be that in lowering the rods the joints work tight or loose because of the friction of the rods revolving in the hole.

The Cleveland-Cliffs Iron Company
Ishpeming, Michigan
RECORD OF DIAMOND DRILLING

............................Shift ....191....

Where Working...

Section..Hole No..............

	Feet	Core Saved	Hours
Total depth of hole per last report.........	....		
Moving and setting up.....................			....
Drove..........inch stand pipe............	....		....
Drilled with chopping bit..................	....		....
Drilled with diamonds....................	....	....	....
Reamed from.............to............ft.	....		....
Lowered..........inch casing to........ft.	....		....
Total Depth of Hole............	....		
Kind of Material..........................	....	....	....
....	....	....	....

	Feet	Size	Hours
Bit No....................................	....	....	....
Bit No....................................	....	....	....
Bit No....................................	....	....	....
Number of Men..............			....

Remarks...

....Runner
....Helper
....Setter
Report delays, accidents, etc. ....Foreman

FIG. 6

District.............................. ....

Sec.................................Hole No.................... ....

Depth..

FIG. 7

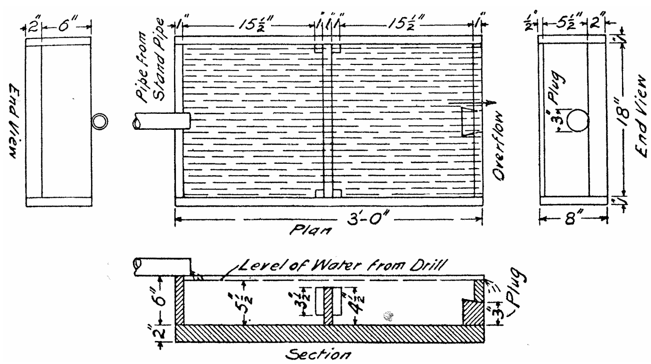


FIG. 8

DAILY REPORTS.

Figure 6 shows a report form filled out by the drillmen every shift for the drill foreman and the head office, and Figure 7 a sample tag which is placed in every bag of core or sludge. The record of time of drilling and footage of each diamond bit is kept to obtain data on the several stones in the bit with the idea of determining which are the most economical. These tests have shown that the wearing quality of the stone depends considerably upon the specific gravity and upon the structure.

Although it is important to have the drillmen report the amount of core saved from each material, yet they rarely measure it accurately and if the analyses of core and sludge are to be combined as described below the core is remeasured when it reaches the office.

SAMPLES FROM DRILL HOLES.

The following directions for saving samples are posted in the drill shanties and enforced by the inspector.

DIRECTIONS FOR SAVING SLUDGE FROM DIAMOND DRILL HOLES.

"Set the standard sludge box just below the floor of the shanty and in such position that there is room to siphon off the water and take out the sample without moving the box. Connect a tee to the top of the standpipe or casing and lead a pipe from it to the nearer end of the sludge box, at such a height that it will either be level or slant towards the sludge box and just rest upon the top of the box, and of such a length that it will not project more than one inch beyond the edge of the box. The pipe must not be more than two feet long, and if longer than one foot must be split on top for the foot nearest the sludge box, so that if sludge collects in the pipe it may be seen. Set the box level so that water will overflow evenly across the whole width at the far end and wedge the partition firmly so that it is in close contact with the bottom of the box. The top of the partition should be one inch below the water level. The box is now ready to receive the sample and drilling may be started.

While drilling, care must be taken that no water from the drill hole escapes around or over the tee except through the pipe leading to the sludge box. Care must also be taken that there is no leak from the box and that the three inch plus at the end of the box is tight. Sludge samples must be taken for every five feet drilled or less, preferably from even five foot intervals; that is, from 460 to 465, 465 to 470, 470 to 475, etc.

