CONSTITUTION & BY-LAWS

OF THE

ALABAMA

Industrial and Scientific Society,

ADOPTED AT THE ANNUAL MEETING,

BIRMINGHAM, JAN. 28, 1891.

WARREN, PRINTER.

CONSTITUTION

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PREAMBLE.

The Members of The Alabama Industrial and Scientific Society, organized at the University of Alabama, Thursday, Dec 11th, 1890, do adopt the following Constitution :

ARTICLE I.

NAME.

The name of this Society shall be THE ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

ARTICLE II.

OBJECTS.

The objects of the Society are the promotion of the Industrial and Scientific development of the State.

ARTICLE III.

MEMBERSHIP.

The Society shall be composed of Members and Associates.

MEMBERS:—Any person engaged in the active prosecution of Engineering, in any of its branches, Geology, Chemistry, Mining, Smelting, or Manufacturing, and the President, General

Manager, Superintendent, or officials of any Company concerned with the production, manufacture or transportation of materials used in the industries of the State, may become a Member, provided that he be twenty-one years of age and be recommended by the Council.

ASSOCIATES :—Any person interested in the prosperity of the State, and in sympathy with the objects of the Society, may become an Associate, provided he be twenty-one years of age and be recommended by the Council.

An Associate shall be entitled to all the privileges enjoyed by a Member, except those of voting and holding office.

ARTICLE IV.

OFFICERS.

The officers of the Society shall be a President, six Vice-Presidents, a Secretary, and a Treasurer. These shall constitute the Council.

No one shall be considered eligible to office who shall be in arrears of Annual Dues or Assessments at the Annual Meeting, or who shall not have been a Member of the Society for at least one year previous to election.

1. The President shall be elected at the Annual Meeting, by a majority vote of all the Members of the Society, and shall hold office for one year, or until his successor is duly elected and installed. He shall be ex-officio Chairman of the Council, and of the Committee on Presentation and Publication of Papers, and shall discharge the usual duties of a presiding officer. He shall have general supervision of the affairs of the Society.

2. The six Vice-Presidents shall be elected from among the Members of the Society in the same manner as the President, and, in addition thereto, as follows: at the Annual election in 1892, two shall be elected to serve for one year, two for two years, and two for three years, and at each succeeding Annual Meeting two shall be elected to take the place of those whose term expires at that meeting, and the terms of the two thus elected shall expire in three years.

The Vice-Presidents, in the order of their election, shall discharge the duties of the President in the event of his death or absence from the meetings.

3. Secretary.—The Secretary shall keep the records of the proceedings of the Society and of the Council. He shall attend to the preparation, printing and mailing of circulars, blanks, and notifications of elections and meetings. He shall collect all monies due the Society, so far as may be possible, turn them over to the Treasurer and take his receipt for the same. He shall be, ex-officio, a member of the Committee on the Presentation and Publication of Papers, and shall edit and distribute such publications as the Council may direct, and have charge of the Library. He shall keep an accurate register of all the Members and Associates, recording the date of their connection with the Society, and notifying them of their election, and of the amount of their dues and assessments.

At each meeting he shall present a report.

4. Treasurer.—The Treasurer shall receive from the Secretary such monies as may be paid to that officer, and deposit the same in some Bank to the credit of the Society, subject to his order. He shall keep a just and accurate account of all receipts and disbursements, in detail, and this shall be audited as hereinafter provided.

He, or in his absence, the President, shall sign all checks.

At each Annual Meeting he shall present a full and detailed report of the financial condition of the Society.

5. The Council.—The Council shall have executive authority; it shall also have legislative power in the intervals of the meetings; but no decree of the Council shall be considered as binding beyond the next succeeding meeting without ratification by majority vote of all the Members.

The Council shall meet on the day preceding each meeting, for the purpose of receiving applications for admission into the Society, and for receiving and examining such papers as may be presented for reading and discussion. No paper shall be read before the Society, either by title or in full, which has not been presented to the Council and approved by them, nor shall any matter be printed without the authority of the Council.

The Council shall have exclusive control of all publications of the Society, and may, at their option, accord or refuse permission to publish any paper in the proceedings.

The Council shall make to such meetings a full report of all matters that have come before them, since the preceding meeting, and this report must be accepted by majority vote of the Members present before it can be considered as in force.

The Council shall have power to order any assessment, not above $5 per annum, that may be necessary, over and above the amount derived from the Annual dues, to carry on the business of the Society.

The Council shall have power to fill any vacancies among the officers that may be necessary between the Annual Meetings.

6. Terms of Office.—The President and Vice-Presidents shall hold office as provided in Article IV, Sections 1 and 2. The Secretary and Treasurer may hold office until, by a two-third's vote of all the members of the Society, these offices shall be declared vacant.

It is especially provided in this Section, that the elections held at the University of Alabama, Dec. 11th, 1890, shall be regarded as if held at the Annual Meeting in 1891.

ARTICLE V.

VOTING AND ELECTIONS.

1. All elections shall be by ballot.

2. Voting by letter or by proxy may be allowed, and such letters must be filed with the Secretary.

3. Election of Members and Associates.—Nominations for Members and Associates shall be signed by two members, according to a form to be furnished by the Secretary on application.

One of these members must be personally acquainted with the applicant.

The nominations thus made must be sent to the Secretary, and by him sent to each member ten days before next meeting, and by him also be laid before the Council at their next meeting. The names of those proposing Members and Associates must be sent out when the nominations are made. If the Council approve the nominations, they shall present the same to the Society at its next meeting, when the election of the nominees may take place. Five negative votes shall exclude the applicant.

4. ELECTION OF OFFICERS.—Nominations for office shall be made by the Council or may be made by any ten Members, in writing, at least sixty days before each Annual meeting. Two Members shall be nominated for each office, and these shall have signified their willingness to serve. All these nominations shall be sent by the Secretary to each member of the Society at least thirty days before each Annual meeting. The ballots shall be returned to the Secretary and by him laid before the Council, who shall count them and announce the result to the Society. In case no one has the majority, the Society shall proceed at once to the election between those having the two largest numbers of votes.

The officers elected at the Annual meetings, shall enter upon the discharge of their duties immedietely upon the adjournment of such meetings.

ARTICLE VI.

MEETINGS.

The Society shall hold at least 4 (four) meetings a year, viz : in January, April, July, and October. The January meeting shall be considered the Annual meeting, at which the officers for the ensuing year shall be elected, and the Reports of the Secretary and Treasurer read. At the Annual meeting, the retiring President shall deliver an address, reviewing the work of the Society for the past year, and suggesting lines along which work should be prosecuted during the coming year.

The exact place and date of the succeeding meeting, shall be determined by majority vote of the Members present at any one meeting.

Special meetings may be called by the Council ; and must be called upon the written request of twenty Members. This request must specify the object of the special meeting, and the place and date of the same.

The President may call a special meeting at any time.

At meetings of the Society, a majority of those registered in attendance shall constitute a quorum.

Five shall constitute a quorum of the Council.

ARTICLE VII.

PUBLICATION.

The serial publications of the Society shall be under the immediate control of the Council. Of these, or other publications of the Society, the Secretary shall be Editor. The price of the publications, to the general public, shall be fixed by the Council from time to time. Extra copies may be furnished to Members and Associates at cost.

ARTICLE VIII.

AMENDMENTS.

1. Amendments to the Constitution shall be proposed by five Members in writing. Such proposed amendments shall be submitted to the Members, for voting by letter-ballot, at time of sending out nominations for officers. Three-fourths of the Members voting being required for passage of any proposed amendment to the Constitution.

2. By-Laws may be made or amended by a majority vote of the Members present and voting at any Annual Meeting, provided that printed notices of the proposed by-law, or amendment thereto, shall have been given to all Members at least sixty days before the meeting.

BY-LAWS.

CHAPTER I.

OF MEMBERSHIP.

1. No person shall be accepted as a Member or Associate, unless he pay the dues for the year, within three months after notification of his election.

The Annual dues shall be $5,00 (five dollars) for a Member, and $3,00 for an Associate; payable on or before the Ist day of January in each year.

2. An arrearage at the time of the Annual Meeting, in payment of the Annual dues or assessments, shall deprive a Member of the privilege of voting for officers and of holding office, and shall deprive a Member, or an Associate, of the privilege of receiving the publications of the Society for the ensuing year.

An arrearage continuing over 2 (two) years, shall be construed as notification of withdrawal, and such person shall not again become eligible for election as Member or Associate, until all dues and assessments have been paid in full.

All persons joining the Society before the close of the Annual Meeting, Jan. 28th, 1891, shall be considered original members.

CHAPTER II.

1. The President shall countersign, if he approves, all duly authorized accounts and orders drawn on the Treasurer for the disbursement of money.

CHAPTER III.

I. Nominations for Members or Associates, may be proposed at any time, on blanks furnished by the Secretary.

2. The FORM for the nomination of Members or Associates, shall be as follows:

> In accordance with his request, we respectfully nominate for Member, or Associate, of The Alabama Industrial and Scientific Society,
>
> (Full Name) ....
>
> Address, ...
>
> Occupation, ...
>
> (Signed by) ....
>
> ....

The form, when filled, is to be transmitted to the Secretary.

3. The Secretary shall bring all nominations before the Council, at each of their meetings, and the Council shall signify their approval or disapproval of each.

If approved, the Council shall bring them before the Society, at its next meeting, for action.

CHAPTER IV.

OF FINANCIAL METHODS.

1. No pecuniary obligation shall be contracted without express sanction of the Society or of the Council. But it is to be understood, that all ordinary, incidental and running expenses, can be paid by the Treasurer without special warrant.

2. The creditor of the Society must present to the Treasurer a fully itemized bill, certified by the official authorizing it, and approved by the President.

The Treasurer shall then pay the bill, and the receipted bill shall be his voucher.

3. At each Annual Meeting the President shall appoint two members, not members of the Council, as a Committee to audit the books of the Secretary and Treasurer, which books shall be posted and balanced to the close of the 31st day of December.

The Auditors shall report to the Society before the close of the meeting, and appropriate action shall be taken.

CHAPTER V.

OF PUBLICATIONS.

1. The publications of the Society are in charge of the Council, and under its control.

2. One copy of each publication shall be sent to each Member and Associate, and each author shall receive 10 (ten) copies of his paper presented to the Society, when printed.

CHAPTER VI.

OF ORDER OF BUSINESS.

The Order of Business at all meetings, except the Annual Meeting, shall be as follows :

1. Call to order by the Presiding Officer.
2. Reading, correction, and adoption of Minutes of last Regular and all intervening Meetings.
3. Reports of Committees.
4. Report of Council.
5. Election of Members and Associates.
6. Unfinished Business.
7. New Business.
8. Presentation and Discussion of Papers.
9. Synopsis of Minutes.
10. Adjournment.

The Order of Business at the Annual Meeting, shall be :—

1. Call to order by the Presiding Officer.
2. Address of Retiring President.
3. Reading, correction, and adoption of Minutes of last Regular and all intervening Meetings.
4. Report of Committees.
5. Report of Council.
6. Election of Members and Associates.
7. Reports of Secretary and Treasurer, and appointing of Auditing Committee.
8. Unfinished Business.
9. New Business.
10. Presentation and Discussion of Papers.
11. Election of Officers for the ensuing year, and Induction of the new President.
12. Synopsis of Minutes.
13. Adjournment.

At an adjourned session, the order shall be resumed at the place reached on the previous adjournment, opportunity, however, being given for the transaction of new business.

PROCEEDINGS

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

VOLUME I. NUMBER 1.

1891

PROCEEDINGS

OF THE

ALABAMA

Industrial and Scientific Society.

VOLUME I. NUMBER 1.

PUBLISHED BY THE SOCIETY.

SECRETARY'S OFFICE,
UNIVERSITY P. O.,
ALABAMA.

TUSCALOOSA, ALABAMA.
1891.

PRESS OF MONT. I. BURTON.
TUSCALOOSA, ALA.

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UNIVERSITY MEETING.

DURING the months of October and November, 1890, the following circular letter (which will explain itself) was sent out to a number of gentlemen in the State of Alabama. The movement originated with William B. Phillips, Professor of Chemistry and Metallurgy in the University of Alabama, who, during the summer of 1890, wrote to Eugene A. Smith, State Geologist and Professor of Geology and Mineralogy in the University of Alabama, proposing the formation of a scientific society for the purpose of discussing various questions of interest to the material progress of the State. They then communicated with a number of other gentlemen in the State whose names are appended to the circular letter, and, believing from the replies received, that the time had come for such an enterprise, a motion was introduced into the Faculty Meeting at the University calling for the appointment of a Committee of the University to co-operate with those immediately concerned in issuing a call to meet at the University and organize the society. The letter was as follows:

"UNIVERSITY, ALABAMA, November 12, 1890.

MR ....

DEAR SIR:—Believing that the time has now come for organizing the civil and mining engineers, mine and furnace owners and managers, chemists, metallurgists, geologists, and all others interested in the material progress of the State into a society for the promotion of the scientific examination and discussion of practical, every day affairs, we earnestly request your presence at a meeting to be held at the University of Alabama on the 12th day of December, 1890, at 7:30 P. M. in the Chemical Lecture-room.

At this meeting the society will be formed and rules and regulations adopted for the effectual carrying out of the purposes above stated. From replies already to hand, we be-

The name proposed for the society was The Alabama Institute of Applied Sciences, but on motion of R. C. Jones this was changed to The Alabama Industrial and Scientific Society.

The following Committee on Constitution and By-Laws was appointed, viz :—E. A. Smith, Joseph Squire, M. C. Wilson, J. Reis. They reported that it was not advisable at this time to adopt a Constitution, but recommended that this duty be laid upon the Secretary, and that the Constitution and By-Laws thus proposed be sent to each member before the next meeting for criticism and amendment, and that at the next meeting the proper steps be taken in the matter. This recommendation was concurred in.

Brief speeches were then made by J. W. Burke, M. C. Wilson, J. H. Fitts, Joseph Squire, W. E. Robertson and J. Reis.

On motion of G. S. Patterson, the annual dues were placed at $5. In the Constitution this was afterwards changed so that members pay $5 and associates $3.

On motion, Birmingham was selected as the next place of meeting, and the 28th of January 1891 as the date.

On motion, the President was requested to prepare for the next meeting an Address on the Nature and Objects of the Society.

On motion, Joseph Squire was requested to prepare for the next meeting a paper on the new map of the Cahaba Coal Field, issued by the State Geological Survey, as he had been engaged for the past thirty years, at intervals,upon the work.

On motion, the thanks of the Society were tendered the Faculty of the University for their cordial interest in and support of the movement to effect an organization of the scientific men in the State, and for the use of the Chemical Lecture-room as a place of meeting. The Secretary was instructed to prepare and spread upon the minutes of this meeting a complete list of those present and taking part in the organization, as well as those who had expressed a desire to aid in the formation of the society, but who were unable to attend.

The list of those present and taking part has already been given. The additional list is as follows, excluding those already mentioned :—

P. D. Bowles, Attorney at Law, Evergreen.
J. W. Castleman, Furnace Manager, Furnace, Bibb Co.
Jas. L. Cowles, Birmingham,
R. H. Fitzhugh, C. E., Birmingham.
Phil. S. Fitzgerald, C. E., Gadsden.
D. W. Ford, C. E., City Engineer, Montgomery.
Prof. C. A. Grote, Southern University, Greensboro.
Lieut. Chester Harding, Willet's Point, N. Y. Harbor, N. Y.
Hugh Howard, M. E., Henry Ellen.
F. M. Hight, Anniston.
Robt. D. Johnston, Pres't B'gham Nat. Bank, Birmingham.
Jos. F. Johnston, Pres't Ala. National Bank, Birmingham.
J. A. Jardine, M. E., Middlesborough, Ky.
R. C. McCalla, Sr., C. E., Tuskaloosa.
Prof. Geo. W. Macon, Howard College, East Lake.
J. A. Montgomery, Pres't Mary Lee C. & I. Co., Birmingham.
Chas. Mohr, Mobile.
Albert E. Noble, Sup't Jenifer Iron Co., Jenifer.
Stephen N. Noble, Sup't Clifton Iron Co., Ironaton.
Jas. M. Reid, C. E., Chief of Construction, Royal Trans-African Ry., St. Paul de Loanda, Africa. Pilot Point, Texas.
B. Steiner, Banker, Birmingham.
Geo. D. Stonestreet, M. E., Birmingham.
Homer R. Stoughton, Sup't Shelby Iron Co., Shelby.
Fred. Sloss, Birmingham.
J. M. Searle, Mech. Eng., Grand Rivers, Ky.
Priestly Toulmin, M. E., Sloss I. and S. Co., Coalburg.
Goldsmith B. West, Gen'l Man. Tredegar Co., Jacksonville.
M. Wymond, C. E., Wymond.
Albert Woodburn, City Eng., Sheffield.

On motion, it was ordered that all who join the Society, by giving their names to the Secretary, before or at the Birmingham meeting in January, shall be considered as original members.

A list of the original members, together with those who joined at the Anniston meeting, will be found in the publication entitled "List of the Officers and Members of the Alabama Industrial and Scientific Society to and including the Anniston Meeting, April 8th and 9th, 1891."

There being no further business on hand, the Society was adjourned to meet in Birmingham January 28th, 1891.

ANNUAL MEETING.

BIRMINGHAM, January 28, 1891.

Pursuant to adjournment, the Society met at 10:30 o'clock A. M. in the Knights of Pythias Hall on 19th St. between 2nd and 3rd Avenues, the President in the Chair.

Forty members were present. The minutes of the University meeting were read and approved. The President, Cornelius Cadle, then delivered his address on The Nature and Objects of the Society. Mr. Cadle said:

GENTLEMEN OF THE ALABAMA INDUSTRIAL
AND SCIENTIFIC SOCIETY:—

The reason for the creation of this Society is found in the extraordinary development of the mineral region of our State, and in the fact that the association of scientific and practical men, for mutual help and interchange of experience, has always proved of great material advantage. We see this result in the work of the large organizations of this country, such as the Societies of the Mining, the Civil and the Mechanical Engineers, and kindred societies, whose work embraces a large scope of subjects as well as of country.

There are many circumstances in respect of geological conditions, qualities and peculiarities of ore and coal, conditions of labor, and other factors, entering into the problem of success in our State, differing in many ways from those of other States, and the object of this Society is to enable the scientific and practical men of our mineral district to meet and confer, and to convey to each other, and to all who care to listen to their reports and statements, the result of their experience and investigation.

The aim of the Society will be to include in its organization all men who can contribute in any way to, or be benefitted by the general or special information of their fellow-members in the line of the objects of the Society.

The Society will necessarily not be large or cumbersome, but it is confidently believed that it will be large enough for practical work, and its results of sufficient interest to make it a permanent and valuable aid to economical industry in this district.

Science is the handmaid of economy. The culmination of profitable industry is reached when its chords are harmonious with those of Seience. The time has passed when the "Rule of Thumb" can be profitably applied to industry. Competition has made necessary the application of improved methods in all branches of production. The elements of success in any new project of development must be determined through the experiments and knowledge of the geologist, the chemist, the mining, civil, and mechanical engineer, before such project can successfully become an industry. To the end that success may better attend our efforts, the men of science and the men of industry are here to-day.

The movements of the earth's crust in this region have brought in close proximity the necessary material for the making of iron. The work of the geologist has been to show where these materials lie, and of the chemist to give their elements and value. The civil engineer has traced upon the ground our lines of transportation, the mining engineer has shown us how to extract our ores and coal and limestone, and the mechanical engineer has devised for us the requisite machinery. The practical men of our State have, with these scientific aids, brought about an industrial success within the last fifteen years that is marvellous, and one that cannot be paralleled in any section of our country.

The statistics in regard to the progress of our development are interesting, but as they are published and accessible to all, I will not occupy the time of the Society with them.

The development has but started. The increase of production for the next fifteen years will be as remarkable as in the past, but more than an increase of production is required to give our section the success it is entitled to. Our iron must be transferred here from its crude condition into finished articles, whether they be pots and pans or rails and engines. This is a self-evident proposition and will soon be an accomplished fact.

In the last twenty-five years, we have paid England $320,-000,000 for tin-plate. At the present prices for tin-plate, we can manufacture it at a profit, provided the English plate is kept out of our market. This plate is made in Wales, where cheap female labor, costing from thirty to sixty cents a day, is largely used. We have been paying the English manufacturer a profit of about 300 per cent on the cost, and every time the American manufacturer has endeavored to produce it, the Englishman has lowered his prices, as he can well afford to do, and forced our manufacturers to suspend, and then he advances the price. Hereafter we shall make our own tin-plate without increase of cost to the consumer, and we shall use in its production each year 1,000,000 tons of iron ore, 300,000 tons of limestone, 2,000,000 tons of coal and coke, 5,500,000 pounds of lead, 15,000,000 pounds of tallow and oil, 12,000,000 feet of lumber: and we will give direct employment to 35,000 working people, to whom will be paid in wages $25,000,000.

Alabama stands third to-day on the list of iron producing States. She has every facility for standing third or higher in the list of tin-plate production.

The improvement in steel manufacture will enable us to become the steel making center of the union, if not of the world, and the phosphorized ores of Alabama will prove to be the best in the world for economical working. Sir Lowthian Bell, in 1884, said in reference to Alabama Iron Makers: "Give them a little time, and I see nothing to prevent their producing pig, as well as other forms of iron, as cheaply, perhaps more cheaply than it can be produced in most other known quarters of the globe." His prediction in regard to pig is accomplished; it remains for us to produce "the other forms of iron."

The labor question is one of great importance. How to deal with it so as to prevent strikes is a difficult problem. Our recent strike among the coal miners was brought about by a few men, ambitious to be called leaders, and anxious to secure such a state of affairs in Alabama as would enable them to live without labor. It was ostensibly based upon a demand for increased pay; it was actually a demand for recognition by the operators of the organization known as the "United Mine Workers of America," and as soon as it was shown by the publication of the pay-rolls of the large companies that the miners were earning larger wages than the miners of any other State, or any other trades in the State, the disguise of increased wages was thrown off by the leaders, and recognition openly demanded.

At the time the strike commenced not over ten per cent of the miners belonged to the "United Mine Workers." At all the principal mines the men were under contract to work at the present scale of prices until the first of next July. Patrick McBryde, of Columbus, Ohio, the Chief of the Organization, in published letters and speeches, advised the miners to break this contract, and at his instigation, with the aid of four or five professional agitators in Alabama, the strike was made, and many thousands of men were thrown out of work.

The spirit of the great mass of the men was not in the strike, but when the "United Mine Workers" ordered it, they all came out. Great suffering among the miners resulted, as well as heavy loss to the operators, railroads and manufacturers.

The operators could have ended the strike at any moment by recognizing Mr. McBryde and his co-agitators. But they had fully considered the result of such recognition and were a unit in refusing. They knew that such recognition meant that Mr. McBryde, from his home in Ohio, would practically manage their business; that the rules for operating their mines, the wages to be paid, the men whom they should or should not employ would be dictated by him and his committee, and that a similar state of affairs would exist among the mines of Alabama, as now exists in the States where the Order is recognized.

The strike was broken by bringing to some of the mines men who were willing to work regardless of the orders of Mr. McBryde and his associates. When the strikers found that such men could be procured, they returned to their work. And such men can always be procured in Alabama.

It has been heralded to the world through the labor papers that the miners of Alabama were treated as slaves, illy paid, badly treated, forced to buy their goods in Company stores at high prices, obliged to live in hovels, and to work in dangerous and unventilated mines. All these statements are false. Disaffection among the miners comes entirely from the insidious work of the agitators and demagogues, working for their personal aggrandizement. And this strike has opened the eyes of the great majority of the men, and these agitators, who a few weeks ago were received with cheers, are now vehemently denounced.

I was impressed by a remark made by Dr. Wedding, during the visit of our foreign friends last autumn. He said, "We, in Germany, who have poor ores, and poor fuel to contend with, would grow rich on your waste in Alabama. See the valuable gases, and by-products escaping from your coke ovens. From these we would make almost as much money as you make from your coke. We would take from the gases the ammonia and tar, and then utilize the gases in giving additional heat to the ovens, and in creating power. Waste is apparent on every hand." Here is a broad field for our chemists, our engineers, and our men of industry.

But, unfortunately for immediate progress in this direction, nature has been so prolific in its storage of easily accessible material, that the incentive for economy has not impressed us, and we go on, and will for some time, wasting from every coke oven sufficient gas to continously heat fifty square feet of boiler surface, the equivalent of say, four horse power. This is a waste, from the five thousand ovens burning in this State, of twenty thousand horse power.

The cokes of Alabama carry ten to twelve per cent of ash, and from three-fourth to one per cent of sulphur. By grinding and washing the coal, the ash can be reduced to three or four per cent, and the sulphur materially lessened. Iron makers can well afford to pay a higher price for coke so increased in heat material. The saving in transportion and in quantity used would more than balance the increased cost. To this point of improvement attention must be given. In such improvement lies profit to the iron master and the coke manufacturer.

Economical improvements, resulting in larger profits, may be applied to every branch of manufacture, and it is the province of this Society to encourage investigation of such improvements and their applicarion.