Whenever a sludge sample is to be taken drilling must be stopped and the hole washed out clean. The pipe leading to the sludge box must be cleaned out into the sludge box and either the pump must then be stopped or the tee turned so that the water will not be discharged into the box. Carefully remove the partition in the box so as not to stir up the sludge any more than necessary and when the sludge is settled siphon off the surplus water, being careful to keep the end of the siphon near the surface of the water and not disturb or draw off any of the fine sludge at the bottom of the box. To use the siphon, fill with water a three foot length of large size flexible hose and with one hand on each end place one end beneath the surface of the water in the box and the other end on the ground eight inches or more below the top of the box. When both ends of the hose are released the water will flow out of the box and may be allowed to flow until it is seen that the sludge is beginning to go off with the water. Then remove the hose and thoroughly mix the sludge in the box to a mud. This must all be removed from the box and placed in a pan on the boiler to dry. The pan must e at least 8"x12"x1" deep, with flat bottom, and must be thoroughly cleaned each time before a sample is put in it to dry. If enough water cannot be drawn off without disturbing the sludge so that the sample can be contained in this pan, a larger pan must be used. All the sludge must be saved and the sludge box cleaned thoroughly. When the sludge has been cleaned out, remove the three inch plug at the end of the box and wash out the box with a pail or two of water, then replace the plug and partition and drilling may be started again. The sludge must be labeled, giving the depths between which the sample was taken, when it is placed on the boiler to dry. It must all be saved and turned over to the inspector. Sludge must always be saved when drilling in iron formation or in any other ferruginous or red material. While drilling in material from which a sludge sample should be saved, if the water is lost, if the sludge does not come up with the water, of if the sludge is contaminated with material caving from higher up in the hole, drilling must be stopped immediately until the hole is put in such condition that good sludge samples can again be obtained, or until the inspector gives orders that drilling may proceed.

Whenever the drill runs into or out of ore, provided the band of ore or rock is one foot or more thick, drilling must be stopped and the sludge box cleaned out immediately, without waiting to complete the five foot run. When the drill runs out of ore continue taking and saving sludge samples for at least twenty feet, no matter what the material, so that it may be determined whether the ore is caving.

Keep the core separate from the sludge and each time core is pulled label it with the depths between which it was recovered. Each run of core must be kept separate and all core must be saved and turned over to the inspector. When the core is pulled if it is found that more core is saved than the proportion of one foot of core to ten feet of drilling, the sludge box must be cleaned without waiting to complete the five foot run, and the sludge labeled and saved separately. If sludge from a shorter distance than five feet is in the box at the end of the shift's work, and if less than the above proportion of core is saved, the sludge may be left in the box provided the shanty is locked and the box is inaccessible from outside the shanty. If anybody can get at the box, however and if there is no watchman, the sludge must be removed from the box, dried, labeled and placed with the other samples."

The standard sludge box is shown in Figure 8.

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DAILY REPORT OF DIAMOMD DRILLS

Ishpeming, Mich., ...191....

Section	Hole No.	Date	Feet Drilled	Total Depth	Material	Remarks

FIG. 9

When the samples reach the office they are carefully examined and a daily report of all drilling made out on the form shown in Figure 9. Samples of all core and of all sludge which runs above 40% iron are preserved in a room and in cabinets designed especially for the purpose. A few pieces of core are saved from every run and the rest sent to the laboratory for analysis if ore formation, or thrown away if not. A little of each sludge sample is placed in a small pasteboard tray with a temporary label, 10' to a tray, until the analysis is completed. Each 10' of sludge sample which runs over 40% is then placed in a gelatine case and preserved in the same drawer with the core. Gummed paper labels are used for both core and sludge and the samples preserved in the drawers shown in Figure 10.

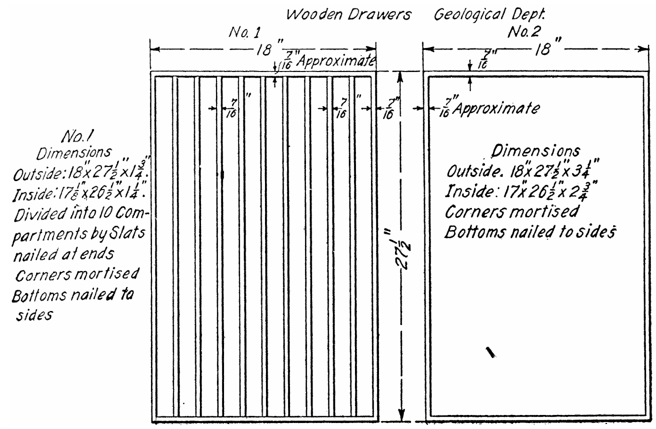


FIG. 10

INTERPRETATION OF ANALYSES.