Mr. Blaine said in an interview published a day or two ago, "The necessities of the United States demand that this government construct and control the Nicaraguan Canal. During its construction it will draw largely on this country for the supplies, which will circulate very large sums of money in the United States, and when completed will open business for our commerce beyond the conception of conservative men, and make the United States the greatest ship marine nation on the globe." Mr. Blaine believes that while the Canal will add untold millions to the wealth of the nation and benefit the whole United States, it will also revolutionize the business of the Gulf States and enrich such cities as Birmingham, New Orleans, Pensacola, Mobile and Galveston, "South America" Mr Blaine says, "will become a great market for Southern iron, coal and timber." Alabama has already received benefit from the projected canal. Two large cargoes of Alabama coal have been shipped from Pensacola to Greytown for the Canal Company, and orders are in for more. It is probable that Alabama coal only will be used in the construction.

The export of coal from Alabama to foreign ports has already assumed respectable proportions. This business was commenced by the Export Coal Company of Pensacola about eighteen months ago, and since then 49,000 tons of Alabama coal have been shipped to Cuba, Costa Rica, Nicaragua and Mexico. This export trade is in its incipiency. When the Nicaraugan Canal is completed large coaling stations will be establised in the Gulf, and Alabama will stock them. Her contiguity will give her the advantage in this respect over other coal districts. To make this export business a quick success, return cargoes are essential. At present there is no sale in Pensacola or Mobile for the products of the Gulf countries. No merchants doing business in foreign products are yet established there. Therefore the coal carrying vessels are obliged to return in ballast. When markets are made in these ports for Cuban, Mexican and Central American products, Alabama can compete successfully with other States in shipping coal to Gulf ports, and when Congress places our shipping on equal footing with that of England through similar subsidies, we can drive English coal out of all South American ports. The prospective immensity of this business is worthy of consideration in calculating the future development of our mineral district.

The most valuable aid to our mineral development is our State Geological Survey. Professor Tuomey commenced this work in 1847. From 1857 to 1873 no work in this line was done. Then a small appropriation was made and the survey placed in charge of Dr. E. A. Smith, of the State University. His energy in the work of the survey as well as in placing its necessities before the legislature, has been untiring, and his valuable contributions to our information as to the Geology of the State speak for themselves. A magnificent map of the Cahaba Coal Field is now in the possession of the members of this Society through the labors of himself and Joseph Squire, Mining Engineer and Geologist. Mr. Squire has for thirty years been collecting data for this map and his report, and there is no acre of ground in the 500 square miles of the field with which he is not familiar. The Society at this session will have the pleasure of hearing from Mr. Squire, a description of the map.

In closing my remarks, I desire to say that the success of this Society will be in direct proportion to the interest taken by its members, and that by hearty co-operation and earnest work, it will not only be an aid to development, but a pleasure and satisfaction to each of us.

Joseph Squire, M. E., then read a paper descriptive of the new map of the Cahaba Coal Field, which, as it was not intended for publication, will not be found in the Proceedings. A handsomely mounted copy of the map had been presented to the Society by E. A. Smith, State Geologist, and was hung in the Hall. Mr. Squire's paper was discussed by Henry McCalley, of the State Geological Survey, from whose field notes much of the geology delineated had been worked out. Mr. Squire stated that for the past 30 years he had been collecting material for the map, on account of private persons, corporations and the Geological Survey, and that the map was issued by the Survey.

A. W. Haskell, Mining Engineer of the Cahaba Coal Mining Company, then read a paper on Mine Surveying. He spoke as follows:

MINE SURVEYING.

In this short article, I wish to call the attention of those engaged in mining operations, to the importance of mine surveying, in the proper prosecution of underground workings; and also to furnish a few directions, as to the manner of making surveys and of platting maps. As a matter of reference, one can readily appreciate the value of an accurately platted map, in its relation to boundaries, obstacles, and adjacent workings. It is often the case, that the growing scarcity of mineral, in an old established mining district, causes abandoned mines to be reopened, or new ones opened near by, to win that part of the seam not worked by the old mine. In a situation such as this, an accurate map of old workings is an absolute necessity. Any encroachment on the limits of an abandoned mine is dangerous, as old workings are always filled with water or noxious gases. In England where the depths of the earth have been honeycombed by centuries of mining, you will find records of the earliest workings carefully stored away for reference.

About one year ago, in Pennsylvania, there was a frightful loss of life and property, caused by breaking into the old workings of an abandoned mine. The old mine was full of water, and flooded the new workings before the men could escape.

Many instances could be cited; but it is not so much the importance of a map for reference, that I wish to call attention to. I wish to go further and urge the use of the map as a working drawing. Too much mine work is done in the dark, when we might have the light of the sun, and the light of brains to illumine the way to success.

The map of a mine should direct its extensions, not simply record its straggling courses. From the setting of the first set of timber, until abandonment of the mine, the surveyor's instrument should play a constant part. No heading or gangway should be started without its direction being fixed by lines. By lines, I mean, two points a short distance apart, fixing a course.

As the mine is opened out, let a plan of working be adopted and lines given; so that extensions will conform to plan. Owing to minor flexures in strata, and changes in direction of dip of seam, it is not always possible or expedient to enforce original plan in all of its details; but lines can be changed to suit, and in all cases, headings will be straighter and grades more uniform on haulage roads, than when left to the eye of the practical miner.

Main return airways, parallel with slope, can be kept straight only by lines. This is urgent, as friction of air is very materially lessened, and large steam pipes to pumping engines, usually being laid in return airways, do not have to be bent to conform to every crook and turn. Also in rooms, where nature of roof requires pillars to be left between working breasts, the direction of each must be fixed by lines. Otherwise, rooms break into each other, leaving thin weak pillars, which are insufficient to prevent local squeeze, and rooms are lost.

Maps should be made on scale of (100) one hundred feet to (1) one inch, and should show, in addition to the extent of underground workings, all water courses, boundary lines, outcrops of mineral, and all buildings and other structures, liable to be damaged by the removal of mineral underearth. No colors should be used on this working drawing, except a shade of blue to represent water courses.

Indicate the part from which mineral has been taken by a black shading of close parallel lines. Pillars remain white. When pillar is robbed, it is in turn shaded. Thus erasures are avoided in showing the later workings. The extent of working faces of headings should be shown as near as possible to date.

In making survey, let it be done with extra care, for mistakes are not so readily detected as in outdoor work, and the consequences of errors underground are generally more serious. Owing to iron rails, wire ropes, and electric wires, the magnetic needle is utterly unreliable; and there are few places in the mine where there is not some local attraction.

A light transit with extension legs, and level bubble on telescope, will serve both for taking angles and levels.

Plummet lamps being cumbersome I do not recommend. Ordinary plumb-bob, with lamp held behind string, suspended from point, is accurate and quicker. Use steel tape. The cloth and so-called metallic tapes will stretch and shrink.

Establishing a base line, for instance, the center line of a slope, take all angles on branch lines by continuous vernier readings. Continuous vernier readings lessen liability of errors and facilitate the platting of notes. In platting, use large paper protractor graduated and numbered as vernier plates on transit. Make zero line correspond with base line of survey. Thus direction of line by vernier notes is shown at once by corresponding degree on protractor.

Where possible, angle points in mine should be permanently fixed in top rock, so that survey line may be continued from last point, without re-surveying from base line.

Levels should be taken in various parts of mines, and should all refer to one fixed datum plane, thus giving relative elevation over the whole area worked. Levels are not to be neglected, for by them the knowledge of, and safety in working under water courses, buildings, etc., is known.

The extent, direction and elevation of the workings being brought to light upon the map, the Engineer or Superintendent can so modify his plans, as to conform with tolerable certainty to any changes in degree or direction of pitch ; and by study of map is assisted in projecting the most economical method of developing new workings.

Let managers take steps to collect and record certain information in regard to the mines, and rely less upon conjecture and the practical miner.

That there are fatal blunders made, is proven by the fact that many abandoned mines have been reopened and made to pay, and many a corporation saved by change of management.

William B. Phillips presented to the Society some notes on the Simon-Carves System of Coking, with Recovery of the Bye-Products. A synopsis of the chief points is as follows :

NOTES ON THE SIMON-CARVES SYSTEM OF COKING.

This system has been in operation since about 1878. According to a statement made in a pamphlet entitled "Simon-Carves Process for the manufacture of Coke and the collection of Bye-Products, Samuel A. Tuska, New York, October, 1890," it is now in use at the following places :—

France.—At St. Ettienne and Terrenoire.
At Besseges and Tamaris-Alais.

Spain.— At Bilbao by the Societe de "La Vizcaya."

England.—By the Messrs. Pease Partners, at Darlington.
Jos. Cliff & Co., Miklefield, Leeds, Yorkshire.
Altham Colliery Co., Accrington, Lancashire.
Dyson & Company, Dearpark, Durham.
Bignall-Hall's Colliery, Newcastle, Staffordshire.

Colliery Company, North Bitchburn, Durham.
Everswood Colliery Co., Low Hetton, Durham.

The advantages claimed for it are—

1. Greater yield of coke by 15 per cent.
2. Greater purity of coke.
3. A yield of about $0.98 worth of useful bye-products per ton of coke.
4. An almost entire absence of smoke and noxious vapors.
5. Reduced cost for repairs.

Its disadvantages seem to me to be—

1. Greatly increased cost of first construction. Each oven costs from $750 to $1000.
2. The necessity of disposing of the bye-products for economical working.
3. The liability of producing coke less suited for blast furnace use than ordinary bee-hive coke.
4. The risk of injuring the quality of the pig iron.
5. The severe competition with ordinary coke which must occur in the attempt to put this kind of coke on the market.

It must be said that experiments on a very large scale with bee-hive and Simon-Carves coke have not as yet given very satisfactory results. Sir I. Lowthian Bell, in the Journal of the Iron and Steel Institute, 1885, No. I., is quoted as deciding against the Simon-Carves coke, while Sir Bernard Samuelson, if he does not indeed uphold the use of it, still has a favorable opinion of it. The first named of these gentlemen experimented with some 5000 tons and the latter with some 2000 tons. They came to the same conclusion as regards the risk to the quality of the resulting pig iron and the increased consumption of coke necessary for a given out put.

Sir Lowthian Bell is inclined to base the value of the Simon-Carves System more on the use to which the bye-products can be put than to the use of the coke in the blast furnace. On the other hand Mr. Simon stated that at Besseges in 1883-84 the total consumption of coke was about 37,000 tons of Simon-Carves coke and about 6000 tons of Coppee coke. The Coppee coke was very inferior, containing 13 per cent of ash. But with a consumption of 43,000 tons of coke, the production of iron was 39,750 tons. This gives a consumption of Simon-

Carves coke of 2396 pounds per ton of metal. The quality of the metal was as follows :

No. 1 Bessemer - - -	31,000 tons.
Foundry pig - - - -	4850 tons.
White iron - - - - -	3900 tons.

This is certainly a good showing.

The increased yield of coke by this system is counterbalanced in large measure by the increased consumption needed in the furnace for the same out put of iron.

It would certainly be a most desirable thing to obtain for each ton of coke nearly one dollar's worth of bye-products, but this is by no means assured. If it were it would soon create as great a revolution in the coke trade as did the introduction of cupriferous pyrite into the sulphuric acid and fertilizer trades. From the great stress laid on the value of the bye-products, it would seem as if the system could best be judged by this one feature. Allowing that the coke is even 10 per cent inferior to bee-hive coke in the blast furnace, and that the quality of the pig may be somewhat lowered, although the evidence on this point is not conclusive, if from each ton of coke made one could obtain 98 cents worth of bye-products, our coke makers could well afford to take less for the coke and make up the difference in the bye-products. It is, however, just here that the largest element of doubt comes in. The value of the bye-products will depend almost entirely upon the kind of coal used in the ovens. Coals even from the same field vary quite widely in the amount of tar, gas and ammonia they yield. A variation of the half of one per cent in Nitrogen represents a variation of $1.40 per ton in Sulphate of Ammonia. Thus a coal giving one per cent of Nitrogen will give in Sulphate of Ammonia per ton $3.00, while a coal with the half of one per cent gives a value in the same salt of $1.60. A variation of the half of one per cent Nitrogen in Alabama coals is not uncommon. Some of our coals give as much as 1.73 per cent Nitrogen, while others yield only one per cent and even less. A coal giving 1.73 per cent Nitrogen gives as the theoretical yield of Sulphate of Ammonia per ton of coal (2000 pounds), 160 pounds, worth $5.20. Such a coal can be had in Alabama in any quantity, but there are other coals that give less than half of this value. The same may be said of tar and gas. If this system is ever to gain a foothold in Alabama, it will be after the most careful and painstaking investigation as to our local conditions. Mr. Simon himself has said "Practical experience must in each case determine what is best adapted to local requirements and conditions." Until the matter has been worked our for Alabama, our coke and blast furnace men will not care to look at it lovingly. In technical matters also is it true, "'Tis distance lends enchantment to the view."

J. H. Fitts, of Tuskaloosa, offered the following Resolutions, which were unanimously adopted:

"*Whereas*, In view of the great benefit to be derived from a more rapid geological survey of the State,

"*Be it resolved*, That the Alabama Industrial and Scientific Society, petition the Legislature of Alabama now in session to appropriate the sum of $30,000 for that purpose, $10,000 to be expended in 1891, $10,000 in 1892, and $10,000 in 1893, under the supervision of Dr. E. A. Smith, State Geologist.

"*Resolved*, That the President of this Society be requested to present this petition to the Legislature, and, in conjunction with other members of the Society, who may be in Montgomery, use the best efforts to secure the passage of a bill making this appropriation."

Mr. Fitts was requested by the President and the Society to co-operate in this matter.

The subject of the Constitution and By-Laws now came up for discussion. The Secretary reported that he had prepared and forwarded to each member of the Society a Constitution and set of By-Laws as provided for by motion at the University Meeting.

This proposed Constitution was then taken up, discussed, amended and revised, and the Secretary was instructed to cause it to be printed and a copy sent to each member of the Society. It will be found in the publication entitled, "Constitution and By-Laws of the Alabama Industrial and Scientific Society, adopted at its Annual Meeting, Birmingham, January 28, 1891."

Dinner intervening before the discussion of the Constitution was finished, the Society took a recess for two hours. It assembled again at 3 o'clock P. M., Vice President Robertson in the Chair, and was adjourned at 5 o'clock, to meet in Anniston, April 8th and 9th, 1891.

ANNISTON MEETING.

Anniston, April 8, 1891.

The council of the Society met at 10:30 A. M., in the Knights of Pythias Hall, on Noble street, between 10th and 11th streets. The following were present: President Cadle, Vice Presidents Harding and Robertson, Henry McCalley, Treasurer, and Wm. B. Phillips, Secretary.

After transacting such business as came before it, an account of which will appear in the Report of the Council to the Society, it adjourned to meet with the Society at 3 P. M.

At this hour the Society met. There were present, C. Cadle, H. Harding, W. E. Robertson, H. McCalley, B. F. Peacock, J. M. Reid, Walter Crafts, Wm. B. Phillips.

The minutes of the last meeting were read and approved.

The President reported that the Committee appointed at the last meeting, relative to the Geological Survey, had presented the petition to the legislature, but that this body had not seen fit to grant it. The amount appropriated by the legislature for the Geological Survey was $7,500 per annum, instead of $10,000. The report was received and the committee discharged.

The Secretary, on behalf of the Council, reported that the Council had met at 10:30 A. M. The following papers were presented to the Council, as required by Article IV., Section 5, of the Constitution, approved, ordered read before the Society and printed in the Proceedings, Vol. I., No. 1:—

The Road Movement—W. E. Robertson. C. E.

Natural Gas and Petroleum in North Alabama—H. McCalley, C. and M. E.

The Future of the Iron and Steel Industry of Alabama—B. F. Peacock.

Design for Lock Valves—Horace Harding, C. E.

The Ultimate Composition of some Alabama Coals—Wm. B. Phillips.

The Council recommended that hereafter any person desiring to present a paper to the Society, must file with the Secretary at least two weeks before the meeting at which the paper is to be read, an abstract of its contents containing at least 150 words. The Secretary must furnish each member with a complete list of the titles of papers represented by these abstracts at least one week before said meeting. No paper is to be presented to the Society, the title and abstract of which has not thus been filed with the Secretary, except by consent of a majority of the members present and voting at the meeting in question.

The Council also recommend that hereafter certain meetings be set aside for the discussion of special topics, without however excluding papers on other subjects, and that the next meeting be devoted to the subject of Coke.

The Council also recommended the following for membership in the Society :—

William Herbert, Mine Foreman, Coal City, Alabama.

John M. McKleroy, Pres. Anniston City Land Co.,and Gen'l Agent Ala. Mineral Land Co., Anniston, Ala.

H. Atkinson, Anniston.

R. L. McCalley, Agent Ala. Land Co., Anniston.

These were endorsed by W. E. Robertson and G.S.Patterson.

J. A. Wiggs, Philip and Wiggs Machinery Co., Birmigham.

Fred M. Jackson, Secretary and Treasurer Standard Coal Company, Brookwood, Alabama.

Endorsed by C. Cadle and William B. Phillips.

The report of the Council was accepted and all of its recommendations concurred in. The gentlemen recommended for membership were then unanimously elected.

The papers to be read were postponed until the evening session and by request Jas. M. Reid, C. E., Chief of Construction of the Trans-African Royal Railway,Loanda,Africa, a member of the Society, spoke of the nature of his work there and exhibited some very interesting specimens of wrought iron, cloth, pipes, tobacco, etc., of native manufacture. Mr. Reid was unable to present a regular paper to the

Society, and his remarks were not intended for publication. It is hoped that at some other time he will prepare a full account of his work for the Portugese Governnent in that part of the world.

He exhibited to the Society some very instructive cross sections and profiles, showing the method used in railway construction. The Society then adjourned to meet in the evening at 8 o'clock.

Evening Meeting, April 8th.

The Society was called to order by the President, and W. E. Robertson read a paper on

THE ROAD MOVEMENT.

The time in the history of Alabama has been reached when something broad and liberal must be done in respect to our roads and highways. If Alabama is to retain her position in the march of progress which she has so proudly achieved, it is imperative that this question should receive prompt and careful consideration, and the defects immediate remedy.

Everywhere there is a demand for better roads, and the press from Maine to Mexico, from the Atlantic to the Pacific Ocean, is agitating this most important question. Colleges and Technical Schools have taken up the matter; citizens in many portions of the country are offering prizes of no inconsiderable amount for information on construction and maintenance of public roads. It is manifesting itself in popular meetings of citizens, in technical societies and scientific periodicals, everywhere it is prevalent that our roads are a disgrace to our civilization and a serious impediment to our development; Alabama has joined her appeals with the rest, and the demand is for better roads.

Now is the time to cope with this gigantic question, for sooner or later it must be recognized, by the most indifferent, as a stumbling block in the path of progress, and a menace to the greatest and best interests of the commonwealth.

No State can grow as it should, with limited means of communication and transportation, for facility of communication is one of the most potent elements in promoting the general welfare. The sooner then this question is taken up and settled, the sooner will we move forward and the more rapidly will we move.

The reasons for better roads are manifold, and the benefit incalculable. Under our present system we have grown and developed and prospered, until now we wonder if there still be room for improvement. We have unearthed in our midst vast mineral wealth ; broad coal fields generously respond to our demands ; mammoth industries have sprung into existence, and ten thousand other developments have so engrossed us that we had, hitherto, no time to devote to the question before us. Is is now necessary ; development in other chanels is a confirmation of our needs, and with the establishment of every industry the need is increased the more.

The highway is daily expanding its mileage to meet the requirements of the locality, but it does in no wise receive either care or skill in its construction. The road of fifty years ago, undrained, ungraded and unimproved, is the road of to-day, in the same disgraceful condition.

It is not to be wondered at then that not only the farmers, but many of the railroads dependent on the common roads for their traffic as well as the manufactures needing prompt and constant supplies of raw materials and fuel, citizens of large communities, requiring cheap produce, have become alive to the necessity of improvement in this long neglected line of traffic.

Common roads, despite the almost unlimited utility of modern means of communication, remain the most important and effectual means of commerce, for they are the means by which the greater part of human intercourse is made possible.

In the United States, various and unavoidable circumstances have tended to retard the improvement of the common roads, so that the country, as a whole, remains less provided with such means of communication than other area of equal culture in the world.

The first steps toward the development of better roads resulted in toll roads, built by private corporations "Which acquired by their construction a perpetual right to embarrass the commerce of the country by a tax laid upon every vehicle which used their improvements." The advantages derived from readily passable ways are great despite the toll which may be levied on transportation. The effect of the turnpike system on the development of a community, is, on the whole, evil. In many instances the people have been compelled to accept this as a lesser evil of the two, solely on account of ignorance in the ordinary methods of road construction. The present system of working out tax has resulted in no good, and should be abolished for economic reasons, if for no other.

There can be no question of more importance which this State has before it, for solution,—a problem of far more menacing nature than is presented by the railway. Yet our authorities are untiring in their zeal to more thoroughly equalize the benefits accruing from this means of communication.

The first aim of legislation should be to promote and facilitate human intercourse. On this rests the fundamental principles of intelligence. How then can this end be obtained with more than one-half our population dependant almost wholly on common roads for communication and intercourse, and these roads at their best not productive of even ordinary results?

"The evil of poor roads, depending, as it does, on the lack of the proper engineering skill, as well as the indisposition to direct taxation, must be remedied in the main, by slow growth in public knowledge of road construction." Something however can be done through our colleges and universities, and particularly through our mechanical and agricultural schools, for from here will we get the earliest and most beneficial results.

It seems that public ways in general lie at the root of all economic development. Would it not then be greatly to the benefit of our road system if men were thoroughly well educated for the duty of road masters, and laws enacted requiring only such to be appointed?

The problems which present themselves to the road master are extremely varied and very often require mature experience. Careful consideration should be given to every detail in order that the whole may meet the requirements for which it is intended.

A road may be defined as "A device by which the energy of our larger domesticated animals is applied to the transportation of burdens on wheeled vehicles," as well as a means of communication, and an essential element to human intercourse. The considerations which should govern the location and construction of common roads are: 1st, "The present and prospective amount of traffic over the road; 2nd, Its general character, whether light or heavy; 3rd, The convenience and necessities of the community tributary to the line; and 4th, The natural features of the country through which the roads must pass."

Our roads, as they at present exist, take into consideration none of these conditions. In many places the road could be so changed, that not only would the distance be shortened and better grades secured, but such a change would result in better drainage, the condition of the surface would therefore be improved, and less land would be taken from the farmer.

Comparatively good roads, for at least six of the twelve months, could be obtained by giving more attention to the very important question of drainage of our present roads. In order to accomplish this drainage, side ditches, parallel to the axis of the road, must be cut. Care must be taken to give them such an inclination that they may promptly discharge their contents. The ditches should be sufficiently deep to insure a thorough drainage of the subsoil of the road to a depth of at least two feet below the crown.

There are circumstances to be considered where further precaution is necessary. I refer to roads over swamps and like places. To facilitate the drainage here, a system of cross drains must be used at intervals, calculated to produce the best results, cut ditches diagonally across the road bed, down to within a few inches of water level of side ditches, prepare these ditches with the necessary slope to one side, or both, for properly conveying the water, and in them construct the ordinary blind drain, or lay drain tile. If stone is convenient, a drain that will answer every purpose, may be constructed by simply casting in the stone in an irregular manner up to a foot or so of the surface; fill back the earth compactly, and if proper care has been exercised in this matter of drainage, the road bed will have been wonderfully improved. It is very essential too that roads of any material but sand should not be shaded, that the action of the sun and wind may hasten the drying process.

In sandy countries the problem is very much simplified. The aim here should be to have the roads as narrow as circumstances will admit; an abundant growth of vegetation is desirable, and the growth of trees should be encouraged as near the roadway as possible. Ditching beyond the depth necessary to carry away the occasional rainwater is not desirable, for it tends to hasten the drying out of the roadway, which is to be avoided. As long as the sandy soil contains sufficient water, the particles of sand, like bits of glass, are firmly held face to face, thus offering less resistance to traction than when in a dry state.

The most unsatisfactory material presented for the construction of roads is clay. It can be converted into acceptable roads only by a thorough and systematic process of drainage, so contrived that the least possible amount of moisture will be retained. Deep side ditches are absolutely necessary, and the narrower the roadway the more effectual will the drainage be. It has been suggested that gravel, or some other suitable binding material, incorporated with an equal amount of clay, will make a durable and satisfactory road covering, provided, however, that this material extends at least one foot below the surface of the road at the centre. Earth roads necessarily possess many defects at their best, but these defects should in some degree be compensated by having the grades as light as circumstances will admit of,—say not greater than one in twenty-five. The road surface should slope from the centre towards the sides not less than one in twenty, and the side ditches should be deep and capacious, with a fall of not less than one in one hundred. In repairing earth roads, materials composed largely of gravel and coarse sand, or small angular fragments of broken stone, free from sod, muck or other substance calculated to impair the surface, should be used. All ruts, cradle holes, etc., should be repaired as soon as formed. The custom of repairing our roads only once a year is decidedly in favor of bad roads, the costs of maintenance would be greatly reduced by frequent repairs.

When it becomes necessary to open up a way across any great stretch of marsh, other methods than those described, must be resorted to. The usual method is by what is known as the corduroy road, from its ribbed character. Though this means of communication is scarcely worthy of the name of road, it has its merits and is susceptible of considerable amelioration over the usual method of construction in this State.

The corduroy road is constructed by cutting logs, fifteen or sixteen feet in length, and laying those of uniform size side by side on the natural surface ; triangular pieces of the same length are split out and used to fill in the spaces between the logs. Upon the bed thus prepared, a layer of brushwood is placed with a few inches of soil or turf to keep it in place. The road is then ready for traffic with nothing to recommend it, save the accomplishment of an end almost unattainable by other methods both on account of the natural obstacles and an endless expense.

In communities where lumber is cheap and stone and gravel scarce and expensive, plank roads offer some advantages. The method of construction consists usually in laying down lengthwise on one side of a well graded and drained bed two parallel rows of stringers, spaced about five feet between centres, and upon these are spiked cross planks, four inches thick and eight or ten feet long, so arranged that their ends will not be on line, but form offsets every few feet to prevent the formation of ruts at the edge of the road and aid vehicles in regaining the plankway from the earth turnout.

New plank roads offer many advantages for heavy traffic and pleasure driving, but, owing to their short life, the benefits are not commensurate with the original cost, and great expense of maintenance. Common gravel roads, at least in most localities, will be found more durable, and, in the end, very much more economical. Particular care must be exercised in the selection of proper materials for a gravel road. Clean rounded gravel and water-worn pebbles will not pack, owing to their tendency to slide upon each other, and, therefore, should not be used as a road covering, unless suitable binding materials be used with it. Pit gravel that does not contain too much earthy material, answers the best purposes, and should be coarse, varying in size from half an inch to an inch and a half in largest dimensions, and should contain just sufficient clayey loam to thoroughly bind it together. A road of this material is made as follows : excavate the top soil of the roadway to a depth of ten or twelve inches, on top of the subgrade thus formed spread down a layer of four inches of the coarsest gravel in its natural state, roll this layer until it becomes fairly imbedded, then upon this bed spread another layer of three or four inches, using material somewhat finer and cleaner than the first, and roll as directed for the first layer. Successive layers follow each other until the surface of the road is made up to the required height, with a fall from the centre to each side of one foot in twenty. The top layer of gravel roads should be hard and tough,so that travel will not convert it into dust and mud, and if it is deficient in binding qualities, a thin layer of gravelly loam or clay should be spread over it and slightly moistened before the rolling is begun. In rolling always roll from the sides towards the centre, as this prevents the road covering from sliding out towards the sides, which would be the case were it rolled first from the centre. A road of this class, properly made and drained, possesses all the requisites of a good road.

We come now to the type of road which should under all circumstances be constructed where the conditions justify the outlay. It is generally supposed that the pike, or what is known as macadamized road is necessarily very expensive,and, indeed, the ordinary methods of construction, in a measure, justify this belief.

The first requisite to a macadamized road is location with reference to the best alignment and lightest grades. Were it possible, great advantages for metaled roads would be gained by having the subgrade in subsoil or hard pan, but since this is impossible, except in extraordinary cases, care must be had to so construct the road bed that it will offer the least possible resistance to the tendency of the covering to be forced downward.

If care has been exercised in the construction of the road bed, and drainage is ample and well regulated, nothing remains but to find suitable metal. It is not good practice or economical to cover more than one-third of the roadway with metal,except near large towns and cities, and this one-third is usually laid in the centre of the roadway, the remaining two-thirds, or wings, is constructed after the manner of gravel roads already describrd. The sensible teamster will prefer the wings, if properly kept repaired, at least six months out of the twelve.

No empirical rule can be laid down for kind and class of stone to be used, this, of course, will always be governed by local conditions. It is essential to the life of the road that the stone should be hard and offer great resistance to abrasion; however, it is far preferable to use stone of inferior quality rather than none at all. It is believed that limestone offers superior advantages to any other stone for this climate. The fragments should, in all cases, be of limy nature, as a process of natural cementation takes place, whereby the whole is rendered firm and unyielding.

On the road bed, prepared as directed, successive layers of stone fragments are placed, each layer being well rolled before it receives its successor, and the last layer (preferable the last two) being composed of small angular fragments of one and a half or two inches in its longest length, and rolled, not once or twice, but many times, always from the sides towards the centre. Care must be exercised in the selection of stone composing the first layer, and the interstices should be carefully filled in before rolling. The fragments composing each successive layer should gradually diminish in size towards the top to the dimensions required. Over the top layer, before rolling thorougly, fill in all the voids with the smallest fragments. If the stone has been broken by hand and a testing fork has been used to remove the fragments, quite a sufficiency of the smallest size will be found for treating the top layer. The depth of the macadamized portion of the road should under no circumstances be less than six inches in the centre. Engineers differ as to the most advantageous form of cross section of the surface of the road. It is recommended, however, that the form of the cross section of the road surface be two straight inclined planes connecting at the centre by an arc of a circle five or six feet long, with a radius of eighty to a hundred feet in length. This method seems to carry with it the weight of testimony.

In communities convenient to iron furnaces excellent roads may be constructed of slag or cinder. The method of construction is essentially the same just given for roads of broken stone. The depth of metal, however, should be somewhat greater, owing to its extreme brittleness. The top layer should receive a thin coating of sandy loam, or roasted ore screenings. This is spread on and sprinkled, after which a thorough rolling finishes the road. A more beautiful and pleasing way could not be devised, yet the brittleness and glassy nature of the metal renders frequent repairs necessary, but such repairs can be accomplished rapidly and cheaply.

It is customary to prepare road metal by the slow process of hand breaking and the great cost of macadamized roads is in a large measure due to this fact. Portable stone crushers, operated by horse power, can be obtained at moderate cost, and a contrivance of this kind will prepare more metal in a day than will one hundred men by the usual method. It is also customary to trust to the chance action of traffic to compact the road covering, and after a great deal wear and tear of wagon wheels and horses feet it is fairly imbedded, but never so effectually as when properly done at first by means of a cylindrical roller of four to six tons, which can be loaded up to ten, or even twelve tons.

The ease and facility with which suitable road metal can be procured in this State leads me to estimate that high class of roads can be constructed at a cost not exceeding two thousand dollars a mile. Assuming then that a single mile of roadway renders service to a strip of country, on either side of it, two miles back, it would result in a cost of but seventy-eight cents an acre for the area served, and it is presumed that if the land is worth anything to begin with, it must at once be enhanced at least the cost of this improvement.

There are other considerations calculable within slightly varying limits, and entering directly into the discussion before us, which will be considered entirely on a basis of dollars and cents, leaving out of the discussion altogether the justly recognizable views of the humanitarian.

The following calculations are based on M. Morir's experiments :—

We will assume that it requires fifty horses, twenty-five wagons, and twenty-five drivers to conduct a given traffic over a hard, smooth macadamized road between two points ten miles apart, making a round trip a day of twenty miles, which is supposed to be a fair average day's work the year round. An annual allowance of two hundred dollars for purchase, care and feed of each animal, and purchase and repair of harness and vehicle, which is very much below what the actual cost would be, amounts to ten thousand dollars. The hire of twenty-five drivers at one dollar a day amounts to seven thousand two hundred dollars a year. The aggregate, representing an essential outlay amounts to seventeen thousand two hundred dollars a year. We will suppose, now, instead of the ten miles of macadamized road, we have a common earth road, in fair condition, with the same amount of traffic to be conducted. Experiment has repeatedly demonstrated that if fifty horses, with twenty-five wagons and twenty-five drivers, can conduct a given traffic over a hard, smooth macadamized road, connecting two points ten miles apart, it will require, to conduct the same traffic the same distance over a common earth road, in fair condition, ninety-two horses, forty-six wagons and forty-six drivers. Putting the cost of men and animals the same as before, it would cost to conduct the same traffic over the same length of ordinary earth road, in fair condition, thirty-one thousand six hundred and forty-eight dollars per year, or an excess of fourteen thousand four hundred and forty-eight dollars, equal to eighty-four per cent in favor of macadamized roads. This, you will observe, takes into consideration an earth road far above the average road of the State. Now, then, if the excess for every twenty miles of traffic is equal to fourteen thousand four hundred and forty-eight dollars a year, and placing the road mileage of the State at twenty thousand miles, which is believed to be less than it actually is, we find the total difference for the State to be fourteen million four hundred and forty-eight thousand dollars a year, a result very astonishing but practically true for the conditions set forth at the outset.

The conditions, however, governing the ten mile road are such that certain modifications are necessary before they can be accepted as covering the road mileage of the State. The conditions of the ten mile road assume that it will require a certain number of horses, etc., working the entire year, Sunday excepted, to conduct a given amount of traffic. It can readily be seen that the condition as to time will not apply, for it is evident that all the traffic of the State, the present means of transportation to be used, can be disposed of in a very much shorter period than a year—it may possible be done in two months, we will suppose that it can,—we have then an excess of two million four hundred and eight thousand dollars a year, which is one-sixth of the excess, under the previous calculation. In other words, the excess annually, due directly to lack of intelligence and skill in road construction, is about three times the entire amount of the road tax of the State, and sustained almost entirely by the farmers. The enormous sum wasted annually by those least able to afford it is a potent argument in favor of high class roads, and demonstrates the necessity of maintaining our public highways in excellent condition from motives of economy. If our farmer friends, upon whom the burden rests so heavily and who are the bitterest opponents to any tampering with the road law, could be brought to understand and appreciate the necessity of prompt and liberal action in this matter, great and substantial good would result from their wisdom. It is not considered fairly within the scope of this paper to offer suggestions as the best means to an end so important and desirable as good roads. It seems to me, however, that if the office of State Engineer, or Road Commissioner, was created, and an active, intelligent and experienced man placed in charge, with sufficient means at his disposal to thoroughly prosecute the study of this problem as it is presented in this State, beneficial results would inevitably follow. He should cause to be made maps, showing all the roads in the State, which should be classified according to their excellence.

From time to time bulletins should be issued by him treating of the road construction and maintenance in minute detail. The County Commissioners should file with him statements, at intervals, of the condition of all the roads within their jurisdiction, setting forth such points on which information would be valuable.

It is further believed that County Commissioners should not grant any application for the opening of a new road, unless application be accompanied by a map of the alignment, profiles and estimates of the cost, furnished by a competent engineer. The cost of such surveys, maps, etc., are to be borne by the petitioner, and maps, profiles, and estimates to become the property of the Commissioners Court, duplicates of same to be fited with the State Engineer. The benefits of such an arrangement are obvious and need no discussion.

There is nothing before the people of Alabama to-day of so great importance as a propor solution of this vexed problem, involving, as it does, not only the welfare of the farmer, but the welfare of every citizen of the State. The industrial and scientific interests of the State are at stake, and we as members of an organization to foster, encourage and promote their cause, should not be idle. Let us then take some action, earnest and united, to secure the accomplishment of that end so essential and beneficial.

It has been my pleasure to visit and study, in this and in other countries some of the greatest roads man can devise, and from observation I am convinced that in the improvement of our common roads the requirements of civilization are but being fulfilled. Knowledge will soon be broadcast and become the property of the many; society will take a strike upward; new hope and new life will be infused into every bone and sinew of our commonwealth, and the inevitable end of peace and prosperity will be our heritage.

The paper was discussed by Henry McCalley, F. M. Jackson, Horace Harding, and R. L. McCalley.

The Society at this time received an invitation from the United States Rolling Stock Company, through B. F. Peacock, Superintendent of the Forge Department, to visit the works the next morning at 9 o'clock. The invitation was accepted and the Secretary instructed to return a suitable acknowledgement of the courtesy.

The Society then adjourned to meet April 9th, at 10:30 A.M.

APRIL 9TH, BETWEEN 9 AND 10 :30 O'CLOCK A. M.

The Society visited the works of the United States Rolling Stock Company, and at 10 :30 reassembled for the transaction of business.

Henry McCalley, C. and M. E., read a paper on

NATURAL GAS AND PETROLEUM IN NORTH ALABAMA.

* A GENERAL REVIEW OF THEM WITH AN ACCOUNT OF THEIR OCCURRENCE IN ALABAMA.

As there has been for some months past considerable excitement in portions of Northern Alabama over the finding of natural gas and petroleum in those sections, and as many inquiries have come not only from those, but also from other sections of the State for information on these subjects, it will not be out of place to give here a general review of these subjects as gathered from the best and latest authorities, and an account of their occurrence in Alabama. Natural gas and petroleum are respectively the gaseous and liquid forms of bitumen. They are closely related to each other, and there is but little doubt but that they have the same origin. They have most likely been derived from organic matter or from vegetable and organic remains, but in what way no one can say for certain. It is most probable that petroleum was the first product, as it is more composite and unstable and is seemingly less removed from the organic world, and can be made to give rise by destructive distillation to marsh gas, which is the principal ingredient of natural gas. The gas and oil that are indigenous to limestones are, doubtless, in the most of cases, of animal origin, while those that come from shades are most likely of vegetable origin. They are so intimately related to each other that every oil field is more or less a gas field, and there are but few gas wells that do not yield more or less oil. Wherever one is found, the other is most likely to occur in greater or less

* Principal authories studied :—Reports of Geological Surveys of Ohio and Pennsylvania, and Report, by Prof. S. F. Peckham, on Petroleum for the Tenth Census.

quantities. They occur in nearly all parts of the world, and in almost every State in the Union, but in comparatively few localities in sufficient quantities to be of commercial value. They impregnate porous rock, and most commonly make their appearance in springs and in wells drilled for them. In this country, the only States that are known as yet to have them in commercial quantities, are New York, Pennsylvania, Ohio and West Virginia, though there are several other States in which the prospects are good of finding them in large quantities.

These substances are as widely distributed geologically as they are geographically, and may be said to be absent from only the crystalline or eruptive rocks, or from those rocks that have in them no remains of vegetable or animal life. Prof. C. H. Hitchcock, in 1867, enumerated fourteen different geological formations in which they occur in North America. In most of these formations, they occur in commercial quantities, but in some of them they are in such small quantities as to be of only scientific interest. Their principal occurrence in this country are in five formations: the Devonian and Upper Silurian of New York; the Carboniferous, Sub-carboniferous and Devonian of Pennsylvania; the Carboniferous, Sub-carboniferous and Lower Sllurian of Ohio; and the Carboniferous and Sub-carboniferous of West Virginia. The great bulk, however, at present comes from the Sub-Carboniferous rocks of Pennsylvania and the Trenton or Lower Silurian (rocks) of Ohio; the present most productive gas rocks being the Sub-carboniferous sandstones of Pennsylvania, and the present most productive oil rocks, the Trenton limestones of Ohio.

The gas and oil rocks of New York, Pennsylvania, and West Virginia are not less than six different strata of sandstones, of very unequal productive values, that are distributed through several thousand feet of Devonian, Sub-carboniferous and Carboniferous strata of these respective States. The gas and oil rocks of Ohio are several seams of interstratified dolomites in the Trenton limestones. The uppermost of these seams of dolomite sometimes caps the Trenton rocks, but it is most commonly covered by a very hard and very fossiliferous ordinary Trention limestone from one to ten feet in thickness. The lowest dolomitic seam is usually the most productive, and has never been seen more than 100 feet below the top of the Trenton. The gas and oil producing rocks are non-continuous with their geological formations, and so have their geographical, as well as their geological limits, which, however, are constantly being widened by the prospector's drill. They are known as *gas* and *oil sands*, which names are applied to porous rocks of any chemical composition that act as reservoirs for the stored gas and oil. They are coarse grained conglomerates, sandstones, dolomites, highly fossiliferous limestones and slaty shales. There may be a dozen or more of these *sands* or gas and oil horizons under any one locality, and no one can tell anything for certain as to their number or productiveness until they have been tested by the drill. One of these *sands* may have in it only water, another only gas, another only oil, another a mixture of any two, and another a mixture of all three, and still they may be separated from each other by only a few feet of strata. This intervening strata would, however, have to be of a very impervious nature.

To be of any economical value, gas and oil must be in large accumulations. These large accumulations do not happen by hap-hazard, but are dependent upon the existence of certain geological features. They must have a certain mechanical arrangement and order of their strata. They must have an impervious cover to prevent their escape, they must have a pervious or porous reservoir to store them away, they must have a very fossiliferous source and they must have a decided change in the regular dip of their strata. The impervious cover is the most essential and usually the hardest to find or scarcest of all these requisites. These covers, however, often do their work most effectually, as frequently, in drilling, no traces of gas or oil are found in them, but in large quantities immediately on getting through them. They are formed by fine grained compact rocks; the best covers being of clayey shales. The pervious reservoir is a porous rock, and may be either a sandstone, a conglomerate, a dolomite, a highly fossiliferous limestone, or a slaty shale. The coarser the grain or the more porous the rock, the better. The source has be a very highly fossiliferous rock, and is commonly a limestone or shale. The decided change in the regular dip of the strata must convert them either into a gentle arch or anticline, or a bench or terrace which is nothing more than a suppressed arch or anticline.

The vast accumulations of gas and oil of Pennsylvania, New York and West Virginia, are strictly confined to anticlinals, while those of Ohio are along terraces or suppressed anticlinals. Small accumulations of gas and oil however do not necessarily conform to this structural arrangement. The gas and oil rocks, or the porous reservoirs, do not always carry accumulations of gas and oil even under the above conditions, but the most of them do, however, in some parts of their extent, at least, have in them more or less of these substances. They are never empty, and when not filled with gas or oil, or both, they have in them water, which is most commonly the case. The water is most commonly fresh, if within 400 to 500 feet of the surface. The porosity of the reservoirs often extend for great distances in lateral directions, as wells separated by half to three-fourths of a mile are known in certain instances to affect each other in flow and pressure, and sometimes a single well will drain, so it is said, an area of several consecutive square miles. There are several theories as to the pressure of gas and the rise of oil in wells, but the one that seems to apply to them best is the Artesian theory, which is that they are due to a water head of a greater or less elevation at a greater or less distance. The artesian principle does not however apparently apply to feeble *shale gas* and *oil*, orto wells of low pressure; nor do the amount of gas and oil of these low pressure wells seem to depend upon the above structural arrangements of the strata. When gas, oil and water are found in the same *sand*, from a well known hydrostatic law, or from the differences in their specific gravities, the gas is always found at the highest level of the productive *sand*, the oil under it or at a somewhat lower level,and then, at a still lower level, at the bottom, is the water. Every gas and oil field is said to have a margin of water, generally more or less saline, that surrounds it in whole or in part, and the influx of this salt water is one of the most common evidences of total failure in wells drilled for gas and oil. The appearance of salt water in the *sands* of the Trenton limestones is not, however, looked upon with such suspicion or disfavor, but rather as an advantage in keeping the *sands* in better condition, provided it does not come in too great quantities or in more than a few barrels per day. With the exhaustion of a field, the gas and oil are followed up, and finally replaced in the *sands* by salt water. The last end of a *gas sand*, as such, is most generally an *oil sand*, and then a *water sand*; and the last end of an *oil sand*, as such, is a *water sand*.

Gas and oil are strictly stored powers, and every square foot of them taken from the reservoir leaves the amount remaining that much the less. In other words, as has been said, a gas or oil well begins to die the moment it begins to live. If they were inexhaustible, they would have to draw from inexhaustible sources, and it is known that all *gas* and *oil sands* are of only medium thickness, and are restricted geographically as well as geologically. No gas nor oil well can therefore be inexhaustible. It is said that the longest life of the best American oil fields has never as yet attained a score of years.

Natural gas and petroleum have various practical applications, and have added much to the industrial development of the world and to the prosperity, health, comfort and happiness of its people. Though natural gas has been used for heating and illuminating purposes for more than half a century, it has only been within the last ten or twelve years that its high value as a fuel has been appreciated. It is the perfect type of fuel, and has opened up a new era in the development of heat and mechanical powers. Its practical use in various ways has given an object lesson of the great advantages of gas as a fuel, and has demonstrated that gas of some kind is to be in large cities the fuel of the future. If natural gas cannot be gotten, a fuel gas will be manufactured. Gas as a fuel is, perhaps, most valuable and available in domestic use and in the production of steam. It gives no soot or dust, and adds so much to the comfort of those using it, that it is said no one will ever give it up who has once used it. Its use is an economy, for it is a well known fact that, in ordinary uses of coal for fuel, there is a loss of from 75 to 90 per cent of the heat units that might possibly be made available. It is even said that, if the coal now burnt in large cities was converted into gas and this gas used for heating purposes, there would be a great saving in fuel, to say nothing of the incidental advantages that it would afford.

Natural gas, owing to its low specific gravity, being but little over one-half the weight of air, and its extreme tenuity is hard to confine, and, being odorless, it is hard to detect. It is, however, under the same conditions less dangerous than coal gas, as the range of its explosibility is greater, and as the resulting explosion is less violent, and as it requires a higher degree of heat to fire it. It requires for complete combustion about ten times its volume of air.

Natural gas and petroleum consist principally of hydrogen and carbon, and hence they are called hydro-carbons. The carbon increases with the density. They are of many varieties, and differ sometimes not only with different localities, but with different wells in the same locality, and even with different horizons in the same well. Natural gas burns with a clear white flame, if unaccompanied by petroleum; but, if petroleum is present, it has a red and smoky flame. It contains from 15 to 95 per cent of marsh gas (CH_4), and from 5 to 85 per cent of other hydro-carbons.

Crude petroleum is of yellow, green, amber and black colors. Its value is usually determined by the amount of distillates that are available for illuminating purposes, and varies with its density, the heavier oils being the more valuable. Though made up principally of carbon and hydrogen, it has also very small per centages, in some instances, of nitrogen and sulphur, and perhaps oxygen. The presence of sulphur gives the disagreeable odor that some of them have.

In Northern Alabama there are many springs that yield natural gas and petroleum, but in no known case of sufficient quantity to be of any other than scientific interest. These springs occur in the out-crops of the Carboniferous, Sub-carboniferous, Devonian and Lower Silurian formations.

There are also scattered over Northern Alabama, in the outcroppings of the Carboniferous and Sub-carboniferous formations, *tar springs*, from which there exudes *maltha* or semi-liquid bitumen. This maltha on exposure to the air hardens into the solid form of bitumen known as *asphaltum*, when it resembles the hard, stiff tar that sticks to an old wagon hub.

Around these tar springs the rocks are usually very bitumenous, and most commonly show in them the maltha in their streaks and seams, and in geodes and in their interstices. In these rocks, there were several wells drilled years ago in search of petroleum, but with what results it is very hard to say, as the information concerning them is very fragmentary and uncertain. Prof. S. F. Peckham, in his special report on petroleum for the tenth census, says that Jonathan Watson, Esq., of Titusville, Ind., drilled wells in Alabama in 1865, and got oil in two of them. The tar springs and highly bitumenous rocks of Alabama are most abundant in the crinoidal limestones of the upper part of the Sub-carboniferous strata of the Moulton Valley. The best known of these tar springs are, however, just outside of Moulton Valley; they are two on Cap's Creek, in S. 26, T. 8, R. 6 W. These springs years ago were places of resort for the afflicted, who drank the water and swallowed pills of maltha, and believed that they were greatly benefitted thereby. These two springs are to the south of the high divide of Coal Measures that bounds Moulton Valley on the south, and hence they are surrounded by Coal Measures. They are on the south bank of the creek which has cut down through the Coal Measures about 50 feet, and then down into the Sub-carboniferous strata about 50 feet more. They are in the out-crops of a very highly fossiliferous, coarse grain siliceous, crinoidal limestone that has a cover of reddish and greenish argillaceous shales. Both of these springs have been spoilt by digging and blasting into them. They are about one-fourth of a mile apart. The one highest up the creek has been drifted into a distance, so said, of some 90 feet. The mouth of the drift, however, has been stopped up by a slide. Several barrels of maltha are said to have been collected in pools in this drift, though most likely the prospects didn't improve as the drift was extended. On the out-crop, the maltha has hardened, and occurs as thin sheets in all the seams of the crinoidal limestone. This limestone is also full of iron pyrites. Near the lower spring, but between the two, is a standard well that is said to have been drilled for oil to a depth of 600 to 700 feet. It is most probably one of the wells that was drilled by Jonathan Watson, Esq., in 1865. Lower down in the Sub-carboniferous strata, as seen in the Moulton Valley, are other beds or ledges of these highly fossiliferous, coarse grain, crinoidal limestones, that are so highly bitumenous as to blaze up when thrown into the fire, and from which petroleum can be driven out by heat or distillation. From an out-cropping of these limestones about one and a half miles northeast of Mount Hope, the petroleum has been distilled out by breaking up the rocks into small fragments and filling up a common wash pot with them and then inverting the pot and building a fire on top of it. When fresh broken, some of the rocks of this locality emit a very disagreeable petroleum smell, and are even so bitumenous as to be moist in streaks along which is to be seen the oil in drops. These rocks are colored a dark gray by the bitumenous matter in them, and on the exposed out-crops have on them black streaks and splotches of hardened maltha or asphaltum. They are a mere mass of fossils, principally crinoidal stems with some few bivalve shells. A company formed at Mount Hope will bore a well near this out-cropping.