Mr. W. J. Mead has described our method of combining core and sludge analyses in an article in the Engineering & Mining Journal of May 6th, 1911, except that we used a formula in the method which I described to Mr. Mead several months ago instead of the diagram which he has developed from it. Since other engineers may also be interested in the formula I give the derivation below:

Let A = diameter of bit outside of carbon.
" B = diameter of bit inside of carbon.
" C = feet of core saved in "D" feet drilled.
" D = feet drilled.
" S = volume of rock actually ground to sludge.
" T = volume of rock actually saved as core.
" $T = 3.1416$.

$$\text{Then } S = D\left(\frac{TA^2}{4} - \frac{TB^2}{4}\right) + (D - C)\frac{TB^2}{4}$$

$$\text{and } T = C\frac{TB^2}{4}$$

$$\text{Hence } \frac{S}{T} = \frac{D(A^2 - B^2) + (D - C)B^2}{CB^2} = \frac{DA^2}{CB^2} - 1$$

	Dimensions of Bits Inside of Carbon	Outside of Carbon
Standard "A" bit	1"	1 13-16"
" "E" bit	27-32"	1 9-16"

$$\text{Hence for an "A" bit } \frac{S}{T} = \frac{1.813^2\,D}{C} - 1 = 3.29\,\frac{D}{C} - 1$$

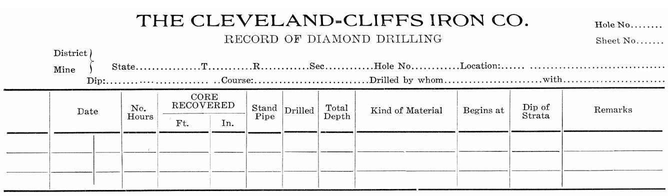
$$\text{and for an "E" bit } \frac{S}{T} = \frac{1.563^2\,D}{.844^2\,C} - 1 = 3.43\,\frac{D}{C} - 1$$

To obtain an average of the sludge and core analyses giving the proper weight to each, the sludge analysis should evidently be multiplied by "S" and the core analysis by "T" and the sum of the products divided by S + T. The result is the same and the operation simpler to multiply the sludge by $^{S}/_{T}$ and the core by 1 and divide by $^{S}/_{T}$ + `; hence the rule for an "A" bit is to multiply the sludge analysis by $3.3^{D}/_{C}$-1, add the core analysis, and divide the sum by $3.3^D/_C$. Since the core is rarely pulled in five foot runs we find it just as simple to figure the ratio from the formula as from Mr. Mead's diagram.

Mr. Mead did not mention the method of obtaining the average analysis which he formerly used, namely, to weigh out proportionate parts of core and sludge and combine them for analysis. This method is ingenious but is open to objections: first, if it is found later that the hole was caving and the sludge of no value the core analysis is also rendered valueless; second, in order to get true analyses it is advisable to send the whole sample for analysis except a small portion kept for record, whereas if weighed out a portion must be rejected.

We only run iron on the five foot samples, with phosphorus if over 40% iron, and manganese if there may be over 1% or 2%. We occasionally combine several of the five foot sludge samples and make a complete analysis for iron, phosphorus, silica, lime, magnesia, alumina, manganese, sulphur, titanium and loss by ignition.

After combining the core and sludge analyses the results are further averaged in continuous runs of ore of the same grade. We call from 45% to 50% iron lean ore, 50% to 57% second class ore and above 57% first class ore.



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RECORD OF DIAMOND DRILLING

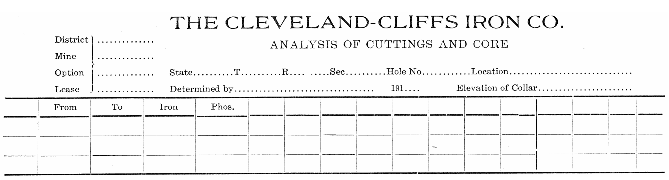
Hole No........ Sheet No.......

District / Mine ..... State................T...........R............Sec............Hole No............Location:......

Dip:.......................... Course:............................Drilled by whom......................with........................

Date	No. Hours	CORE RECOVERED Ft.	In.	Stand Pipe	Drilled	Total Depth	Kind of Material	Begins at	Dip of Strata	Remarks

FIG. 11



THE CLEVELAND-CLIFFS IRON CO.

ANALYSIS OF CUTTINGS AND CORE

District .... Mine .... Option .... Lease ....

State..........T..........R.......... .....Sec..........Hole No............Location.............................