Still lower down in the Sub-carboniferous strata is the ledge of massive sandstones, locally known as the LaGrange sandstone, that caps the Little Mountain. This sandstone in places, as around Hartselle, is highly bitumenous or impregnated with oil. It and the crinoidal limestone, since the oil excitement in the Moulton Valley are used to boom the oil prospects of the country, by throwing pieces of them into the fire to see them blaze and to drive out the oil so that it can be seen. These oily rocks, together with the tar springs of the valley, have led, within the last twelve months, to the formation of several oil companies and the proposed sinking of some half dozen or more standard gauge test wells in the Moulton Valley. One of these wells has already been drilled, and two or three are now under way. The well already drilled, the Goyer Well No. 1, in the n. w. corner of s. w. $\frac{1}{4}$ of s. e. $\frac{1}{4}$ of section 29, township 7, range 6 west, when visited March 10, 1891, had reached a depth of 1820 feet, and the intention was to extend it down to a depth of 2000 feet. In this well there was struck the first gas at the top of the LaGrange sandstone, at a depth of 335 feet; the second gas and strong salt water, in lower Sub-carboniferous strata, at respectively 500 and 501 feet; the first oil, in small quantity, at the top of the Trenton, at 1355 feet, and the second oil, a good dark green oil with a pleasant odor, in the Trenton limestones, at 1509 feet. The first gas is said to have had a very good pressure, and to have burnt with a flame five feet high at the open end of a pipe with a six inch internal diameter. The second gas is said to have been free from sulphuretted hydrogen, and to have had pressure enough to blow aside a hat held over the open six inch pipe. The first and second gas together were estimated by Dr. McRae, the geologist in charge, at 20,000 cubic feet per day. The second oil, on striking it, is said to have risen in the well to a height of about 200 feet. Some eight barrels of this oil was pumped out, so said, and from the distance the oil was lowered in the well by this amount, the well was computed, by Dr. McRae,at about a 25 barrel (per day) well. The salt water on evaporation gave a fine well flavored table salt. After pumping out the eight barrels of oil, a wooden plug is said to have been placed down in the well, and then the well was left alone for several weeks, until some lands could be bought or optioned. On re-commencing work, the oil was found to have been drowned out by the salt water. This misfortune is supposed to have been due to a split in the wooden sopper, made in the driving it in.

The chemist of the Mansfield Drug Company, St. Louis, has made an analysis of this oil with the following results :—

Specific gravity, - - - - -	0.831
Rhigoline, Benzine, gasoline, etc., light oils	16%
Illuminating oil, 15 per cent test, - -	22 "
Lubricating oil, - - - - -	12 "

Residue : contains vasaline, paraffine, and heavy oils.

The *second oil sand* from which the above oil came is believed to be some 300 feet down in the Trenton limestones, or some 200 feet lower, geologically speaking, than any known productive oil sand of this country. The well, however, is being continued on to a depth of 2000 feet in the hopes that a *third oil sand* will be found.

The Goyer Well No. 2 is about one and a half miles to the northwest of Well No. 1 ; at the time visited, March 11, 1891, the derrick of Well No. 2 was completed, and the drilling is doubtless now under way. A Mount Hope company has made a contract, and are now getting ready to drill several wells in that vicinity. A Mr. Young is now having a well drilled several miles southwest of Hartselle. About one mile north of Hartselle just to the east of the L. and N. R. R., at the old site of Hartselle, there is a well that is said to have been drilled in 1887 for gas to furnish Decatur. It is commenced just under the LaGrange sandstone, and, from the non-continuous samples preserved of the drillings, appears to have extended down through the Trenton limestones to near 100 feet into the underlying Knox Dolomite. In it, there was struck, as reported, permanent water at 30 feet; sulphur water at 160 feet; brackish water at 352 feet; the first gas, just over the *Black Shale*, at 602 feet; the second gas, in the upper part of the Trenton, at 1094 feet; petroleum, very black, in Trenton limestones, at 1500 feet; and salt water, in Knox Dolomite, at the bottom of the well, 1730 feet. The first gas struck is said to have burnt from the open end of a two inch pipe with a flame five feet high. This oil is entirely different from that found in the Goyer Well, it is black and much more odorous. It appears to be nearly 600 feet down in the Trenton limestones or some 250 feet lower than the oil or *second oil sand* of the Goyer Well, and hence 500 feet lower, geologically speaking, than any known productive *oil sand*. This *black oil sand*, it is believed, ought to have been struck in the Goyer Well at about 1800 feet. The oils of the above wells, from the limestones, are believed to have no connection whatever with the oily and bitumenous matter of the surface rocks and tar springs of the Moulton Valley.

There are several other bored or drilled wells in this valley. They are old wells, and it cannot be said to what depth they extended or what was found in them. One of these wells, called the *Salt Well*, occurs at the tar spring about five miles northeast of Danville; another, the Terry Well, some four miles south of Courtland, and another, the Curtis Well, some six miles southwest of Decatur. The tar springs of the Ganges Cove, at the foot of the mountain in the s. e. ¼ of s. e. ¼ of sec. 10, township 8, range 3 west, is in the bottom of a ditch. The maltha, or mineral tar, exudes from between slabs of a dark gray, cherty looking limestone. From this spring, there was dug out crystals of calcite that were held together by maltha. This spring occurs in rocks of about the same geological horizon as the tar springs on Caps's Creek. The asphalt from the tar spring near Priceville, four miles northeast of Hartselle, has the following composition, as analyzed by Dr. Wm. Gessner :—

Specific gravity, - - - - - -	1,715
Moisture, at 110 deg., - - - -	1,374 %
Napthine, - - - - - -	3,144 "
Kerosene or Lamp Oil, - - -	25,479 "
Heavy or Lubricating Oils, - - -	53,122 "
Paraffine, - - - - - - -	4,237 "
Coke, - - - - - - -	12,644 "
Sulphur, - - - - - - -	trace.
	100,000

At New Market, in the northeastern part of Madison County, there was bored, with a diamond drill, in 1890, a hole 1077 feet in depth. It commences in the bottom part of the Sub-carboniferous strata, or about 55 feet above the Black Shale, and extends down over 600 feet into the Trenton limestones. In this hole there was struck permanent water at 22 feet and sulphur water at 118 feet and at 700 feet. The rocks from 190 to 700 feet are said to have been more or less impregnated with petroleum, and in the upper part of the Trenton, at 500 feet, smelt very strongly of petroleum. No gas or salt water was reported as occurring in this well. In the hole, two inches in diameter, there has been inserted a pipe through which the sulphur water rises to the surface, and is used by the inhabitants of the village.

A few miles to the southwest of New Market, in Flint River, near the Bell Factory, there was noticed some years ago gas bubbling up through the water from a crack or seam in the rocks.

About ten miles southwest of Guntersville, in an out-cropping of Knox Dolomite, the upper part of it, there are a great many beautiful quartz crystals, and in many of these crystals are inclosed small globules of a bright honey colored oil. In the out-croppings of these rocks, a well, the Smith Well, was bored, so said, to a depth of 1000 feet, but with what result is not known. Doubtless nothing of importance was found in this well, as these rocks are somewhat broken up and are much lower, geologically speaking, than any known productive gas or oil rocks.

In the Trenton limestones of the quarry at Gate City, near Birmingham, there is said to have been found geodes that have in them as much as a half pint or more of oil. The oils in the above quartz crystals and in these geodes, without a doubt, originated in the rocks in which they were found.

At the base of the Knox Dolomite, a few miles southwest of Ashville, St. Clair County, is a group of several springs that have over them a thick scum of petroleum. Such springs as these are common in Northern Alabama, especially in out-croppings of the Devonian rocks, or Black, Shale and in the Coal Measures, most commonly near the out-croppings of coal seams, the coal seams acting apparently as the oil reservoirs.

In the Coal Measures, in the edge of Village Creek, four or five miles west of Birmingham, or in the n. w. ¼ of n. w. ¼ of section 30, township 17, range 3 east, there was discovered by Col. L. W. Johns, in 1885, a spring or an escape of natural gas. The gas bubbles up in the creek at some eight to ten different points within a circle of a radius of five to six feet. The gas has been bubbling up steadily ever since first discovered, and likely for centuries before. It comes or bubbles up from between strata of shaly and flaggy sandstones that have a dip of 20 to 25 degrees to the west. Some three hundred yards up the creek from this spring is the top of an anticlinal. The strata, however, near this spring are too highly tilted and too badly broken up, or are too near the great fault that here runs between the Coal Measures and the Birmingham Valley, for the above gas to come from any great accumulations. In testing for coal in the Warrior Field, several holes up to a depth of 2000 feet have been bored, and in some of them more or less gas has been found in what are commonly called *small pockets*. Perhaps the greatest quantity was struck in a well some ten miles west of Birmingham as the drill reached a coal seam at 450 feet. That some of the coal seams are gas reservoirs is also shown from the fact that gas in small quantities is found in nearly all, if not all, of the deeper coal mines of the State. It has, however, in none of them as yet been struck in large quantities. The best known, and perhaps strongest sulphur and oil springs of the Coal Measures, are the Blue or Keizer Springs of Winston County, in section 33, township 11, range 9 west. These springs are several in number, and boil up from a low, flat, marshy place near Brown's Creek. The best known tar springs of these measures is in the same county, in section 3, township 12, range 9 west. The maltha, or semi-liquid bitumen of this spring, with water, oozes up through a small hole in a massive friable, coarse grain sandstone that forms glady places. This spring runs much more freely in the summer, so said, than in the winter. In the summer, it yields about every fifteen minutes a ball of maltha of near the size of one's fist.

In the newer formations of Alabama, there have been several wells of over 1000 feet in depth bored. In all of them more or less salt water was found, and in the well at Bladen Springs, Choctaw County, bored in 1884 and 1885 for petroleum, there was struck considerale gas, as it was used for heating the water for baths.

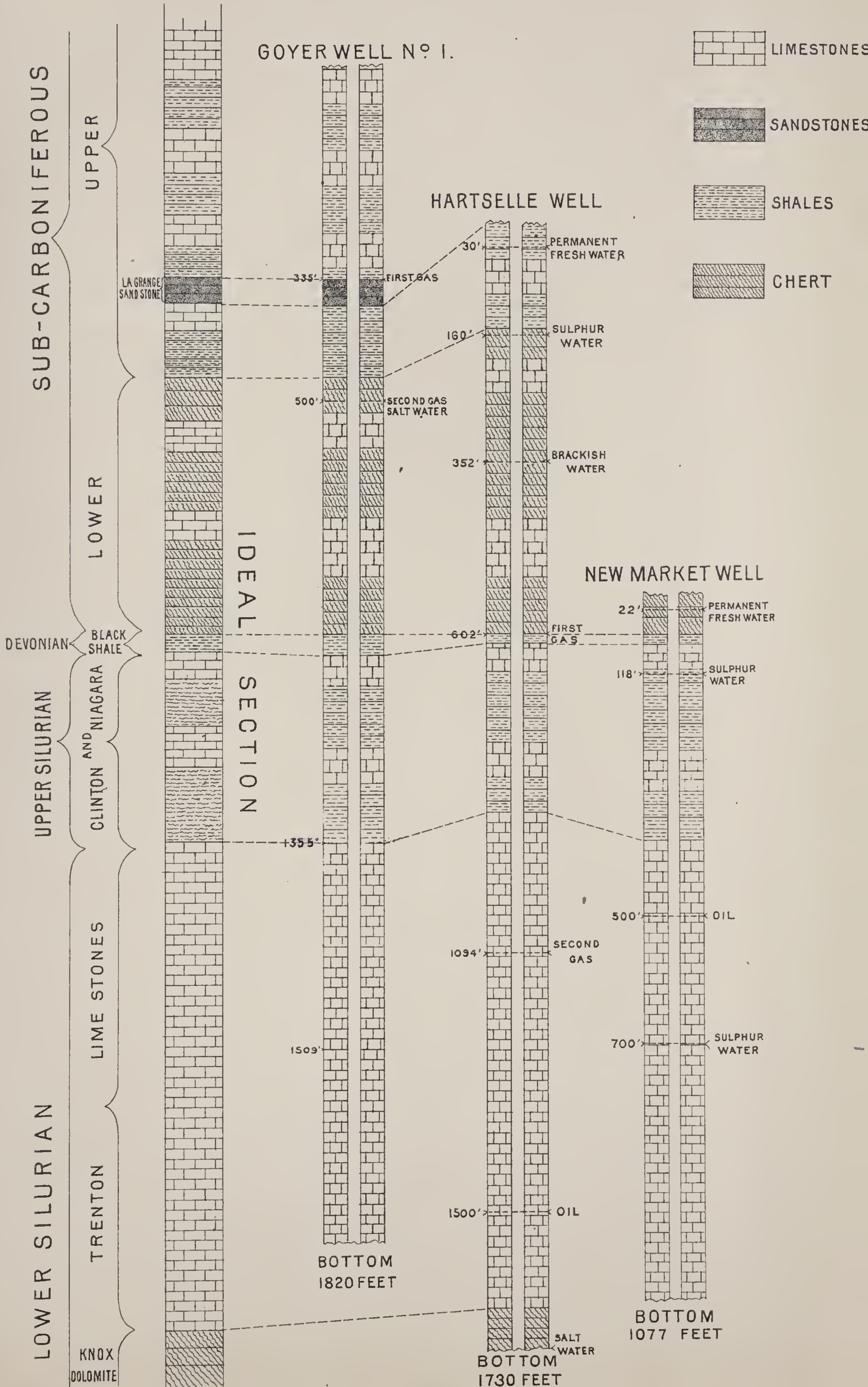
In conclusion, I will say that I have no idea that any large quantities of gas or oil will ever be found in Alabama to the southeast of a line drawn northeast and southwest through Birmingham, unless it is in the newer rocks or in the Mesozoic and Cenozoic rocks of the southern part of the State, for the reason that the older or Paleozoic rocks to the southeast of that line are too highly tilted and too badly broken up to even allow of any such accumulations. I do not think, however, that even to the northwest of that line that there will ever be found in Alabama any such accumulations of gas and oil as have been discovered in Pennsylvania and Ohio, though I do hope that there may be found some paying wells. There is no doubt but that the Sub-carboniferous rocks of the Moulton Valley, believed to be the best oil bearing rocks in the State, have in them in the aggregate a vast amount of petroleum, but whether or not this petroleum is collected together in anyone place in sufficient quantity to be of any commercial value remains to be proved by the drill. Should ever such accumulations be found in these rocks, it will most likely be in wells drilled down through the Coal Measures to the south of the high divide that bounds Moulton Valley on the south, for there alone would the necessary conditions of a suitable source, reservoir, cover and structure of the strata be fulfilled. Nothing, however, can be said with certainty as to such a find, for no man can say that gas or oil exist in quantity in any one locality, until it has been tested by the drill ; all that can be said by the wisest, is that gas and oil may occur, in greater or less quantities, at some depth beneath the surface wherever the strata have never been more than slightly disturbed or where they now lie tolerably flat over large areas.

It is true, however, that the expert geologist can say or point out the localities in which accumulations of these substances are most likely to occur, and also where it would be impossible to find them in quantity, and so no gas or oil wells ought to be drilled, as they are expensive things, until there has been a careful study of the geology of the country. Accurate records should be kept by competent persons of all the strata penetrated in a well drilled for oil or gas, for the reason that should gas or oil be found, or should it be deemed advisable to drill other wells in search of gas or oil, these records would be very valuable in enabling one to tell where or in what strata to expect the gas or oil, and where or in what strata to stop boring with the almost certainty that nothing would be found by going deeper. These accurate records would also be of great advantage to a proper understanding of the geology of the country, and hence to the State at large, and especially to the immediate vicinity of the borings.

This paper was discussed by C. Cadle, W. E. Robertson, Horace Harding, and William B. Phillips.

SECTIONS OF GAS AND OIL WELLS OF NORTH ALABAMA.

SCALE: 1 INCH = 300 FEET.



B. F. Peacock's paper on The Future of the Iron and Steel Industry in Alabama was read by C. D. Allis, as Mr. Peacock was unavoidably absent :

THE FUTURE OF THE IRON AND STEEL INDUSTRY IN ALABAMA.

In committing to me the duty of preparing a paper on "The Future of the Iron and Steel Industry in Alabama," you will not, I trust, expect too much, because I have found it impossible to do justice to such an important subject in one paper. The institution whose success we are met to promote will, we trust, be the means of casting aside all narrow jealousy and of adding immeasurably to the general stock of information. We have in Alabama many intelligent men, both scientific and practical, who occupy positions of trust in our coal and ore mines, iron and steel works, foundries, and divers manufactories, to whom iron and steel is a necessity. It is with such men "through the means of this society" we wish to come face to face ; men distinguished for their practical knowledge, and others equally eminent for their attachments to scientific observation, and so foster, develop and help forward, generally, Alabama's good. There are instances, as you know, even in this day where scientific inquiry is disregarded and practical experience is admitted to be the only true guide ; but what is practical experience but science of a kind? The observation, and to some extent, the connection of certain facts, is the most intelligent and trustworthy ground-work for success in a sound union between these two great principles.

Now-a-days science is so developed and the knowledge of facts so extended that it is impossible for any single association, or a single individual, to master all the different branches of scientific and philosophical speculation : it is therefore desirable and beneficial that one should give his undivided attention to some particular branch of science, or manufacture, and master it, instead of wandering over the bewildering field of inquiry. Of course, we know that man has conquered nature, has harnessed her forces to his service, and the vast creation of wealth and comfort in this country alone would form, when it came to be recorded, the most wonderful chapter in the history of the human race. My duty on the present occasion is not to present you with the many details, but rather to attempt, in as practical a manner as possible, the briefest condensation of them. I have been for many years identified, practically, with the metallurgical and mechanical treatment of iron ores and the production of finished iron and steel sections, at some of the largest and best equipped works in the Old Country, and also have been practically engaged nearly five years in Alabama; long enough to be able to form an unbiased and practical opinion of the wonderful resources which nature has lavished upon this section. Alabama is one of the Gulf States; is situated between 30 deg. 31 min. and 35 deg., north latitude, and between 84 deg. 56 min. and 88 deg. 31 min. west longitude. Its greatest length from North to South is 336 miles, and its greatest breadth is 200 miles. Its area is 52,250 square miles, and is about the same as England. Its principal rivers are the Mobile, Alabama, Tombigbee, Coosa, Black Warrior, Chattahoochee and the Tennessee, which are natural water ways and navigable nearly 2000 miles in length, and it seems to me that no other State in the Union equals Alabama in this respect; therefore, gentlemen, I am starting out, naturally, with a very good opinion of the importance of this State; feeling sure that it is only in its infancy as regards its industrial career. The far-seeing officials belonging to different railway systems have done, and are doing wonderful service in helping the quick development of this State, and very wisely so. By giving the South all the railway facilities in their power, coupled with reasonable freight rates, they are simply laying up for themselves a rich harvest, and benefitting mankind by making it possible for tens of thousands of iron and steel workers, farmers and others to find employment.

Now, these sagacious, far-seeing and enthusiastic developers of the South, as I may call them, are being called to order on account of their giving us too generous freight rates, thereby as one friend says "enabling us to compete in the open market;" of course, we are competing, but gentlemen, we are only just getting the thin edge of the wedge in, because it is not the so-called partial Southern rates that have caused us to become dangerous rivals, but it is Alabama's natural causes, with its native sinews, brains and foreign capital that has and will enable her to become an acknowledged rival in the open market. We cannot help our Mining Engineers, Chemists and practical men finding in Alabama the best coal, some of which we shall see later, making the best of coke;—finding iron ores which we know are suitable to manufacture such specimens as you see placed around the table, and which we think are fit for any market in the world;—we cannot help finding an abundance of ore, quite suitable for making steel;—we are finding the very best of fire clays, best of limestone, marble, slate; also extensive deposits of oil, which, in the near future, will only be a repetition of the discoveries in the North, with this difference, that the natural gas is here to stay. The fact is, seeing that we have in this State such unmatched mineral wealth and the finest timber in the land, would it not be a surprise, to any thinking and practical man, with all these natural resources at our very feet, if we could not compete, even in the World's markets, in pig iron, manufactured bar iron or steel products? Of course, whilst I believe that the efforts of various industrial and immigration conventions which have been held in the South, going hand in hand with the railway systems, have had their effect, still Alabama has had its present advertisement from strangers and practical men, who have personally investigated its resources for themselves, and have carried the wonderful story to their homes and friends into every part of the world. So may the good work of the railway developers and other agencies go on penetrating every timber and mineral region of the State, helping to increase its vast resources! But, gentlemen, something else is needed before we can, as a State, stand in the front rank, and our people reap the full reward of independence that is surely awaiting them. I refer now to the immense amount of business we could do if the navigation of of our water-ways was judiciously improved, and all our raw materials were manufactured at home, into finished products worth $300.00 per ton, instead of as now from $9.00 to $30.00 per ton. We have as good, if not better facilities, as you know, for manufacturing profitably by skilled labor, than any other State, and when Alabama wakes up intelligently to this fact, then will follow, so sure as night follows day, such a commercial and industrial prosperity as has never been dreamed of; then Alabama will certainly become one of the richest States of the industrial South, and her prosperous development will go on forever. We will now consider the most reasonable means to that end. I find historical notices of furnaces whose place is almost forgotten—the fuel used at that time was, of course, charcoal, and the furnace was always located near some iron deposit. Wood for the charcoal was abundant everywhere, but as the forests were gradually cut down and charcoal became dear, in the older settlements, the make of iron decreased, and the furnace itself was finally abandoned for a new one, built in the vicinity of fresh woodland. The march of settlements has gradually thrust the manufacture of charcoal iron into sections of the country, where, not only vast forests, but local deposits of iron ore exist, and so long as charcoal-iron maintains its supremacy in the market for various purposes, the question of wood supply is not without interest to iron men. The raw products, so various, so diverse, found in Alabama, are the gifts that the Creator, with a hand always bounteous, but wisely unequal and discriminative, has scattered amongst the families of men to be sought for, their hidden properties discovered and evolved, to become the foundation of power, of commerce, of mutual help, of greatness, national and individual, of every material comfort and enjoyment. It is known to most of my hearers what has been, and is being done in Alabama as regards mining, and iron and steel manufacture; some of you also know a few of the best locations for the better carrying on of the most profitable and successful iron and steel industries; therefore, I will only speak in a general term of localities and their products. First, then, it seems the coal fields of Alabama form the southern extremity of the great Appalachian coal fields,and the coal deposits of this State are known to underlie the whole, or portions of the counties of Franklin, Lawrence, Morgan, Marshall, Jackson. DeKalb, Cherokee, Marion, Winston, Cullman, Etowah, Blount, Walker, Fayette, St. Clair, Jefferson, Tuscaloosa, Shelby and Bibb.

The State Geological Survey of Alabama estimates that the coal deposits embrace an area of 8,660 square miles, although actual mining operations are conducted in but ten counties, viz: Blount, Cherokee, Tuscaloosa, Jefferson, Etowah, St. Clair, Bibb, Shelby, Walker and Cullman. This region is divided into three distinct districts—that portion drained by the Warrior River and its tributaries and the Tennessee River and its tributaries in Alabama, constitutes the "Warrior Coal Field." The Coosa field, situated in St. Clair and Shelby counties, is drained by the Coosa River. The Cahaba field lies along the Cahaba River in the counties of Shelby, Jefferson, Tuscaloosa, and Bibb. The coals of Alabama embrace all the bitumenous varieties, such as gas, coking, block, splint and cannel; thereby providing the rapidly developing industries and increasing population of the State with an inexhaustible supply of fuel for furnace, steam and domestic uses, for generations to come.

It seems that the mining of coal was begun in this State about the year 1853, and the growth of this industry since then has been almost phenomenal. The product for the calendar year 1889 being 3,378,484 tons, value $3,797,426.00. The railways traversing the Alabama coal fields and providing facilities for the transportation of the products are the

Alabama Great Southern.
Louisville and Nashville.
Kansas City, Memphis and Birmingham.
Kansas City, Fort Scott and Memphis.
Georgia Pacific.
Nashville, Chattanooga and St. Louis.
East Tennessee, Virginia and Georgia.
East and West Railroad of Alabama.
Cahaba Coal Mining Company.
Columbus and Western.

I find after examining the analyses of the coal from Tennessee, Pennsylvania, Kentucky, Maryland and Illinois, that in Alabama, we have coal the highest in fixed carbon of all but one of the States just mentioned; that we have coal the lowest in ash and the lowest, but one, in sulphur; thus showing the superior qualities of our coal either for steam or coking purposes, also for heating and puddling furnaces. It is therefore as foolish for our friends as say "that first-class coke cannot be made from Alabama coal," as it was for them to have said "that good Merchant Iron could not be manufactured from Southern Pig." At the same time, there is room for improvement in both. If, in the manufacture of coke the most improved methods were employed, less waste would be the result,and a purer quality could be produced, equal to any that is used in blast-furnaces practice, and this, I believe, is being arrived at by some of the coke manufacturers in this State already. It seems the first attempt that was made at all in this country, to manufacture iron, was made on Falling Creek, Virginia, in 1619, but in 1622 the Indians destroyed the works and massacred all the workmen.

I find, also, that the first coke pig iron made in the South was in the year 1860, and the final chapter in the history of this furnace may be a little interesting to some of my hearers at least. It seems that in the summer of 1862, before the Union troops took possession of Chattanooga, the machinery of this furnace was removed to Alabama by W. Giles Edwards, who used it in the equipment of a small charcoal furnace, near the site of the present town of Anniston.

As regards iron ore, I find the first discovery of it was made within the limits of the United States, in North Carolina, in 1585, by the expedition fitted out by Sir Walter Raleigh, and commanded by Ralph Lane, which made in that year, on Roanoke Island, the first attempt to plant an English settlement on the Atlantic coast.