Determined by................................ 191.... Elevation of Collar.......................

From	To	Iron	Phos.

FIG. 12

REPRESENTATION OF RESULTS.

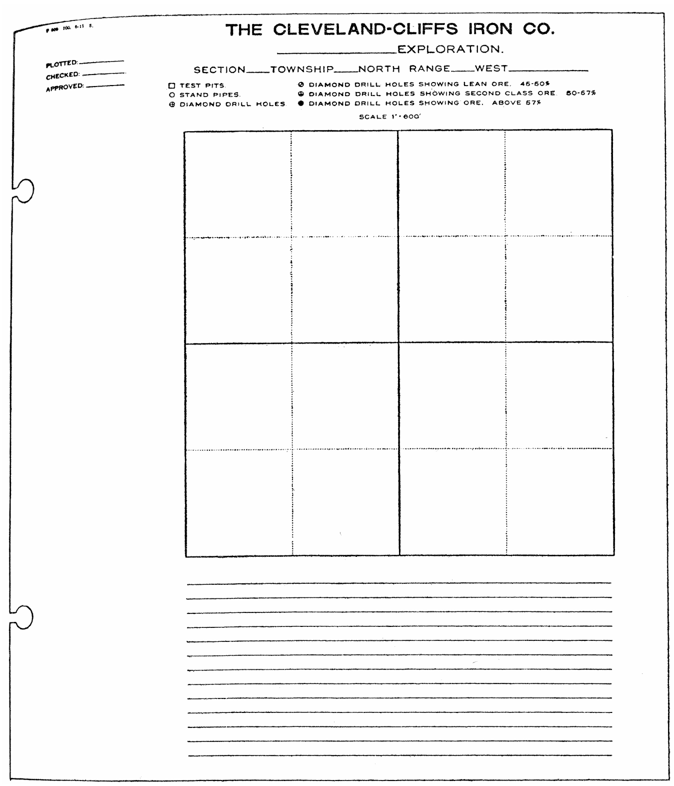
As soon as possible after the first of the month the record of material drilled through the previous month is compiled from daily reports and averaged analyses. This is carefully checked over with the core and then recorded permanently in the drill book. This is a loose-leaf book with pages shown in Figures 11 and 12. The reports of the drillmen and analyses of samples are copied in this book daily and it forms the complete and permanent record of drilling. From this book tracings are plotted which are blue printed for the various parties entitled to receive the information. Figures 13 and 14 show the printed forms on tracing cloth used for this purpose. They are 14"x16", the same size as the loose-leaf sheets in the drill book, and are bound in covers of the same size.

CROSS-SECTIONS OF DRILLING.

For scientific location of drill holes cross-sections must be made through previous drill holes, preferably at right angles to the strike of the formation, showing the holes plotted according to the surveys for inclination and course, and showing the material encountered. We make these on cross-section tracing cloth ruled in inches and tenths, on a scale of 50' to the inch. The sections may be superposed and compared, and the cross-section ruling makes it easy to read distances and areas without a scale. On these tracings the geological boundaries of formations and the outlines of ore bodies are drawn in soft pencil, which prints satisfactorily but may easily be erased and changed if further drilling shows the first assumptions to be wrong. When necessary longitudinal sections are made and taken in connection with a plan and cross-sections give a very good idea of the structure.

DEFLECTIONS OF DRILL HOLES.

In an article written for the South African Mining Journal of June 11th, 1910 and again in an article in the same journal of March, 1911, Mr. J. S. Curtis gives an interesting theory of the cause of bore hole deflections with results of experiments which he made to substantiate his theory. He endeavors to show that the influence of terrestrial magnetism should cause vertical drill holes to deviate to the North in the Southern Hemisphere and states that this is the case in the great majority of holes, although the direction may be changed by the character of the country rock.



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______________EXPLORATION.

PLOTTED: ______ CHECKED: ______ APPROVED: ______

SECTION____TOWNSHIP____NORTH RANGE____WEST________

□ TEST PITS. ○ STAND PIPES. ⊕ DIAMOND DRILL HOLES. ◐ DIAMOND DRILL HOLES SHOWING LEAN ORE. 45-50% ◑ DIAMOND DRILL HOLES SHOWING SECOND CLASS ORE. 50-57% ● DIAMOND DRILL HOLES SHOWING ORE. ABOVE 57%

SCALE 1"-600'

FIG. 13