It is an acknowledged fact that the iron ores found in Alabama embrace most known varities; also they are found in large quantities, and have been worked for many years; the iron made from them is of great toughness and strength. It is a mistake to say there is no ore in this State low enough in phosphoros to manufacture Bessemer Pig Iron. Manganiferous Iron Ore suitable for the manufacture of Spiegeleisen is found in considerable quantities. The fact is, it is simply nonsense to say that good steel cannot be made from Alabama ores. We are not now so dependent as we were years ago, on one process of steel manufacture. In these days we have to arrange the processes to the ores, and not the ores to the processes, and we can make steel, in any quantity and quality from ores in this State and at a profit, without waiting on Cuban ores.

We are now living in a wonderful, progressive, practical and scientific age, some call it the "Steel Age," and talk "steel" morning, noon and night, till one is nearly smothered by steel, and I suppose it takes a certain amount of assurance for a man to even say a passing word in favor of iron, but I for one, have not by any means lost all confidence in our old and reliable friend, IRON. Of course, we have heard and known of some wonderful things as regards steel; so we have and do of iron. It is manufactured and formed for a great variety of purposes, for which it is, in my mind, more suitable than steel, and it is a question with me whether iron is to be entirely superceded at all, but rather continue to be our good and faithful servant, so long as we treat it as it deserves.

I come now to the practical part in developing the wonderful mineral resources of Alabama. Nature has done her work nobly and well, but something else is needed. The chemist, practical knowledge and capital must work hand in hand to do the rest. Then science, skill and enterprise will work such an industrial development in this State, in the near future, that will be a surprise to all.

Seeing that most of the present and future blast-furnaces in Alabama will have their supplies of iron ore, coal, coke and limestone at their very doors, is it any wonder that this State has been fixed upon and predicted to become the very centre of iron and steel manufacture, at a minimum cost and in any quantities, posssessing, as it does, a monopoly of all the advantages necessary for producing special qualities of both iron and steel? I think a great deal of the out-put of these furnaces will, very soon, be used by the Basic process, notwithstanding the very narrow-minded policy of the owners of the patent, because there are other substitutes for the Basic furnace linings, outside the Steel-Patent-Company's rights, that will practically answer the same purpose, without paying their unreasonable tax of one dollar per ton, because it is too late in the day for any rings or monopolies of patent rights, (so far as the manufacture of steel is concerned), to try and stop its progress in this or any other Southern State, and it is needless for me to say that every obstruction placed in the way of manufacture and all superfluous costs incurred, are simply taxes upon the public.

Another scare is going the rounds to prejudice people's mind against the progress of the South, and that is—we cannot succeed in producing steel by the improved Basic process, long nor successfully, for the want of "scrap." Now, what is the reason? Will iron products not resolve themselves into "scrap" as fast now as in years gone by? Certainly, the consumption of old material at the present time bears almost the same relation to the consumption of pig iron as it did some years ago; if so, we need not be alarmed on the score of "no scrap." But in my opinion the coming process and the one that will help forward the future development of the great mineral resources of Alabama, is the direct one.

It is now about ninety-eight years since the first Puddling Furnace was constructed, and it may seem strange, but from that date to the present, the very trying labor and severe physical task required of the puddler, has been lessened but very little, and after watching this process for years, I feel sure that the endurance exercised by the puddler to make a heat of good iron is greater, and taxes the muscles and strength of the operator to much greater extent, than any other trade, particularly if the puddler is bent upon doing his work well, so as to produce proper yield and a good quality of iron; therefore any attempt to save this labor, also coal, and thereby lessen cost of production, would confer the greatest boon on the proprietor, the puddler, and the world at large, for it cannot be denied that the consumption of iron is so interwoven with the material and social progress of the age, that any amelioration in the cost of its production will be a blessing to mankind generally. For many years I have thought this matter over, and always considered the direct production of iron and steel from the ore, without the intervention of the blast furnace and puddling furnace, as a possibility, in view of the fact that a direct process was practiced by the Ancients, Indians and Romans.

There are two patents taken out in this country to produce iron and steel by the DIRECT PROCESS, both of which I have been examining and investigating for some time, with a view of seeing how best this could be adapted to our Alabama ores. The Conley-Lancaster Process seems a good one ; so is the Adams Process ; the former process can successfully reduce ores of such low grades of quality, that they have hitherso been considered useless for making steel ; but all ores require crushing and pulverizing and cleansing. Gas coal is essential for use in the gas-producers, and either good coke or charcoal (as carbon) for mixing with the prepared ore in Deoxidizers- Usually fifteen to twenty per cent. of powdered carbon is mixed with the prepared ore and charged together into the Deoxidizers. About ten per cent of pig or scrap iron is furnished in the open hearth furnace, into which is passed the ninety per cent of spongy or Deozidized ore from the Deoxidizers ; twelve to fifteen hundred-weight of gas coal is usually required to produce a gross ton of steel ingots. A good plant to turn out sixty tons of ingots daily capacity would cost $85,000.00. This is, you will see, comparatively cheap, when we consider the cost of blast-furnaces, blowing-plants, converters and other appurtenances. A soft steel of uniform and excellent quality is produced by this direct process, and they claim that steel can be made for at least $10.00 per ton less, from the same ore, than by the Bessemer, Siemens, or any other known process or plant. One great advantage in this process seems to be, that the ore in the Deoxidizers can at all times be gotten at, and the heat suitably regulated to meet the varying conditions of the ore while under treatment, there being no risk of having it over-heated, and thus sticking to the Deoxidizing Retorts. There is a great future for this process.

The Adams direct process, also, is coming to the front, and is being recognized and endorsed by some of the best Metallurgists of the day. It has gone beyond the experimental stage, and I see there has recently been a company formed at Pittsburg to use this process to manufacture pure wrought iron, to take the place of the imported Swedish bar iron. The elements of saving by this process seem two-fold, namely : the substitution of raw ore for pig metal, and the substitution of non-Bessemer for Bessemer stock. I look upon this process as very promising and favorable to the better developments of our Alabama ores, and there seems economy in its working. The tests of steel made by it from pig, with twelve hundredths per cent phosphorus, and from ore, with eighteen hundredths per cent phosphorus, are most remarkable, and great praise is due Mr. Chas. Adams, the inventor, for the success he has reached after thirty-five years of labor.

Having been a believer for some years that the Direct Process was to come to the front, surely I intend to examine, and more carefully, both this and the Conley–Lancaster Process, with a view of demonstrating their practical and commercial worth to this State.

Before concluding, however, I beg to call your attention to the specimens of muck, and re-rolled bars on the table, and to the two railway axles. These I am now making of Alabama pig in the daily course of business. The test sheets hereto appended will show the quality of the axles.

The paper was illustrated by a number of pieces of muck and rerolled bars and by two railway axles which had stood the severest tests. All of these specimens of wrought iron were prepared by the United States Rolling Stock Company from Alabama pig iron and Alabama fuel (coke).

Owing to the absence of Mr. Peacock in person, there was no regular discussion of the paper.

THE UNITED STATES ROLLING STOCK COMPANY, ANNISTON, ALABAMA.

MILL AND FORGE DEPARTMENT.

Axles made by U. S. Rolling Stock Company. and subjected to the following tests, by
Mr. A. W. Fiero, Inspecting Engineer of Robert W. Hunt & Co., 3–8–90, for S. F. & W. R. R.
Drop weight, 1640 pounds. Supports, 3 feet centres.

Axles tested in the following order.	Deflections 1st Blow. 10 feet.	Deflections 2nd Blow. 10 feet.	Deflections 3rd Blow. 10 feet.	Deflections 4th Blow. 15 feet.	Deflections 5th Blow. 15 feet.	Remarks.
1st Axle Tested, - - - - - -	$1\frac{1}{4}$ inch.	$\frac{1}{4}$ inch.	$1\frac{1}{8}$ inch.	$\frac{7}{8}$ inch.	$1\frac{1}{8}$ inch.	No Fracture.
2nd Axle Tested, - - - - -	$1\frac{3}{8}$ inch.	$\frac{3}{8}$ inch.	$1\frac{3}{8}$ inch.	$\frac{3}{4}$ inch.	$1\frac{1}{4}$ inch.	No Fracture.
3rd Axle Tested, - - - - - -	$1\frac{5}{8}$ inch.	$\frac{1}{4}$ inch.	$1\frac{1}{2}$ inch.	$\frac{7}{8}$ inch.	$1\frac{1}{2}$ inch.	No Fracture.
4th Axle Tested, - - - - - -	$1\frac{3}{4}$ inch.	3-16 inch.	$1\frac{1}{2}$ inch.	$\frac{7}{8}$ inch.	$1\frac{1}{2}$ inch.	No Fracture.
5th Axle Tested, - - - - - -	$1\frac{3}{8}$ inch.	$\frac{1}{4}$ inch.	$1\frac{1}{4}$ inch.	$\frac{7}{8}$ inch.	$1\frac{1}{4}$ inch.	No Fracture.

These Axles were required to be submitted to tho following tests without breaking, viz:

A 1640 pound weight dropped from a height of 10 feet, 3 times in succession.

A 1640 pound weight dropped from a height of 15 feet, 2 times in succession.

B. F. Peacock, Sup't Mill and Forge Dept.

THE UNITED STATES ROLLING STOCK COMPANY—ANNISTON, ALABAMA.

——MILL AND FORGE DEPARTMENT——

Axles made by U S. Rolling Stock Company, and subjected to the following tests,

For the Chicago, Milwaukee, and St. Paul Railway, 2–3–91.

HEIGHT OF DROP TEN FEET THROUGHOUT THE TEST.

No. of blow, - -	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 axle tested.	in	in	in	in.	in	in	in	in	in	in	in.	in.	in.	in	in.
Deflections, - -	1⅜	⅜	1¼	7-16	1¼	¼	1¼	¼	1¼	¼	1 5-16	5-16	1 5-16	⅜	1 5-16
No fracture.															

No. of blow, - -	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1 axle tested.	in	in.	in	in.	in	in	in	in.	in	in	in	in.	in	in	in
Deflections, - -	⅜	15-16	⅜	1 5-16	⅜	1⅛	⅜	1 1-16	⅜	1⅛	⅜	1 3-16	⅜	1¼	⅜
No fracture.															

Weight of drop, 1640 pounds. Between centres of supports, 2 feet.

These axles were required to be subjected to the following test without breaking, viz: A 1640 pound drop falling from a height of 8 feet 15 times in succession, axle being turned after each blow.

B. F. PEACOCK, Sup't Mill and Forge Dept.

William B. Phillips's paper On the Ultimate Composition of some Alabama Coals was not read at the meeting, as request was made for more time. The paper was follows :

THE ULTIMATE COMPOSITION OF SOME ALABAMA COALS.

BY

WILLIAM B. PHILLIPS, PH. D.,

Professor of Chemistry and Metallurgy, University of Alabama. Chemist to Alabama Geological Survey.

In seeking to compare the Alabama Coals with similar coals from England and the Continent of Europe, a serious difficulty was encountered in the absence of analyses showing the actual percentage of Carbon, Hydrogen, Oxygen, and Nitrogen. Hundreds of proximate analyses, giving the percentage of volatile and combustible matter, and of fixed carbon were available, but as a rule such analyses are not in use to any great extent outside of the United States.

Analyses made by what is known as the Proximate Method, are but rarely met with elsewhere than in this country, and on this account it is difficult to institute a just comparison between our coals and the English, or German, or French coals.

As is well known, the Proximate Method is based on the assumption that, after the hygroscopic moisture is removed at a temperature between 105 and 110 degrees Celsius, the Volatile and Combustible Matter is removed by igniting in a closed crucible for three and a half minutes over a Bunsen burner,and then for the same time over a blast lamp at a very high heat. What is left in the crucible is termed "Fixed Carbon." This is then burned off in the air, and the residue is termed "Ash."

In Proximate Analyses, the Moisture, Volatile and Combustible Matter, and Fixed Carbon are added together and subtracted from 100, the difference being termed "Ash." The Sulphur is not added in but is expressed separately.

In such analyses, no account is taken of the Hydrogen, or Oxygen, or Nitrogen, although these ingredients are of great importance in valuing a coal either for its calorific effect or for its gas-making qualities. Proximate analyses are of a very little use in valuing coal for gas-making, or for the manufacture of ammonical salts, as in the first place they do not give the content of any of the fixed gases, and in the second place they give no information as to the content of Nitrogen. Why they have been preferred in this country to the practical exclusion of Ultimate Analyses, would be an interesting question to discuss but one outside of the scope of the present paper. Suffice it to say that they have been preferred, and that there seems but little hope of changing the custom, much as this is to be desired for many reasons..

An Ultimate Analysis of coal gives the content of Carbon, Hydrogen, Nitrogen and Oxygen, the last being usually determined by difference, that is, by adding the percentage of Carbon, Hydrogen, Nitrogen, Sulphur, Ash and Moisture, and subtracting from 100, the difference being termed Oxygen. In this way we arrive at two important results, viz : the possibility of valuing the coal for gas-making, this value being largely dependent upon the content of Hydrogen, and for the manufacture of ammonical salts, this depending entirely upon the content of Nitrogen. These very important results are lost sight of when we confine ourselves to Proximate Analyses, for such analyses afford no reliable information on either subject. One might go further and say that no judgment can be rendered as to the calorific power of a coal without an Ultimate Analysis, for by the Proximate Method we are told nothing of the nature of the Volatile and Combustible Matter, although this may exceed one-third by weight of the coal under discussion. It is not meant that the calorific power of a coal is to be calculated from tbe ultimate analysis and the result accepted as true for all cases, but that such an analysis gives us a clew to the energy which the coal is capable of affording when burned under proper conditions.

Having these things in view, a diligent search was made for Ultimate Analyses of the chief Alabama coals, but without success. If they have been made they are not available to the general public or to the Geological Survey. It was therefore determined to begin a series of analyses which would give both the Proximate and the Ultimate Composition of the principal Alabama coals. It was hoped at one time to have the samples drawn by an officer of the Survey, but as this could not be done now without great inconvenience, the chief companies were requested to send average samples of their coals and cokes to the Laboratory of the Geological Survey and the Metallurgical Laboratory of the University. They very kindly complied at once and the work was begun during the month of February.

Up to this time the following coals and cokes have been analysed both proximately and ultimately :

Cahaba Coal Mining Company, Blocton. Woodstock and Underwood Seams, and the coke made from these coals.

DeBardeleben Coal and Iron Company, Bessemer. Blue Creek Coal, and the coke made therefrom.

Tennessee Coal, Iron and Railway Company. Pratt Mines Coal and the coke made therefrom.

Standard Coal Company, Brookwood. Brookwood and Milldale Seams, and the coke made therefrom.

Sloss Iron and Steel Company, Coalburg. Coalburg Coal, and the coke made therefrom.

Joseph Squire, M. E., of Helena, very kindly sent a sample of the Wadsworth Seam at Helena, and from the Birmingham and the Mobile Gas Works there are samples of the coal used in making gas at these establishments, together with samples of the gas carbon and the ammoniacal liquor made.

A full account of each sample will be found immediately after the table of analyses. In this table will be found also a few typical analyses of some foreign coals by way of comparison.

The analyses of the cokes do not appear in the table, as it was thought best to defer any discussion of them until the Fall Meeting of the Soctety, when the subject of Coke is to come up for detailed investigation.

The samples of coke have, however, been analysed and now await the proper occasion for publicity.

It may be said that permission was freely given by all the companies for the publication of all the analyses. It may also be said just here that there has always been found a most hearty response from these companies to any request made of them which tended to throw any light upon the problems we have to face in Alabama. I would take this opportunity to return my public acknowledgements to them for the uniform courtesy with which they have replied to letters of inquiry. In regard to the shortness of the list of analyses, it must be said that the work has just been begun, and it was impossible to attend to pressing duties of other sorts and at the same time finish more of the ultimate analyses. It is fully realized that the list is not as long as it should be, for there are many coals of equal importance with those treated which could not be reached in time for this paper. During the next twelve months it is hoped to finish all or very nearly all of the prominent coals and cokes, and to give the results to the public through this Society. Work is now in progress, especially on the cokes, to include many items of great interest and importance not usually expressed in ordinary analyses.

From an inspection of the table it will appear that there is but little information to be had concerning the yield of tar and ammoniacal liquor from our coals. Only two companies report any tar, and neither of these can give any figures relative to the ammoniacal liquor as no attempt is made in this State, so far as I am informed, to save the ammonia. The Gas Works at Birmingham use Pratt coal, and report a yield of about 13 gallons of tar per ton of coal retorted. The Gas Works at Mobile report a yield of about 10 gallons of tar per ton of coal.

The Alabama Insane Hospital reports no yield of tar, but it can be taken at 13 gallongs per ton.

The total value of products to be obtained from a ton of coal cannot therefore be given for more than three of the coals, viz: the Pratt Coal as at Birmingham, the Cahaba Coal as at Mobile, and the Asylum Seam as at the Hospital.

As to the yield of coke per ton of coal, this has been taken at 1300 pounds, probably the very best that can be done at present. The average yield of coke from the bee-hive ovens in the State is not quite as high as 1300 pounds per ton of coal, but it is steadily increasing,and in some places is very close to it.

The yield of gas per ton of coal can be given for the Pratt Coal, the Cahaba Coal and the Asylum Seam. A yield of

8000 cubic feet can be and is attained regularly, but our best gas coals will hardly give as much as 10.000 feet.

In regard to the yield of Sulphate of Ammonia, it must be said that this is calculated from the content of Nitrogen. As no ammoniacal salts are manufactured from coal in this State, no returns can be given which represent actual work. This is all the more to be regretted since the completion of these analyses, for they show that some of our coals are very rich in Nitrogen, and consequently valuable for the manufacture of the various salts of ammonia.

If all the bye-products that could be obtained from a ton of Pratt coal were utilized, they would show a value of not less than $15 per ton of coal, and might show even more. As it is, however, more than $5 worth of Sulphate of Ammonia is thrown away from each ton of coal used. If we allow that the monthly consumption of coal for gas-making in the State is 1200 tons, an amount somewhat below the true consumption and exclusive of rolling mills, the annual amount of money represented in Sulph. Am. is about $60,000. If to this be added the waste from the 5000 coke ovens, producing about one million tons of coke yearly and using about two and a half million tons of coal, the figures amaze one.

We may take the average value of a ton of coal in Sulphate of Ammonia at $4, and the average consumption of coal in the ovens at two millions tons, we thus get a waste of eight millions of dollars every year. All of this, of course cannot be saved, but there can be no doubt of the possibility of saving a great part of it. The coke oven of the future is the oven that will allow of the saving of a great part of the products of combustion, especially the ammoniacal matter. Such an oven may not yield coke as good for blast furnace work as that in the old fashioned bee-hive oven, but it will enable us to save some of the enormous waste that now goes on. This waste is not only in the ammonia that escapes into the air (this may in some degree be brought down by rains), but is a waste of calories, which are not again within our reach. Heat allowed to escape into the air is a loss to us. The appliances that are now in use for saving the ammonical salts obtained from coal in an oven allowing of the use of the coke may or may not be satisfactory, but the trouble is mainly one of construction, not of principle. The difficulties will sooner or later be overcome, for the advantages to industrial prosperity are too great to allow the matter to remain where it is now.

Whatever may be said concerning the adaptibility of any coke oven to the profitable utilization of the bye-products, there can be no excuse for allowing the ammoniacal liquor from gas works to flow away In England alone the yearly production of ammonia sulphate from gas works is more than 100,000 tons, worth more than $6,000,000. In some parts of France the ammoniacal liquor is transported 300 miles by rail before it is worked up into merchantable articles, such as the various salts of ammonia. From 1867 to 1879, omitting these two years, there was made at Besseges by the Simon-Carves System of coking 983 tons of Sulphate of Ammonia, worth nearly $60,000. In the United States one of the best establishments for the manufacture of Sulphate of Ammonia is in Washington City. There is at all times a good demand for the article, and it is now worth $4 per 100 pounds at retail. It is used almost entirely in the manufacture of guano, as a source of Ammonia.

	Proxim't.		Ultimate.							Remarks.								
Number.	Volatile and combustible matter.	Fixed Carbon.	Carbon.	Hydrogen.	Oxygen. (By Difference)	Nitrogen.	Sulphur.	Ash.	Moisture.	Pounds of Coke per ton of Coal.	Cubic feet of Gas per ton of Coal.	Gals. Tar per ton cl.	Pounds Sulph. Am. per ton of Coal.	Value of Coke, @ $2.50 per ton.	Value of Gas, @ $1.50 per M.	Value of Tar, @ $2.25 per bbl.	Value Sulph. Am. @ $3.20 per 100 lbs.	Total val Products from one ton Coal.
1202	37 11	55 09	59 59	6.31	23.70	1.53	1.01	2.55	4.25					$ c	$ c	$ c	$ c.	$ c.
1203	34 70	62 40	68 04	10.21	17.10	1.22	0.52	1.15	1,75									
1207	39 90	57 40	68 48	8.29	19.02	0.69	0.77	1.45	1,25									
1208	40 75	54 75	63.82	6.24	22.69	0.95	1.80	2.00	2,50									
1209	37 10	57 35	70 91	10.10	9.83	1.73	1.88	3.00	2.55	1300	662)	13	163	1 62	9 93	0 75	5 21	19 51
1210	44 90	46 55	62 24	8.57	19.28	0.33	1.03	7.15	1,40									
1211	62 85	36 20	59.86	7.90	26.17	0.63	4.49	0.85	0,10									
1212	57 65	41 00	63 88	9.07	21.21	0.37	5.12	0.15	1,20									
1213	62 90	34 50	54 47	7.72	29.71	0.22	5.28	2.30	0.30									
1214	42 20	36 60	38 18	7.57	29.77	0.25	3.03	8.80	12,40									
1215	41 40	35 90	38 65	7.07	27.40	0.75	3.43	9.10	13,60									
1216	52 70	34 90	42 82	6.01	37.49	0.30	1.18	0.50	11.90									
1217	34 30	60.50	73.23	7 98	11.92	1.07	0.60	3.50	1,70									
1218	33 45	63 20	75 82	10.52	7.51	1.73	1.07	2.00	1,35	1300	8000	13	163	1 62	12 00	0 75	5 21	19 58
1221	27 80	58 70	72 47	10.38	1.60	0.40	1.65	11.90	1,60	1300			37	1 62			1 18	
1222	34 80	60 60	72 75	8.61	11.12	1.48	1.44	2.65	1,95	1300			140	1 62			4 48	
1223	35 65	57.30	70 82	10.19	9.95	1.31	0.68	5.25	1,80	1300			123	1 62			3 93	
1225†	31 55	64 95	75 05	9.91	8.95	1.62	0.97	2.35	1.15									
1229	30 50	66 30	73 96	10.50	9.57	1.62	1,15	2.20	1.00	1300			153	1 62			4 89	
1230	33 60	61 50	73 88	11.52	6.04	1.51	2.15	3.30	1,60	1300			150	1 62			4 80	
1231	25 80	69 90	72 68	10.77	9.83	1.39	1,03	2.80	1,50	1300			130	1 62			4 16	
1234	30 15	52 90	60 37	10.70	9.00	1.26	1.72	16.30	0,65	1300	8000	10	119	1 62	12 00	0 56	3 80	17 98
1237	34 77	59 60	66 37	10.24	15.58	1.44	0.74	2.73	2,90				136				4 35	
1238	32 55	65 57	74 59	10.58	9.48	1.31	1.32	1.90	0,82				142				4 54	
1240	33 60	57 90	69 70	10.58	7.37	1.65	2.20	4.30	4,20				155				4 96	
A*			77 81	8.47	6.32		0.71	6.01	0,68									
B*			76 50	5.03	11.68		0.94	2.25	3,60									
C*			78 80	4.59	4.88			11.73										
D*	26 70	66 21	79-45	4.81	6.96		1.68	5.96	1,13									
E			80 07	5.53	8.10	2.10	1.50	2.70	1,91									
F			90 45	2.43	2.45			4.67										

*The Nitrogen is not given separately, but will be between one and one and a half per ct.

†See No. 1218.

Explanation of the Table of Analyses.

Nos. 1227, 1228 and 1236 are in a subsequent table.

1202—A small sample of coal received from Major George D. Fitzhugh, marked "From 40 inch seam at Natural Bridge, Winston County, Alabama. From near out-crop." The sample had been in his office for some time. Compare also No. 1240.

1203—A small sample from Major Fitzhugh, marked "From Beeman Basin, Cullman County, Alabama." Sample had been on hand for some time.

1207—A small sample received from Major Fitzhugh, marked "Birdeye Coal from head of Patterson's Creek, Whitley County, Kentucky. Near outcrop."

1208—A small sample received from J. A. Wiggs, Birmingham, Alabama, marked "Lowest seam, Bon Air Coal and Coke Company, Bon Air, White County, Tennessee."

1209—Sample from the Asylum Seam, Tuskaloosa County, Alabama. For content of Ammonia in the gas liquor see No. 1228.

1210—Sample of the so-called Cannel Coal from the Peacock Mines, Walker County, Ala. Received from J. M. Francis.

1211—Tertiary Coal from a local deposit eighteen miles south of Eufaula, Ala. From E. A. Smith, State Geologist.

1212—Tertiary Coal from a local deposit at Dayton, Marengo County, Alabama. From E. A. Smith, State Geologist.

1213—Tertiary Coal from a local deposit at Rescueville, Choctaw County, Ala. From E. A. Smith, State Geologist.

1214—Tertiary Lignite from a local deposit near Pickens' Landing, Marengo County, Alabama. From E. A. Smith, State Geologist.

1215—Tertiary Lignite from a local deposit on Landrum's Creek, Marengo County, Alabama. From E. A. Smith, State Geologist.

1216—Lignite (almost a jet) from the Tuskaloosa Formation in Bibb County, Alabama. From E. A. Smith, State Geologist.

1217—Sample of the Wadsworth Seam at Helena, Shelby County, Alabama. From Joseph Squire, M. E. The seam is fiery, although no very serious accidents have occurred.

1218—Pratt Mines Coal, Jefferson County, Alabama, from Erskine Ramsay, M. E. Color of ash, light brown. This coal is used on a very large scale for making coke in beehive ovens at Pratt Mines and at Thomas. It is used also by the gas works at Birmingham as a gas coal. Compare No. 1225 and No. 1227.

1221—Brookwood Seam, Brookwood, Tuscaloosa County, Ala. From the Standard Coal Company. With No. 1229 used for making coke. Color of ash, grey.

1222—Woodstock Seam, Blocton, Bibb County, Alabama. From Cahaba Coal Mining Company. With No. 1223 used on large scale for coke and also by the Mobile Gas Light and Coke Company as a gas coal. Compare Nos. 1234 and 1236. Color of ash, reddish brown:

1223—Underwood Seam, Blocton, Bibb County, Alabama. From Cahaba Coal Mining Co. Color of ash, grey.

1225—Pratt Mines Coal used by the Birmingham Gas Company as a gas coal. Color of ash, light brown. Compare also Nos. 1218 and 1227.

1229—Milldale Seam, Tuskaloosa County, Alabama. From the Standard Coal Company. Compare also No. 1231. Color of ash, reddish brown.

1230—Deep River Coal, Chatham County, N.C. From Egypt Coal Company, Egypt, N.C. Triassic Coal. Color of ash, pink. This coal is used for making gas at Greensboro, Fayetteville, Raleigh, &c., N. C. It is not used for coke, though it would probably make a fair article, especially if crushed and washed. The seam is fiery.

1231—Blue Creek Coal, from Jefferson County, Alabama. From DeBardeleben Coal and Iron Company, Bessemer, Alabama. Used on a very large scale for making coke in bee-hive ovens at Bessemer.

1234—From the Mobile Gas Light and Coke Company, marked "Cahaba Coal used for making gas." I am unable to identify the seam as the content of ash is much higher than that of any coal I have examined from the Cahaba Coal Field

1237—Coal City Coal, Walker County, Alabama. Jagger Bed. Sample had been on hand for some time. Color of ash, light grey.

1238—Coalburg Coal, Jefferson County, Alabama, from the Sloss Iron and Steel Company. J. T. Hill, Manager of Coal Mines. Color of ash, buff. This coal is used on a large scale for making coke at Coalburg in bee-hive and "Thomas" ovens.

1240—Coal from Henry McCalley, Assistant Geologist of Alabama, marked "From Natural Bridge, Winston County, Alabama. Out-cropping at the west spring. Sample, average of 15 feet from the out-crop. Thickness of seam, 28 to 29 inches." Color of ash, dark grey. Cokes badly.

A—Curly Cannel, Leeswood Green Colliery, England. Given by Percy, "Fuels, &c." p. 330. He says of it, "This is certainly one of the finest cannel coals I have seen."

B—Gin Seam, Kelty Colliery, Fifeshire, England. Percy, "Fuel, &c." p. 336. He says of it, "It is regarded as a highly bituminous, rich, coking coal, and good for producing coal tar and gas."

C—Frostburgh, Maryland. Percy, "Fuel &c." p. 569. Calculated on a dry basis.

D—Bearpark Coal, England. From this coal is made the celebrated Bearpark Coke. Sir I. Lowthian Bell in an article in the Journal of the British Iron and Steel Institute, No. I, 1885, p. 70.

E—Wigan Coal, Wales. Phillips Elements of Metallurgy, p. 48.

F—Anthracite Coal, from Pottsville, Pa. Same authority. The Sulphur is not given in the analyses, but in such coal it varies from 0.50 per cent to 1.20 per cent.

Thinking that it might be of some interest to know how much Ammonia was contained in the ammoniacal liquors made at the gas works in the State, although this liquor is not used for the preparation of ammoniacal salts, I secured samples from three separate establishments, viz: the Alabama Insane Hospital, at Tuskaloosa, the Birmingham Gas Works and the Mobile Gas Works. On submitting them to analysis, merely for the total amount of Ammonia they could be made to yield, the following results were obtained:—

No. 1227—Ammoniacal Gas Liquor from the Birmingham Gas Works. Received March 16th, 1891. Obtained from Coal analysis No. 1225. Taken from the Hydraulic main. Amount yielded, not known. Ammonia in 1000 gallons, 21.34 pounds, equivalent to Sulphate of Ammonia 82.79 pounds, worth $2.64. Specific gravity, 1005.

No. 1228—Ammoniacal Liquor from the Alabama Insane Hospital. Received March 23rd, 1891. Taken from the first tank. Obtained from Coal, analysis No. 1209. Amount given per ton of coal retorted not known. Ammonia in 1000 gallons, 14.93 pounds, equivalent to Sulphate of Ammonia, 57.92 ponnds, worth $1.85. Sspecific gravity, 1005.

No. 1236—Ammoniacal Liquor from the Gas Light and Coke Company. Received April 10th, 1891. Obtained from Coal, analysis No. 1234. Ammonia in 1000 gallons 43 pounds, equivalent to Sulphate of Ammonia 166.84 pounds, worth $5.33. Specific gravity, 1010. Amount yielded, not known.

These liquors carry by no means as much ammonia as could be dissolved in them. Good gas liquors carry from 1 per cent to 5 per cent of Ammonia. whereas the richest one of these does not carry one-half of 1 per cent. By being used again for washing the gas, any of these liquors could have the content of Ammonia increased from two to ten times. In the preparation of ammoniacal salts from such liquors they are concentrated as much as possible, that is, they are saturated with the ammoniacal matters which by distillation with milk of lime are made to yield free Ammonia.

The chemical composition of these liquors varies within quite wide limits, thus, besides Ammonia, a gas liquor may contain such salts of ammonia as the Hyposulphite, Sulphide, Carbonate, Bicarbonate, Sulphate, Chloride, Sulphocyanate, and Benzoate. On distillation, however, with lime they are decomposed into free Ammonia and this is absorbed in various acids for the manufacture of the various merchantable salts of ammonia.

It is to be hoped that those who have in mind the erection of coke ovens that will allow of the utilization of all the bye-products, will give this matter their serious attention. There are coals in this State which yield large amounts of ammonia and make also good coke, and as the success of any Utilization-of-Bye-Product-System depends to a great extent upon the chemical nature of the coals to be used, too much consideration cannot be given to the weighty question of Ultimate Composition and Nitrogen content.

The paper by Horace Harding, C. E. U. S. Eng. in Charge of the Improvement of the Warrior River was not read at the meeting, as request was made for more time. The paper appears at the end of the volume.

There being no further business on hand, the Synopsis of the Minutes was read and approved, the Secretary was instructed to return the thanks of the Society to the Local Committee, W. E. Robertson, G. S. Patterson, and B. F. Peacock for their kind attentions, and the Society was adjourned to meet in Birmingham on the second Wednesday in October, being the 14th day of the month.

The following members of the Society attended the Anniston Meeting :—

C. Cadle,	Horace Harding,	W. E. Robertson,
Henry McCalley,	B. F. Peacock,	Walter Crafts,
F. M. Jackson,	Phil. S. Fitzgerald,	Jas. M. Reid,
H. Atkinson,	John M. McKlroy,	R. L. McCalley,
N. H. Ballard,	C. B. Allis,	Wm. B. Phillips.

DESIGN FOR LOCK-VALVES.

BY COL. HORACE HARDING,

U. S. Engineer Corps, Tuscaloosa, Ala.

The large capacity, now given to locks designed for river-improvements, requires that the culverts for filling and emptying them shall be of ample cross-sectional area, in order to expedite the time consumed in lockage. None of the various styles of valves used for controlling the discharge through these culverts seem to have given entire satisfaction. There should be quick movement; but as the power needed to overcome the frictional resistance, incident to the great pressure, is ordinarily limited to the capacity of the lock-tender, the time consumed is considerable. Balanced valves, in which the resistance is from journal friction only, can be operated quickly by one man, but the leakage is objectionable, and when, from axle-wear or other cause, the valves must be repaired, the work of taking down and replacing is troublesome.

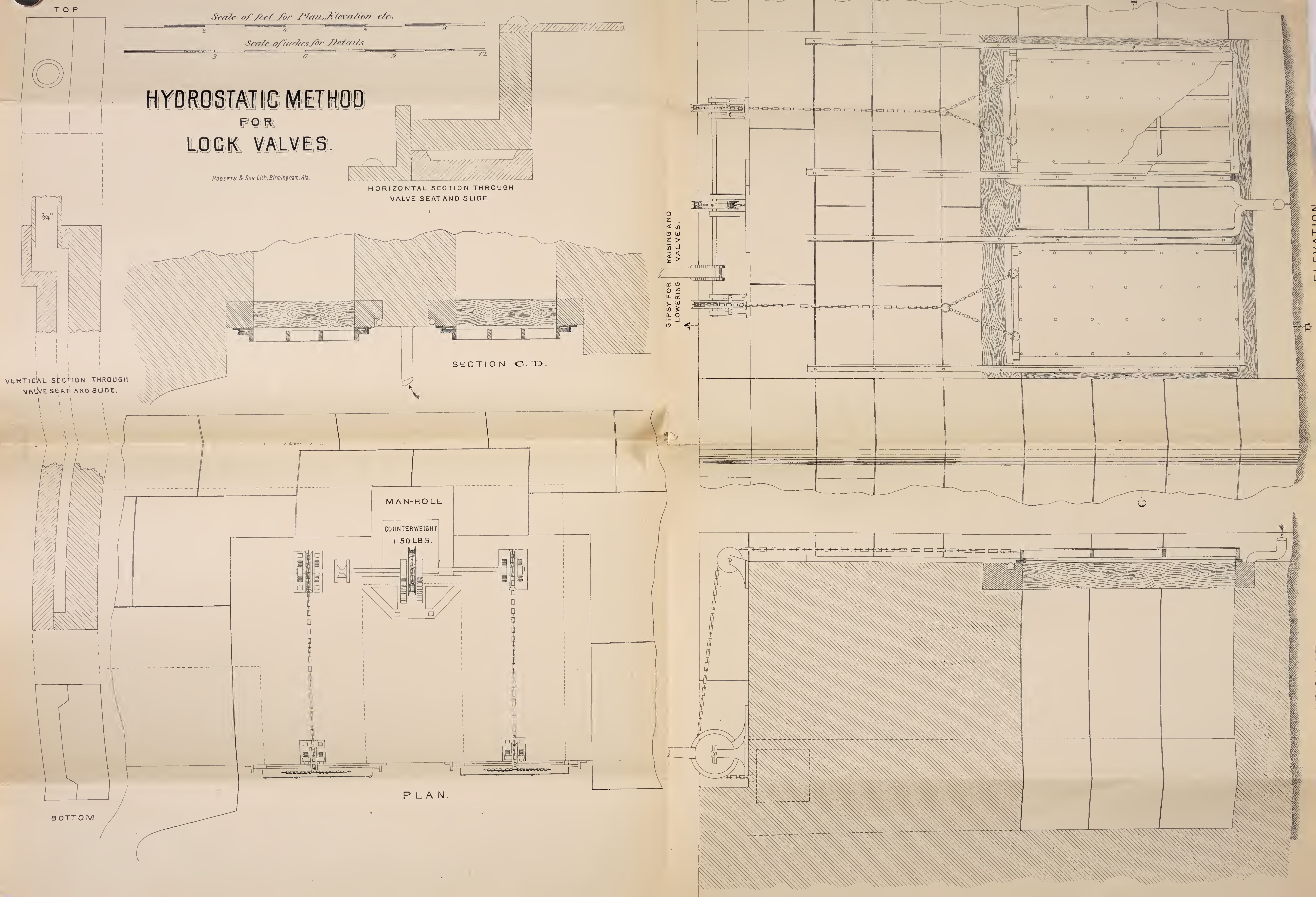
A gate sliding vertically is, doubtless, the simplest and most convenient valve for horizontal water discharge. Freedom from axle-wear and from leakage, together with its non-liability to get out of order, and its accessibility in case examination or repairs should become necessary, would always give it the preference over the wing or flap-valve, were it not that, when of large size, frictional resistance, due to pressure, becomes so great that the power required for raising it is beyond the capacity of one man, where quick movement is desired.

The design shown in the accompanying drawings was devised for the purpose of rendering the vertically sliding gate-valve available for river locks. But little explanation will be needed. The valves have a width of 38 inches, each, subject to a pressure due to a ten-foot head. The valve seats are recessed to a width of three inches, each, being six inches to each valve. Hence, the ratio of the recessed area to the valve area is 1 to $6\frac{1}{3}$. The valves bear against the valve seats with a pressure due to ten feet head of water. Evidently, then, if water be introduced into the recessed valve-seats under 65 feet head, the back pressure thus caused will neutralize the front pressure, and there will be no sliding friction.

In the particular case for which the design was intended, the high banks make it easy to locate a water-tank 65 feet above the valves; and, generally, such a head would not be difficult to establish. The drawings show how the movements are to be effected and how, also, the weight of the valves is balanced by a counter-weight, so that the only resistance in raising the valves is that derived from journal-friction.

Taking the co-efficient of axle-friction (lubricated) at 0.10, a simple calculation will show that 30 lbs. pull, on the end of a 4 feet lever, (attached to a gipsy, as shown), will lift, in a quarter of a minute, valves that are sustaining a pressure of over 20,000 pounds. Without the back-pressure, there would be required fully 750 pounds, applied in the manner shown, to effect the movement. With the gearing necessary to enable 30 pounds to do the work, the time required would not be less than six minutes.

The accompanying drawings are intended simply to show the design in a general way. They are presented as explanatory, merely, and not as giving details further than necessary for that purpose.


TOP
Scale of feet for Plan, Elevation etc.
Scale of inches for Details
HYDROSTATIC METHOD
FOR
LOCK VALVES.
Roberts & Son Lith. Birmingham, Ala.
HORIZONTAL SECTION THROUGH
VALVE SEAT AND SLIDE
3/4"
VERTICAL SECTION THROUGH
VALVE SEAT AND SLIDE.
SECTION C.D.
MAN-HOLE
COUNTERWEIGHT
1150 LBS.
PLAN.
BOTTOM
GIPSY FOR RAISING AND
LOWERING VALVES.
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PROCEEDINGS

OF THE

ALABAMA

INDUSTRIAL AND SCIENTIFIC SOCIETY.

VOLUME 1. NUMBER 2.

1891.

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1892.

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BIRMINGHAM MEETING.

BIRMINGHAM, OCTOBER 14, 1891.

The meeting was called to order at 11, A. M., on Wednesday morning, Oct. 14th, 1891, at the K. of P. Hall, in the city of Birmingham, Ala. Col. Horace Harding, Vice-President, in the Chair.

The Minutes of the last meeting, at Anniston, were read by the Secretary, Dr. W. B. Phillips. No corrections or suggestions being made, they were accordingly adopted.

There were no reports made from the different Committees.

A paper by Mr. J. S. Kennedy was presented, on the subject of "Going Into Blast with a Coke Furnace." Mr. Kennedy expected to attend this meeting in person, but was unavoidably detained, and the paper was read to the Association by Dr. Phillips, Secretary:

GOING INTO BLAST WITH A COKE FURNACE.

The technical literature of the present day is surprisingly deficient in all that relates to one of the most important of metallurgical processes, viz: The blowing-in of Blast Furnaces. With the exception of several articles published in the "Transactions of the American Institute of Mining Engineers," but little can be said to have been written on this subject. An absurd air of secrecy, together with a fear of criticism and the fact that most blow-ins are susceptible of some trifling changes, are probably the reasons which deter Furnace Managers from giving more candid expression to their views.

It was suggested to the writer that an article, giving a brief and practical account of the several methods of blowing-in furnaces, would be of interest. This paper has accordingly been prepared with a view of giving what the writer believes to be the best practice. Also, some notes taken from the records of the blowing-in of an Alabama furnace on the ores of this district.

It is an axiom that the success of a furnace campaign depends most intimately on a smooth start. The most important factors of a satisfactory blow-in, may be stated as follows:

The thorough drying of the furnace, as well as of stoves, gas-flues and hot-blast main, is of the greatest importance.

As large a coke blank as the cubical capacity of the furnace will warrant.

Proper calculations of the burden to insure a Bibasic slag.

Filling of the charges with a gradual increase in the burden, so as to have the last charges filled about 60 to 65 per cent. of the estimated burden to be carried on normal work.

Lighting the furnace in a horizontal plane, preferably at the tuyeres, and the early application of the blast, preferably before lighting.

Gradually increasing the number of cubic feet of blast per minute as temperature of the same rises up to 1000 or 1050 degrees, with slight additions of burden from time to time, holding blast temperatures not over 1050 degrees until end of the first week, and then, after the furnace is thoroughly dry, increasing gradually the burden and blast temperatures until the maximum of economy and product is reached.

The opinion often expressed that "blowing-in will dry out the furnace," is bad practice and liable to be a dangerous as well as expensive method. It is true, that the drying of the furnace is only completed after it is in blast, so the expression "thorough drying" must be taken to mean the removal of all the moisture that can be expelled by preliminary firing. The drying warms the hearth of the furnace, drives off the greater amount of moisture present, and leaves the brick work in good condition to withstand the effects of the blast.

Of the various methods for drying the furnace, the use of natural gas will not be referred to here, as it is only of local importance. Drying by furnace-gas, taken from a companion furnace, has never been tried by the writer, and while it undoubtedly possesses merit, it is an operation which will have to be sharply looked after and the gas kept carefully ignited to avoid explosion. Where the stoves can be heated by gas taken from a companion furnace, drying may be attempted by blowing hot blast lightly through the furnace. A favorite method of many furnacemen, is to build a small brick furnace close to the stack, connecting it to the cinder notch opening by a short flue. The tap-hole and tuyere openings are closely stopped, and the hot products of combustion are passed through the furnace. The last two methods described, are slow, and should always be supplemented by at least a week's hard firing. The writer has found, in practice, the following method to be the most satisfactory: After closing the cinder notch and tuyere openings, a gradual fire is started in the furnace hearth, and increased in intensity, from day to day, until the hearth is hot and the crucible walls are warm to the hand. This fire is then drawn over night, and the next morning, as soon as it is cool enough for workmen to enter, brick piers are roughly built on the hearth as high as the cinder notch and a grating composed of railroad iron and old grate bars is built at this level. On this a hot fire of coal or coke is started, and the draft being carefully regulated at the tap-hole. The hearth is kept warm by the hot coals and ashes. The fire is thus brought higher in the furnace, and one of the most important elements of a smooth start is assured by the drying and warming of the boshes. In all cases, the bell should be kept closed, and the hot products of combustion can be carried out through the bleeder, or better yet, led through the down comer into the flues, by slightly opening the gas valves on the boilers or stoves. In the writer's experience, from three to four weeks hard firing has always proved ample to dry the largest furnaces.

The subject of drying cannot be dismissed without some reference to the precautions to be taken during construction. The bricks should be thoroughly protected while awaiting use, from damage by rain or frost, the latter being a great factor in the disintegration of the brick work. The fire clay should always be steamed, not only to remove all lumps, but as a precaution against freezing in cold weather. The tunnel head should be roofed over, not only to protect the brick work, but to prevent any water finding its way into the expansion space between the in-wall and the counter-wall. When this space is filled with granulated cinder, which makes the best material for packing, the cinder should be dried before using, and it is well to fill it as hot as can be handled.

Before discussing in detail the filling of the furnace, it is well to call special attention to the physical character of the stock. Limestone, added to the first charges, should be broken sufficiently fine to pass through a three inch ring. It is taken for granted that the proper preparation of stock is diligently looked after. But both ore and stone should be broken smaller for filling the furnace than is necessary under ordinary conditions. Too large a proportion of fine ore should be avoided. Lump ore, broken to a suitable size, should constitute at least one half the burden.

Close attention must be paid to the varying amount of moisture in the ore, altering as it does, the percentage of silica and other constituents in the burden. The Hard Fossil ore of the Birmingham district contains very little moisture. The Soft Fossil ore, owing largely to the quantity of earthy matter associated with the gangue, the result of careless mining, contains a notable amount. The increasing use of the Brown Hematites calls for special notice, as the percentage of moisture, in addition to the water of combination, varies from five to fourteen per cent. in the washed ores. In the writer's opinion, frequent determinations of moisture are as important as those of Silica. As soon as the samples are taken they should be sent quickly to the laboratory and the percentage of Hygroscopic moisture determined by loss of weight on the water bath. All analyses should be reported in the natural state, as well as dried, at 212 degrees, otherwise the results are worthless.

Another point, worthy of attention, is the changing composition of stock-house ore piles. Not only do different parts of the same ore pile vary in moisture, but also in the relative proportions of lump and fine ore. The lump is generally higher in Iron and lower in Silica than the fine. Thus, errors in burdening will occur unless promptly corrected. It is a good rule to keep the fillers alternating from one part of the pile to another, thus getting an average mixture.

We now come to the subject of filling the furnace. It may be here stated, that drying should be continued until the last moment, the fires only being drawn the evening of the day before filling is to be commenced. The wood should be placed in the hearth as soon as it is cool enough for the workmen to enter. The wood and fuel in the lower part of the furnace are thus well dried and left in excellent condition for ignition. Planks may be laid for the men to stand on, and precautions taken against premature lighting by supporting the first layer of wood on brick. The manner of placing the wood varies in some essentials with the method adopted for blowing-in. Shavings and fine kindling are worse than useless. Elaborately constructed systems of channels or scaffolds are waste of time and labor. The two methods of blowing-in will be here mentioned : The older practice of drafting the furnace before the introduction of the blast, will be designated the Indirect, in contradistinction to the latter method of applying the blast as early as possible, which will be called the Direct.

Wood is used in the lower part of the furnace, not only because it is easily kindled, but also by reason of its great shrinkage in volume when consumed, thus starting the initial settling of the stock column of the furnace. Any more wood than is necessary to accomplish these results is a waste. The old time charcoal practice consisted in filling the furnace full of charcoal and lighting at the top. When the fires had burned down to the tuyeres, the furnace was refilled, the blast was put on and burdening commenced. With the use of mineral fuel, this method was modified as follows : The hearth was filled with kindling and fire wood reinforced with channels and piers. The furnace was then filled to the top of the boshes with cord wood. On this was filled, by means of a windlass and buckets, a small fuel plank and then the burden, consisting of small charges, gradually increasing in weight at short intervals. When the furnace was full, the torch was applied to the tap-hole and drafting conscientiously followed for from twenty-four to thirty-six hours. If the furnace drafted freely, after gas was seen burning at the stock line and cinder found to be trickling down into the hearth, it was thought time to put on the blast. It is not surprising that on the introduction of the wind, the furnace was often found to be bridged or scaffolded. Why a furnaceman should venture to go into blast with a hotter top and a cooler hearth than he would dare maintain in practice, is one of those mysteries which can only be explained by the fact that his fathers did likewise. The use of the windlass has been abandoned by all progressive furnacemen and the charges are now dumped over the bell. In most cases only three lengths of cord wood are used above the tuyere circle, and this can be reduced to two lengths with advantage. The size of the fuel blank has been increased, and the idea that it was necessary, in order to insure a smooth start, to blow in on a cold hearth with its accompanying evils of a dark cinder and a mottled iron is well exploded.

The only two advantages claimed for the Indirect method of blowing-in, are the gradual heating of the hearth and the carbonization of the wood before the blast is applied.
The former may be dismissed as insignificant, as after the blast is on, a balance is soon established in the hearth, whereby the loss of heat units by conduction, radiation, and the withdrawal of the fluid iron and slag, is compensated by the constant descent of incandescent fuel, the conditions of normal work are reached and the Furnaceman is justified in saying, "The hearth is hot." If the crucible has been well dried and warmed, the hastening of the means to attain this end can result in no injury to the brick work, while long delay in putting on the blast after lighting, is often productive of evil results. It is true, that the carbonization of the wood drives off the products of distillation, and the liability of danger from gas explosions is lessened. But the same results can be accomplished with equal safety while using the Direct method, as described further on.

The disadvantages of the Indirect method are, the increased cost of arranging the wood in the furnace, the long wait from the time the furnace is lighted until the blast is turned on, and the tendency of the furnace to draft stronger on one side than another, thus causing irregular settling. And if drafting is continued until cinder commences to drop into the hearth, the bosh walls are apt to become "scabbed" with masses of cold cinder, partly charred wood, and unreduced stock. Thus bad scaffolds are liable to be formed, and this is essentially true where the old method of building the wood high in the furnace and starting with a small fuel blank has been pursued. While many of the best furnacemen of to-day still use the Indirect method, they have done much to lessen its dangers by using a smaller amount of wood, largely increasing the size of the fuel blank and shortening the time to an average of seven or eight hours from the lighting of the furnace to the putting on of the blast.

During the last six years the writer has always used the Direct method and has found it satisfactory in every way. The general outline can be given as follows: Let us take for example a modern coke furnace, say 75x17 ft. which, with a 10 ft. hearth, would have a cubical capacity of some 10,500 feet. It is to be blown in on Alabama Coke, containing say 15 per cent. of ash and on a mixture of one-half Hard and one-half Soft Ore, giving an average yield in the furnace of say 43.5 per cent. The gas flues and hot blast main are dry, the stoves sufficiently warm to give at the start a temperature of from 400 to 500 degrees to the blast, and the most thorough precautions have been taken to insure the drying and warming of the furnace. As soon as the crucible is cool enough for the workmen to enter, a strong double cribbing of cord-wood is erected on the hearth as high as the bottom of the tuyeres, the lower wood being supported on pieces of brick to avoid any danger of premature lighting. This crib work is further strengthened by building in pieces of wood as radii, thus joining the inner and outer circles together. An average space of about one foot in width should be left between the outer crib and the crucible wall, and about two feet between the inner and outer cribs. All the space in the crucible not occupied by the wood is now filled with coke, which can be introduced through the tuyere openings and leveled even with the top of the cribbing. On this is laid a layer of one foot thick of coarsely split dry pine kindling, and on this another layer of the same thickness of split pine cord-wood. A space is left opposite a convenient tuyere arch, forming a well through which the cord-wood is passed up. On this layer of split wood is loosely placed pine cord-wood stood on end, and on this is placed another course of wood, preferably of dry hard wood.

Sufficient wood is now piled up in the furnace to close the well, which is then filled with kindling and wood, and the furnace is ready for the coke. In a furnace of this size, the fuel blank should consist of at least 80,000 lbs. of coke. The first 20,000 lbs. of which should be charged without any limestone. Sufficient finely broken stone should be filled with the remainder of the blank to flux the coke ashes. Some blast furnace cinder, if convenient, can be added, but its use is of no especial advantage. About 6,500 pounds of coke would make a convenient fuel unit for the charges of a furnace of these dimensions. The first charges of the burden would then consist of 6,500 lbs. of coke, and about 3,500 lbs. of ore with sufficient limestone to give a slag containing 36 per cent. of Silica. After filling five charges of the above, the burden should be increased at regular intervals until the last charges filled should contain 1.3 to 1.4 lbs. of ore to 1 lb. of coke.

The furnace should be filled to the stock line. While the filling is in progress, all necessary connections about the furnace should be completed, the water turned on all coolers and tuyeres, one of the stoves arranged for the blast and the tap-hole put in. It is a good plan after putting in the tap-hole, to drive a bar into the hearth at the level of the iron notch. After blast is on, the bar is withdrawn and the escaping gas kept lighted by a shovel full of hot coals. The notch is thus well dried, and after the blast has been on several hours the opening can be closed with stopping clay or by driving a bar again into the hearth. The cinder notch is closed, a brisk fire built in the gas flue where the down comer enters, and the bell and bleeder opened. A small quantity of coal oil is poured into each tuyere by means of a piece of bent pipe, and a handful of waste saturated with the same, is pushed back in front of each tuyere. The caps are then put up and everything being ready, one of the blowing engines is started and warm blast blown into the furnace. About 5,000 cubic feet per minute would be sufficient for the start. The probability is that if the blast has a temperature of about 500 degrees, all the tuyeres will at once light, but if the heat is not sufficient to accomplish this, after blowing for about five minutes, a red-hot pricker rod should be run into each tuyere when the wood is at once ignited. What the writer believes to be one of the most important essentials of a smooth blow-in, is now accomplished—the furnace has been uniformly lighted in a horizontal plane at the tuyere level. The coke in the crucible lights quickly, heats the hearth, and keeps the iron in good condition. If the work of the furnace is now closely watched through the tuyeres, the burning wood will be seen settling in the hearth. This is quickly followed by the appearance of incandescent charcoal, then comes the coke in rapid motion before the tuyeres. No attempt should be made to light the gas at the tunnel head. The dense wood smoke should be allowed to escape freely through the open bell. As the wood in the furnace becomes carbonized and burned, the color of the smoke changes until, when the coke nears the tuyeres, coke gas is observed at the top, which shortly lights itself. When the gas is burning strongly around the bell, the gas valves of the boilers and stoves should be opened, and the bell and bleeder closed. The gas is thus safely passed through the flues and ignited without danger of explosion.

It is of course impossible to lay down any iron-clad rules for blowing-in a furnace. The experienced manager will be guided by the size of his furnace, the character of the coke and ores, the condition of the stock, whether wet or dry, the first temperatures given by the stoves to the blast, the percentage of moisture in the atmosphere, and numerous other details. He has as his indicators of the reactions taking place in the furnace, the appearance of the tuyeres, the blast pressure, the character, volume and temperature of the gases, the composition of the slag and the percentage of silicon in the iron. Although neither cinder nor iron has yet appeared, the other signs are sufficiently plain to indicate the volume of wind required.

We have started with 5,000 cubic feet of blast, and as the temperature of the stoves is apt to be under rather than over 500 degrees and as the heats at first come up slowly it is probable that this amount of wind will be sufficient for several hours. The revolutions should then be increased at intervals, as the temperature of the blast rises, until by the time of making the first cast, which should be about 15 hours after lighting the furnace, the volume of the air blown should be at least half that which the furnace receives under normal conditions. No additions should be made to the burden until after making the first cast. By that time, the last charges filled in starting the furnace are nearing the hearth and such necessary changes can be made in the burden and rate of driving as are indicated.

The best practice seems to demonstrate, that while the volume of air and the weight of the burden should be increased as the temperature of the blast rises, when the stoves show 1000° to 1050°, it is better to hold them at that temperature for a few days, counteracting any tendency of the furnace to get too hot, by increases of burden. After the blast has been on for about five days, most large furnaces exhibit a marked tendency to suddenly swing off too hot. If the blast heats have been forced unnecessarily high, the danger is intensified. The reason for this is, a furnace does not become thoroughly dried and heated until after it has been in blast at least five days. This critical period safely passed, the furnace should be quickly brought up to normal work.

Some notes will now be given on the blowing-in of No. 1 Blast Furnace, one of the four furnaces comprising the plant of the Tenn. Coal, Iron and R. R. Co. at Ensley, Ala. This furnace, as originally built, had a total height of 80 ft., the bosh and hearth being respectively 20 ft. and 11 ft. in diameter. The bosh was located 37 ft. above the hearth, much higher than advisable. When remodeled by the writer, the bosh diameter was reduced to 19 ft. in order to lower the bosh to a point 28 ft. above the hearth level, as it was impossible to alter the bosh angle without expensive changes in the wrought iron jacket. The bosh lining was protected by 1 1-4 inch horizontal coils of the Hartman pattern. The furnace was well dried by nearly a months hard firing and the stoves were heated by gas taken from the adjoining furnaces. That the stoves were well dried and warmed is shown by the first temperatures being over 800 degrees. This was no disadvantage as it enabled a rapid increase to be made in the engine revolutions and no difficulty was felt in holding the stoves at the desired temperatures.

The hearth was filled with a strong cribbing of cord-wood and a layer of split pine wood was laid across the furnace at the tuyere level. On this three lengths of cord-wood were stood on end. As only pine wood was obtainable, it was thought better to use three lengths instead of two. On this was next filled the fuel blank of Pratt Coke, 22,000 lbs. being filled without any stone, and 78,000 lbs. with 12 per cent. of stone. The burden was composed of equal parts of hard and soft ores, and sufficient stone was added to form a slag containing 36 per cent. Silica, allowing for 2.5 per cent. Silicon in the Iron. The first cinder flushed contained 35.41 per cent. Silica. The first seven charges filled contained, coke 6,500 lbs., ore 4,000 lbs., stone 980 lbs. The burden was raised every seven charges, until the last charges filled consisted of 6,500 lbs. coke, 8,700 lbs. ore, and 2,000 lbs. stone. A small piece of greasy waste was placed in front of the nose of each tuyere, and when everything was ready, 7,000 cubic ft. of blast was turned on through a hot stove. In less than two minutes all the tuyeres lighted, the temperature of the blast being 820 degrees. The heats were ordered to be kept at 800 degrees, and the revolutions increased gradually until at the end of the first 24 hours, the furnace was receiving about 16,000 cubic feet. Owing to the favorable auspices under which the furnace was blown-in, the dry condition of the stock and the excellent soft ore accumulated while relining, it was thought advisable to increase the burden before waiting for the first cast, a procedure which was justifiable as the first iron was Soft. Cinder was tapped fourteen hours after lighting and was hot, grey and fluid. The first cast was run sixteen hours after lighting and contained 17½ tons Nos. 1 and 2 Soft iron. The first complete furnace day, 84 tons, 2,400 lbs. to the ton, were made, 80 per cent. foundry iron; the third day 142 tons were made, and on the sixth day 155 tons, of which 108 tons were foundry iron. By this date the furnace was carrying a burden of 6,500 coke, 2,700 stone and 11,680 lbs. ore.

The writer feels that no apology is necessary for going so fully into particulars. Successful furnacing consists in constant watchfulness over all the details of the art. It might be well, in conclusion, to repeat the advice already given :—Better go into blast hot; a large coke blank furnishes sufficient heat to the hearth, insures the reduction of the ore, prevents the descent of raw stock into the crucible, and gives an abundant supply of gas.

A discussion of this paper being called for, Mr. Meissner, of the Vanderbilt Furnace, (city) said:

The points Mr. Kennedy makes, are points that have been discussed very frequently, and there are none of them that I can see to criticise, except the one of putting on the blast at once; that is a matter where our best furnace-men differ, so I hardly think any discussion on that point, is very necessary. A great many of us prefer to wait 15 or 20 hours before we put the blast on, and others put it on as Mr. Kennedy does, with great success. The other points are very well taken. We wait 15 hours before we put the blast on. One trifling point is, instead of placing the wood on brick in the hearth, to use pieces of pig iron; I don't like to have any more loose brick in a furnace, than is necessary.

A paper on the "Thomas Coking Oven," by Mr. J. T. Hill, Manager of the Coal mine at Coalburg, was read by Mr. Priestly Toulmin, as Mr. Hill was unavoidably absent from the meeting. In introducing this paper, Mr. Toulmin said:

This paper was made out at the Spring meeting, six months ago, and if Mr. Hill had been present, he would probably have added to it. I have simply added the figures with reference to the cost of late; the cost has come down very perceptibly in the last six months. I find that the average cost was considerably less than Mr. Hill thought that it would be, when this paper was written:

THE THOMAS PATENT COKE OVEN,

(WITH PLATES, I, II, III.)

Having received many inquiries in regard to the practical workings of the "Thomas" Ovens, now in operation at the Coke Works of the Sloss Iron & Steel Company, at Coalburg, I have in the past been compelled to give somewhat indefinite replies because of the uncertainties existing in my own mind, but after sixteen months of practical experience with them, I now feel qualified to present my views, and believing that the subject would not be lacking in interest to the majority of the members of our Society, I have adopted this means of presenting them.

The "Thomas" oven is not, as is generally believed, a modification of the "Belgian" oven altogether, as, except in similarity of shape and method of drawing the coke, it possesses none of the various arrangements incident to the application of heat, the saving of by-products, waste gases, etc., but it is more an improvement upon the old "Welsh Oven" which is now, and has been for a great many years, largely in use in Wales and certain parts of England. The "Old Welsh Oven" is described in the books as "a simple rectangular chamber, 7 x 12 ft., with an arched roof 6 ft. high. The whole front of this oven is movable, and the coke is drawn by means of a drag laid across the back of the oven prior to the charging."

The essential difference between the "Old Welsh Oven" and the "Thomas," exists in the facts, that the latter is much longer, affording greater capacity, and that both ends are movable ; thus doing away with the necessity of placing the drag in the oven prior to charging. In nearly every respect the ovens themselves are identical.

At Coalburg, there are 64 "Thomas" ovens arranged in one single continuous battery. In construction, the same principles are carried out and material used as in the Bee-Hive Ovens, except that the bottoms are of hard red brick, upon the theory that they resist the wear of the drag better than the fire brick. In detail they are discribed as follows, viz:

Length,	36 ft.
Width inside,	7 ft. 3 in. at back.
" "	7 ft. 9 in. at front.
Height over all,	8 ft.
Height of Door,	4 ft.
Height inside,	5 ft.

Fall in bottom from back door to front, 1 in.

Both the BACK and FRONT are movable and have swinging doors (as shown on the accompanying sketch) which are in two sections and built of fire brick of special design laid in iron frames. There are three openings on top—two tunnel heads and one draft stack near the back end of the oven. In front of, and on a level with the floor of the ovens, is an "apron" of stone and brick masonry, eight feet wide and running the entire length of the battery. Four feet below this apron is another piece of masonry seven feet wide, which also runs the entire length of the battery on which the track for the "Dinkey" containing the machinery for drawing the coke is located. Still further below is the railroad track on which are placed the cars for the receipt and shipment of the coke. At the rear of the battery is another track on which runs a car used for conveying the "drag" from oven to oven, and on this car is permanently fixed a crab for pulling the drag back after discharging.

In the process of coking, the same general principles as to drafting, etc., are observed as in the Bee-Hive ovens. It is proper to state, however, in this connection, that in the original construction of the ovens, a flue was put in for the admission of air, but in practice, it is found that an ample quantity unavoidably finds its way in through the crevices of the doors, in consequence of which, it is necessary to keep the flues closed. Twelve tons of coal are charged from two six-ton larries, through the tunnel heads, as shown in the sketch, and the levelling is done from both ends. When ready to "draw," the doors at both ends of the ovens are swung open and an iron rod passed through the oven over the top of the hot coke and attached to the drag at the rear. The hot coke is thus drawn in a body out at the front end of the oven and over a screen attached to the Dinkey, at which point the fire is quenched with water falling from a tank, situated above the screen, (no water whatever being thrown into the oven.) From the screen it falls in broken pieces to the railroad car below and is ready for shipment.

The yield is practically the same as from the Bee-Hive Ovens, under skillful management, and the quality of the product, so far as can be determined by analysis and observation, is fully up to the standard. I regret that I cannot present data showing its relation to the Bee-Hive coke, in furnace practice, but the conditions of consumption are such that it has not been practicable to make such a test.

It is unnecessary to enumerate the many advantages claimed by the patentee for his ovens, at the time of construction, nor the many discouraging circumstances that have been met with incident to their management, and I shall confine myself to a statement of results as I know them to be. I find:

1st. The yield is equal to the Bee-Hive Oven.

2nd. The quality of product is fully up to the standard.

3rd. That it is practicable to quench the coke outside the oven without detriment to its quality, resulting in leaving the oven hot and dry for the reception of the following charge of coal.

4th. The saving of one handling, by which a large percentage of coke is saved, which would otherwise be rejected as braes.

5th. Economy in production. In demonstration of this last statement, the following table, showing the comparative cost of labor between the Bee-Hive and Thomas Ovens, is submitted, viz:

STATEMENT SHOWING LABOR COST OF COKE, BY MONTHS, FOR FISCAL YEAR ENDING JAN. 31, 1891.
(Coalburg Department.)

Months.	General Average Bee Hive Ovens.	Thomas Ovens.	Difference between Thomas Ovens and Bee Hive.
February,...1890..	.415	.402	.013
March,......."...	.440	.343	.097
April,........"...	.397	.301	.096
May,.........."...	.385	.332	.053
June,........."...	.424	.274	.150
July,.........."...	.432	.288	.144
August,......."...	.435	.239	.196
September,..."...	.466	.246	.220
October,......"...	.474	.300	.174
November,..."...	.405	.303	.102
December,..."...	.731	.249	.482
January,...1891..	.416	.280	.136
Average for year,	.440	.291	.149

Average cost per ton, Bee-Hive Oven,	44 cts.
" " " Thomas "	29, 1 cts.
Difference in favor of Thomas Ovens.	14, 9 cts.

By reference to the above figures, it will be seen that the cost, during the first months of the year, was considerably more than the succeeding months. Had the ratio of the latter months been maintained throughout the year, the average cost of production would have been considerably less. In explanation of this, I will state that at the time I took charge of the ovens in December, 1889, the coke was costing considerably more than the highest figure shown, the product did not exceed 50 per ct., and the quality was so poor and its condition, when placed upon the cars, of such character as to cause its universal condemnation. The President of our Company was utterly discouraged, and had about decided to abandon them, and probably would have done so but for my earnest solicitation to be allowed an opportunity to give them a trial. Considerable time was of course necessary to perfect reform and obtain results, but that results have been obtained, the above figures and the good quality of the present product will testify, and with still further reforms and changes which I have in contemplation, I am confident that the average labor cost, for the present year, will not exceed 25 cts. per ton.

The above figures include all items of cost except material for repairs, which latter I have not at hand, but can state that such cost is less than for the Bee-Hive Ovens.

I am confident that a great many improvements can yet be made upon the oven that will not only lessen the cost of production, but result in large savings in other ways. At Coalburg, I believe that by a simple arrangement of flues, similar in construction to those attached to the "Welsh" ovens at Browney Colliery, in the Durham region, England, a sufficient quantity of gas, which is now wasted, could be utilized without detriment to the coke, to run all machinery of the adjacent coal mines.

In conclusion, I will state that while I am not by any means an enthusiast in regard to the "Thomas" ovens, I do feel that enough has been accomplished and demonstrated, to cause us to step aside—at least for consideration and investigation—from the commonly accepted opinion that there is no oven equal to the Bee-Hive, and it is with this object in view, that this paper is submitted. J. T. HILL.

Coalburg, Ala., April 8, 1891.

Mr. Richard Thomas, the Patentee of the oven, was called on for some remarks on this subject; instead of responding verbally, he distributed some circulars, descriptive of his patent.

(Dr. Phillips, Sec'y,)—There were two or three other papers to come at this meeting—one was on the "History of the Manufacture of Coke in this State." Unfortunately, the writer is not prepared to give it. There is also a paper on the list entitled "The Consumption of Coke in the Alabama Furnaces"—a very delicate question, and one on which we have not been able to get any information so far. The last one on the list is still in an inchoate condition. I gave notice at the Anniston meeting, that at the Birmingham meeting, I hoped to have an ultimate analysis of all Alabama cokes, a complete natural history. Unfortunately, I have had a very severe case of sickness in my family, and I have been in the sick room for weeks. I have a number of cokes that have been analyzed.

Dr. Phillips then gave the analyses of a number of cokes from Alabama coals, together with the results of a series of experiments made by him in these cokes, to determine their resistance to crushing force. The complete paper will be published in the next volume of the Proceedings. The reading of these analyses gave rise to the following discussion:

(Mr. Meissner:)—What is your opinion, in regard to the effect the per cent. of ash will have on the crushing strain of coke?

(Dr. Phillips:)—Let us take these cokes of the DeBardeleben Co., the 48 hour, at 12 : 90 per cent. of ash, and the other 72 hours has 11 : 80 per cent. ash. There is a difference of only 9-10 of 1 per cent. in ash, and you will see there is a difference in the crushing strain of 400 lbs. This difference must be referred to the duration of combustion.

(Mr. Toulmin:)—Here is Pratt Mines coal with 7 : 90 ash, and the Cahaba with 6 : 10 ash; the Pratt Mines coke breaks at 540 lbs, and the Cahaba at 445 lbs.

(Mr. Meissner:)—I hardly think you can make a comparison, unless you take the same cokes. Take the Pratt Mines coal with 6 per cent. to 12 per cent. of ash, would there be much difference in the crushing strain?

(MR. T. H. ALDRICH, Cahaba Coal Mining Co., Blocton.)—An idea occurs to me; it rather strikes me that a little more ash would make harder coke. If you take the Connellsville coke, it will run from 8 per ct. to 10 per ct. of ash, and I think the amount of ash has something to do with its hardness. Lately, I have made an experiment, at our place, by grinding the coal up, and we have succeeded in making very hard coke by distributing the ash through the coal; it will stand a great deal more pressure than if we had not done that; in other words, a chemical analysis is only one of the means of judging of a coke, and the mechanical condition is just as important. I really believe we have succeeded in making a harder 48 hour coke by grinding the coal up, than the former 72 hour coke without grinding it up. That is the way it looks, in our experiments.

(MR. MEISSNER:)—What breaks up the coke is small particles of slate; whenever we see a piece of coke broken, the fracture will show a small quantity of slate. If all coal was crushed, I think the percentage of ash would cut a much less figure than now. I think it is not so much the percentage of ash, as the mechanical condition of the coal; we have proof in various cokes we have used.

Some coals that are very free of ash will not stand the burden that some will carry, with more ash. That is why I asked the question: whether in your opinion, ash would affect the crushing strain of the coke?

(DR. PHILLIPS:)—I don't think it would if the coal was put in the oven in a finely crushed condition.

(MR. ALDRICH:)—We crush our coal with a disintegrater; it crushes to the size of a grain of wheat. The slate present, induces cracking, not only on account of the lack of cohesion between slate and the carbon, but also on account of a contraction and expansion of the slate itself. It radiates heat quicker than carbon and it cools there and makes a fracture. If you grind it up and distribute the slate, it does not have that action; the coke will not crack so badly and it will be harder coke.

(MR. SEDDON :)—I think we have demonstrated that ourselves, at Brookside; all the coal we coke at that point is very strong. There is a very curious thing about the physical structure of coal; you will find that some coals, after the coking, would break in a knotty structure. Mr. Aldrich's coke always has a tendency to break into fingers, and the Pratt coal also, has very much that tendency; the New Castle coal always breaks into chunks, and the Pocahontas breaks in chunks, and the Connellsville breaks in the same way. I don't think it depends upon the quantity of ash, there is something in the coal that is inexplainable. I think the coke is made harder by ash. We get very much better results from the coal being crushed in the disintegrater, despite the fact that all the coal is mined by machinery. and the quantity of ash is higher in that coal; despite that fact we get a better coke and a harder coke.

(MR. MCCORMACK, of Pratt Mines:)—At Pratt Mines we have crushed some coal with a hammer, I suppose to the size of a pea. I do not admit that the crushing of the slate improves the quality of the coke; for instance, if you have a lump of coke about as big as a half bushel, you have 20 or 30 small pieces of slate in it, then all the coke immediately surrounding the small pieces of slate would be made of pure coal; to crush that slate up and mix it with the mass, it certainly would not improve any other coke except that part lying next to the slate.

(MR. SEDDON :)—You do not eliminate the slate, but you certainly put the slate in a shape that makes the coke harder; I think there is no question about that.

(MR. HASKELL:)—Experience at Blocton has shown that whenever there is a particle of slate in the coal, there was a fracture in the coke; if the coal was finely ground up there could be no fracture.

(MR. MEISSNER:)—If that slate is not any larger than the size of a pea, I have no idea that will make any difference; however, when the slate becomes larger, it is bound to break the coke, and very naturally increases the breakage. There is no question about breaking it up to a small size, you will get a much harder coke; of course, in small pieces, it won't tell so much ; these small particles of slate will not break it up, and the moment it becomes larger, you will see where the fracture is.

(Mr. Aldrich :)—It seems to me that we lose sight of the question of temperature ; when the slate is heated very hot it expands, and when it cools it contracts. All slate contracts suddenly by putting water on it, and it makes a crack every time ; there is where your small braise comes from in the coke ovens.

(Dr. Phillips :)—There would be no crack if there was sufficient bituminous substance to make it fuse ; if it did fuse it would not crack so badly. Do you find any difference in the structure of coke from crushed and uncrushed coal ?

(Mr. Aldrich :)—Yes, sir ; the coke from crushed coal is much harder and stronger.

(Dr. Phillips :)—Does it finger ?

(Mr. Aldrich :)—No, sir ; it fingers when it is uncrushed, after being crushed it does not. That is something I don't understand.

(Mr. Meissner :)—I think it must be a matter of the physical structure of the coal. Col. Montgomery was telling me of some cokes that will finger beautifully from the coal being crushed, and other cokes will not do that. In Connellsville coke there is very little difference in the fingering, whether the coke was washed or unwashed.

(Dr. Phillips :)—I think the key note of this whole business is, that we have paid too little attention to the composition of the coal itself.

Another point which helps the coke is this : dumping from the main track into the oven, all the lumps run on the side, the hot bricks will set the coal on fire, and if the coal is highly bituminous coal, it will melt and run together. The bituminous matter escaping from these lumps prevents their sticking together, and you will find the coal is spongy.

(Mr. McCalley :)—Is it known what grade of coke a coal will make without actually coking the coal ?

(Dr. Phillips :)—No, sir ; it can't be told, a great many costly mistakes have been made from trying to predict the quality of coke from an analysis of the coal. I think it arises from the fact that it is so hard to get an average analysis of the coal. Sampling coals, cokes or ores, is the hardest business a chemist has to do, and the most particular. I think it has had less attention than anything else in this district, and it is the most important.

(MR. McCORMACK :)—I would like to know what makes the coal coke ?

(DR. PHILLIPS :)—I don't know. Do any of us know ? If anybody knows I hope they will speak up, for I would like to know. Nobody knows, so far as I know, what makes coal run together and coke. When you subject coal to distillation of that sort, there may come off 135 different things ; 86 different things, excluding parafine in the coal ; the number of parafines is legion, and which one of these things comes off in distilling coal, and induces the running together, nobody knows. We can't tell which one of them is the thing that causes the coal to run together.

(MR. SEDDON :)—I suppose it depends upon the ratio between these different things.

(MR. MEISSNER :)—You can't coke ordinary coal that lacks 5 per ct. of bitumen by adding 5 per ct. of asphalt to it ; if it had been found in practice that it was a good thing, or an economical thing to do, it would be done now.

(MR. COWLES :)—There is a very interesting question coming up here, as to the use of gas. As I understand it, the City of Pittsburg has a great advantage over the City of Birmingham in the use of natural gas ; they can work up their iron cheaper than we can do it here, and if the gas can be saved for manufacturing purposes, it will be a matter of immense importance to the city and entire district. Inasmuch as the matter was suggested here, I mentioned this question.

(MR. PROCHASKA :)—I want to correct you on one point ; the natural gas in the City of Pittsburg costs just as much to make a ton of steel there as here ; they are shutting down on the Companies' use of it anyway.

(MR. COWLES :)—One great advantage in the use of gas is, that we have always control of it. If you take it from your ovens, and let that fact be known, it would be of immense importance in attracting people down here.

(MR. SEDDON :)—In Tracy City, Tenn., they have been taking the gas from the ovens. If you have a double battery put in, it is an easy matter to put the flues in, and you can take these combustible products and carry them to the boilers.

(DR. PHILLIPS :)—Do they find any difference in the quality of the coke?

(MR. SEDDON :)—Oh, no; it is exactly the same coke; there was some difficulty at first, as to the clogging of these flues, but we have not had any trouble.

(MR. MCCORMACK :)—I made some experiments at Pratt Mines, in taking the gas from the ovens to generate steam; our flues were rather too small and we abandoned it at the time. We are putting in larger flues and are making steam without any trouble; we did not have the flue capacity, and did not have a high enough stack.

[Q. by a Member :]—On the other hand, don't you think it might affect the quality of the coke, if you had too much of a draft? Isn't it very easy to get too much of a draft? That has been probably the cause of some of the failures in trying to utilize the gases.

(MR. MCCORMACK :)—I think that would have a very important bearing on it, and of course is a matter that would have to be looked after. I would like to ask Mr. Seddon, in the filling of ovens, and the drawing of them—the general use of those ovens—would it be a saving to build the rectangular ovens instead of the Bee-Hive ovens?

(MR. SEDDON :)—My personal opinion is that they would not do. I think one great trouble in the Thomas oven is, our yard was too small at the time they were having them built. We made the yard narrower; that yard should have been 40 feet wide.

(MR. MEISSNER :)—There is a question I would like to ask: whether the coke from the Thomas ovens has not been more moist than the coke from the other ovens? You may remember, we had some Connellsville coke; I had taken the samples all the week; we had three different kinds, and the Thomas coke was moist while the others were dry, and it seemed that the Thomas coke was water-marked to the very center. I would like to know if that is an exceptional matter, or whether that is the case with all coal?

(MR. THOMAS:)—Rich bituminous coal will commence to coke from the sides but not on the top. The volatile matter in the coal drops down to the bottom; and you will get about three distinct kinds of coke; the top part is very spongy, the middle part is very good, but the bottom part is very heavy and has too much bituminous matter in it.

(MR. ALDRICH:)—I would like to ask if you ever made any experiment in regard to the coking of coal under pressure?

(DR. PHILLIPS:)—No, sir; I have not.

(MR. SEDDON:)—I would like to ask Dr. Phillips to present his paper to the Society, and say that I think that it is one of the most important studies that could possibly be made. I offer a resolution that Dr. Phillips go ahead and complete his paper at the next meeting, and that the question of "coke" be continued. Motion seconded and carried unanimously.

(MR. MCCORMACK:)—I suggest that Dr. Phillips take another sample from the Bee-Hive. Samples will never be satisfactory until there is an automatic sampler; you make a machine do that and there will be no dispute.

(MR. MEISSNER:)—If you sample ore in car-loads, I believe the automatic sampler will not do. You can do the sampling; but in the first place, you can't make the machine go and pick up the samples. I think the human apparatus, with a brain on top of it, is the best for samples.

(DR. PHILLIPS:)—I have found that the brain he talks about is not exactly angelic; if that brain was angelic we would all be happy. I have just gotten back from sampling 40,000 tons of ore, and I don't want that job any more; no more than 12,000 or 15,000 were from one place, and it took me a week to do it. I don't swear now that I could go back over the piles and get the same result.

(MR. MEISSNER:)—I don't think there is very much difficulty in getting average samples; we take a sample from every car, put it altogether, and mix it up at the end of a week. In a very short time the operation becomes so mechanical, and you get so tired, you don't pay any attention to it and go about it indifferently.

(MR. SEDDON :)—We go over all the cars, and the samples are analyzed twice a month. It seems to me, the best plan for sampling is to put a little boy alongside the scale, and take from each tram car or larry, a sample; put it in a box and take a portion from this each day. I think our samples are pretty correct, because they do not vary much. I have it figured up every week.

(DR. PHILLIPS :)—I havn't found any variation in anything in this State that will compare with the variations in the composition of coke. I used to make an analysis every week for a Corporation in this district, for about 18 months, and the coke made from the different veins of coal varied from 6 per ct. to 16 per ct. in ash.

(MR. MEISSNER :)—We have followed the result up, and the figures vary comparatively very slightly; whereas, last year, they varied a great deal. This year, I think the variation is only 1 1-2 per ct., and in many cases I doubt that they will vary that much. I think there has been a wonderful improvement on that score; that is, from our own sampling. I am satisfied when we get in our crusher, our coke will give us very close results with the Connellsville coke.

(MR. ALDRICH :)—I find that water has something to do with the reduction of sulphur; you wet your coal and you will find considerable difference in the coke.

(MR. SEDDON :)—The trouble is in the form of the sulphur as much as the quantity of the sulphur. In the approximate analysis of Birmingham coals, it is difficult to distinguish between sulphur as a sulphide and a sulphate; it is usually about half and half—there is as much sulphate as sulphide. The sulphate would not do the injury in iron making that the sulphide would—one would go into the slag and the other would go into the iron.

(DR. PHILLIPS :)—The sulphate would be reduced to the sulphide in the blast furnace very quickly.

(Mr. Seddon :)—If the sulphur is in the ore, you can take it out, but if it is in the coke you cannot prevent its combining with the iron. I have been experimenting to find what the percentage of sulphur is in the pyrites; I consulted several chemists in Philadelphia and elsewhere on the subject. How does sulphur exist in coal?

(Dr. Phillips :)—It is supposed, in three conditions—SULPHATE, SULPHIDE, and ORGANIC SULPHUR; organic sulphur passes off as soon as the oven gets hot. The sulphate is most likely reduced to a sulphide; you will still have some sulphate, but most of the sulphate will be sulphide.

(Mr. Seddon :)—I want to find out whether there is a sufficient percentage of sulphur eliminated to justify the expense of washing the coal?

(Dr. Phillips :)—You will have to try that in the coal washer itself.

Mr. J. B. Carrington, Superintendent of Gamble Mines, at Jasper, Ala., and Mr. Peter Findly, Editor of the Alabama Sentinel, of Birmingham, Ala., were proposed as members of the Association.

On motion, the rules were dispensed with for the present, and these gentlemen elected, by the Secretary casting the ballot.

(Dr. Phillips :)—If we are going to continue the subject of coke, I think it would be better not to publish the next volume of Proceedings until after the January meeting, and to impress upon our friends in the meantime the necessity of writing something, so it can go down as a matter of record; we would like something to refer to.

(By a Member :)—We expect you to do the writing.

(DR. PHILLIPS :)—I will do my share. Can't we get somebody to write the paper on Blast Furnaces?

(MR. SEDDON :)—I don't think anybody but a practical furnace man is competent to write it, and none of them wants to do it.

(MR. MEISSNER :)—I think it would be better to let that subject rest until after we have the washers in. The results are very unsatisfactory, and it would be very difficult to enumerate all these reasons. I think that probably after we have a washer or two here, in six months from now, a paper of that kind could be written and some very satisfactory results gotten out of it.

(DR. PHILLIPS :)—We will call for volunteers on this subject at the next meeting, and let everybody know that somebody will write a paper of some sort.

(MR. MEISSNER :)—I will undertake, for my part, to give a paper on the Analyses of Coke, and the Analyses of Ash. I can't do any more than give approximate analyses of coke, but I can give pretty complete analyses of ash. I would very much like to do that in connection with your tests of the crushing strain of coke.

(DR. PHILLIPS :)—One paper is "Coke Analyses," by Mr. Meissner; "Coking Coals" by Mr. Haskell.

(MR. ALDRICH :)—I want to call the attention of the Association to an analysis of coal in the Cahaba Coal Field, that is rather different from the ordinary run of coals, and it might give us some food for reflection. It is one of the lowest seams in the Cahaba Coal Field; it shows water 0.17 per cent—volatile matter 25.75 per ct.—fixed carbon 70.10 per ct.—ash 3.68 per ct.—sulphur 0.08 per ct.—less than 1-10th of 1 per ct.

(BY A MEMBER :)—Where do you place that coal?

(MR. ALDRICH :)—It is called the Gould Vein. It would be located where the Black Creek Vein is. It is the lowest seam with one exception ; there is a little seam under it, and there is another seam right above, the millstone grit.

(Dr. McCalley :)—The millstone grit is usually recognized as the base of the coal Measures. I know of other places where there are 3 to 7 seams under the millstone grit.

(Mr. Meissner :)—I would suggest you leave a space open for a paper on the "Coal Washer."

The Secretary then announced the following paper :—"The Manufacture of Coke," by Mr. Aldrich—to be read at the next meeting.

(Dr. Phillips :)—I am sorry to say that I do not think I shall have the pleasure of meeting with this Society again. I have decided to go up in Kentucky to engage in the manufacture of iron, and I will go about the first of the year. If possible, I will be down to the January meeting, and if I am not, my heart is with you, though my body is absent.

(Question by a Member :)—Will you give us your yield of coke for the first six months?

(Dr. Phillips :)—I will give you the whole thing. I don't believe there is any way quite so good to correct errors as to confess them, if a person will "tote fair." We are going to put this furnace in blast with charcoal at first.

On motion to adjourn this meeting until the second Wednesday in January, the meeting adjourned at 1:30 p. m.

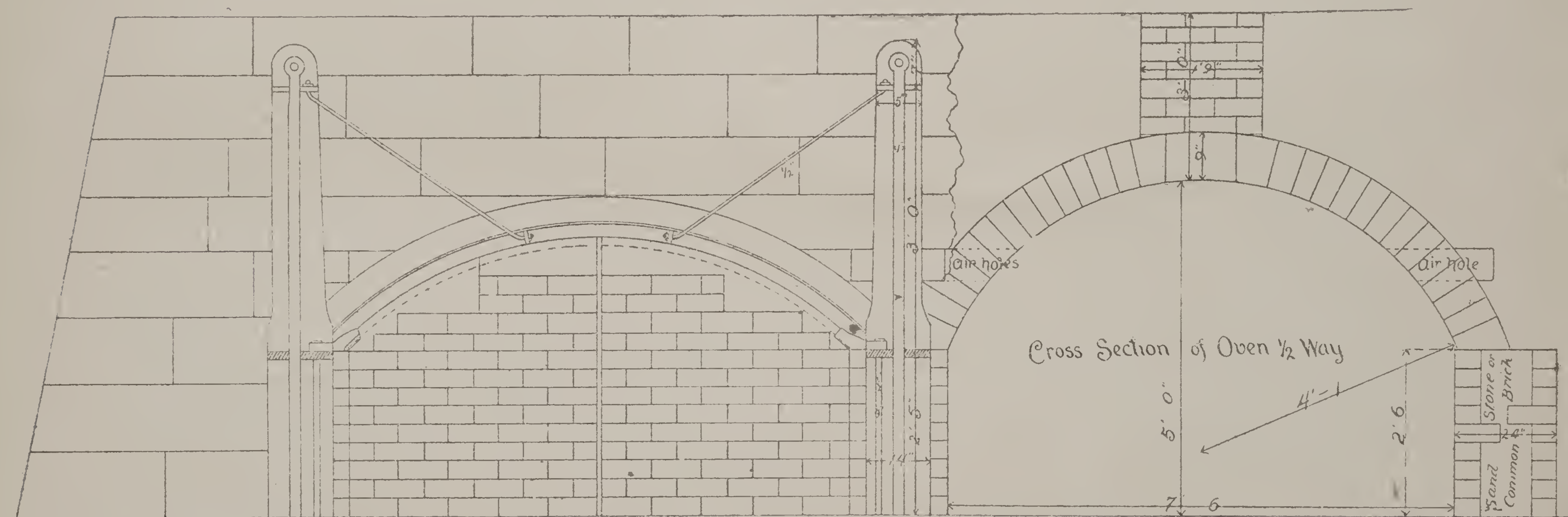
Cross Section of Oven ½ Way
air holes
air hole
5' 0"
4'-1
2' 6
7' 6
9"
3' 0"
3' 0"
Stone or Brick
Sand Common

PLATE I

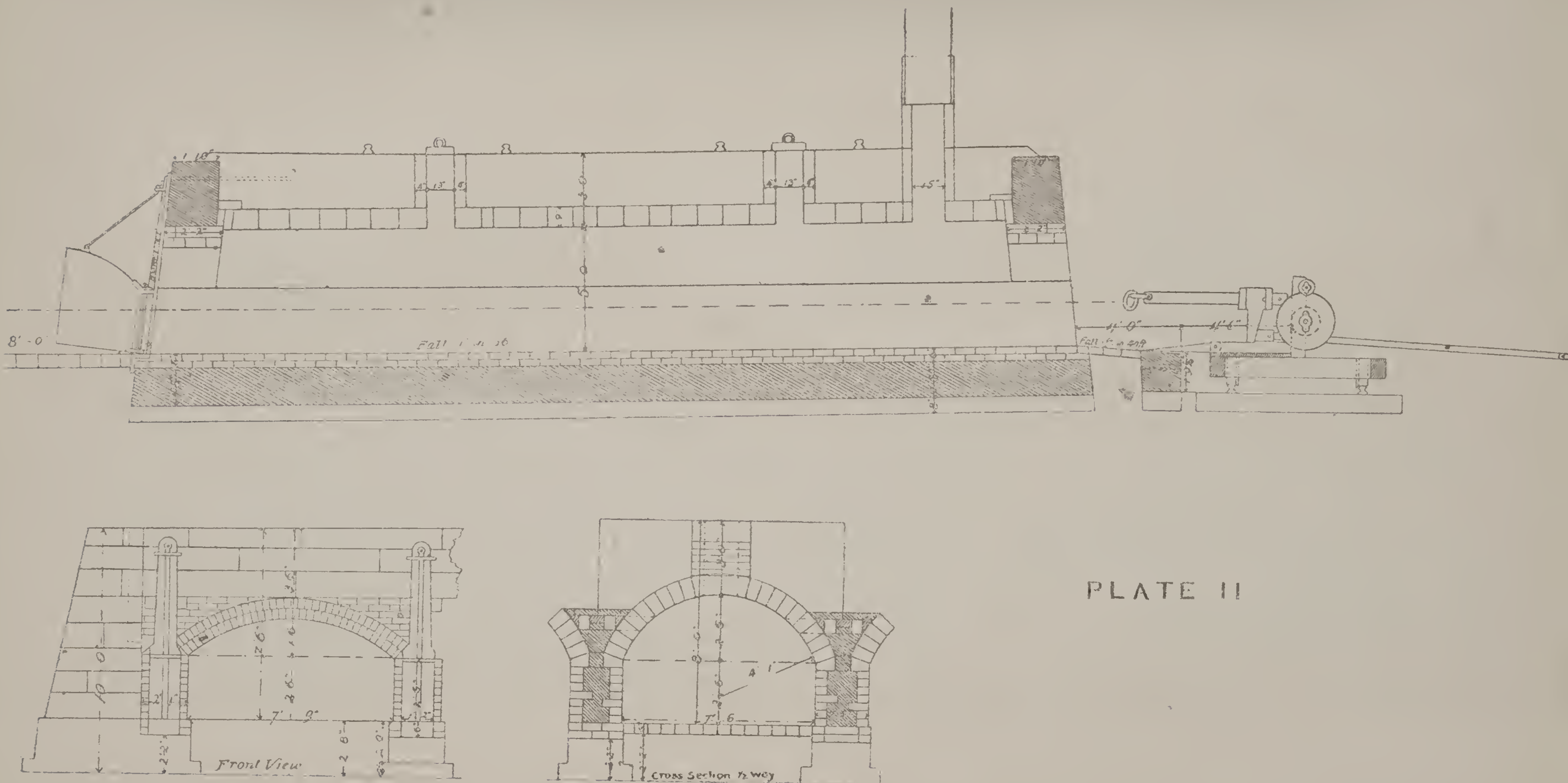

PLATE II

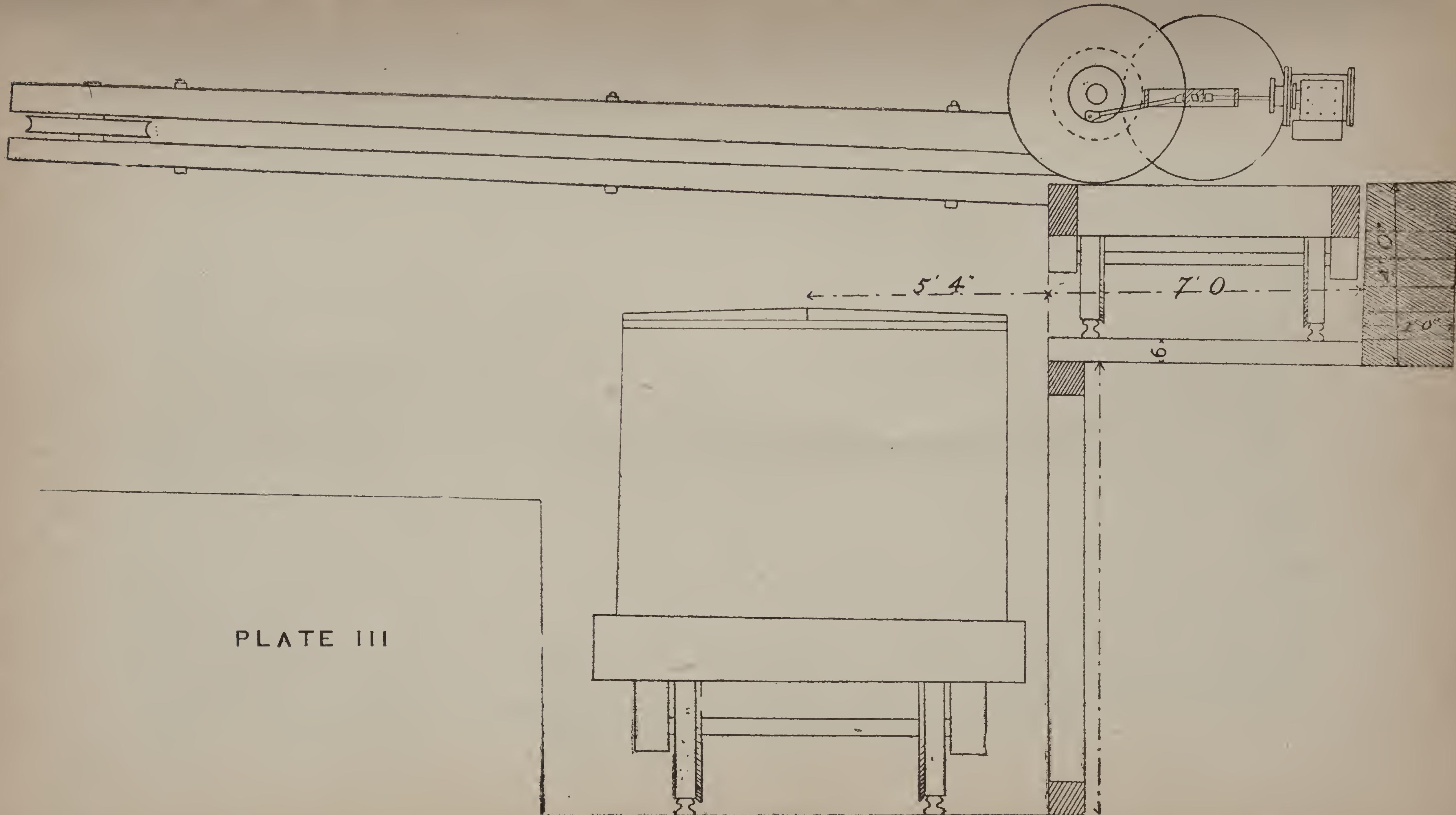

PLATE III

PROCEEDINGS

OF THE

Alabama Industrial and Scientific Society.

VOLUME II.

—1892—

PROCEEDINGS

OF THE

ALABAMA

INDUSTRIAL AND SCIENTIFIC SOCIETY.

VOLUME II.

1892.

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1892.

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Henry McCalley, - . - - University, Ala.

SECRETARY.

Eugene A. Smith, - - - - University, Ala.

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PROCEEDINGS OF THE ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

The time set for the Winter Meeting was the second Wednesday in January (13th), 1892. At this time a few members only were present, and the meeting was deferred, subject to the call of the President, till some time in May.

SPRING MEETING.

BIRMINGHAM, May 18, 1892.

The deferred meeting was called to order at 11 A. M., May 18, 1892, in the Hall of the Knights of Pythias, in Birmingham, Ala. Col. C. Cadle, Jr., President, in the chair. The minutes of this meeting having been lost, it is impossible to give anything more than an outline of what was done.

On counting the ballots the following gentlemen were found to be elected to the offices mentioned below, viz: Mr. C. A. Meissner, President, Messrs. T. H. Aldrich and J. M. McKleroy, Vice Presidents, and Eugene A. Smith, Secretary.

Upon announcement of the vote, Col. Cadle retired, and Mr. Aldrich, Vice President, took the chair in the absence of the President. Mr. Meissner came in later and presided till close of the meeting.

The conclusion of Dr. Phillips' paper on Alabama cokes was read, and this was the only paper before the meeting. Dr. Phillips' paper was discussed at length. It will be found in full in the present volume of the proceedings.

It was decided that hereafter only two meetings of the Society are to be held, one in the winter or spring, the other in the summer or fall, and the winter or spring meeting is to be considered the annual meeting for the election of officers. It was also thought best to have the meetings at night instead of during the day, since it was thought that the members would find this time more convenient. Inasmuch as the hall of the Knights of Pythias could not be had at night, it was suggested that the meetings be held in the offices of some of the members, and several offers of rooms were made.

Adjourned to meet at the call of the President some time during the autumn months.

Wm. B. Phillips, Secretary.

AUTUMN MEETING.

BIRMINGHAM, ALA., November 16, 1892.

The meeting was called to order at 11 A. M., on Wednesday morning, November 16, 1892, at the office of the Tennessee Coal, Iron, and Railroad Company, on Morris Avenue, in the City of Birmingham.

The President being absent, Mr. T. H. Aldrich, Vice President, presided in the chair. Dr. E. A. Smith, Secretary.

BY DR. SMITH: The first thing in order, an explanation in regard to the minutes of the previous meeting. These minutes were never written up; or at all events they have never come into my hands since I have been in charge of the office of Secretary. I can give from memory about all that was done; there was an election of several officers, Mr. Meissner, President, Mr. T. H. Aldrich, Vice President, and Mr. McKleroy, Vice President; Eugene A. Smith, Secretary. A paper was read by Dr. Phillips, on the "Crushing Strength of certain Alabama Cokes." That paper is in my hands. There were certain papers promised for this meeting; one was on "Brown Ore," by Mr. Lancaster.

MR. T. H. ALDRICH: The next thing in order, comes the reading of any papers that have been prepared for this meeting.

MR. MCCALLEY then read an able paper on the "Bauxite of Alabama." There was no discussion on this paper.

DR. E. A. SMITH next read a paper on the "Clays of Alabama." This paper was listened to with great attention, as it covered the subject fully, and Dr. Smith added to the clearness and interest of this paper, by illustrating his remarks, by the aid of a geological map. No discussion followed.

Owing to the absence of Mr. Geo. H. Montgomery, Dr. Smith read a paper on "Mine Enginnering," which was prepared by Mr. Montgomery. A short discussion was entered into, on this subject, in which the following members took part:—

Mr. Alber said in substance as follows: The method of platting inside of a mine, should not be done by compass, but by taking the angles, as this would insure the most accurate work. It never can be done as accurately as if the parts are calculated.

Mr. Wilson: I should like to speak about the "helps." I have been out surveying, and they have given me a "gentleman of color" that they tried on every other work about the mine, without success, and then they gave him to help me. The consequence was, nothing would fit, until we got the plumb of that sort of work.

Mr. T. H. Aldrich: I have had a little experience myself on this subject; we have always found that it was difficult to make the mine maps and the land lines fit in our work, owing to the fact that the Government Surveys don't give any internal lines except section lines, and there is a good deal of guess-work in regard to old Government Notes. We have had one case, where there is a difference between the line that has been established by possession, for a long number of years, and the line that would be indicated by the Government Survey, of over 100 feet, and it raises a question, that a Mining Engineer would have to be something of a lawyer to decide.

It has given us a good deal of trouble in that respect; we have found it was quite necessary to find out actually where the lines are on the surface.

In transferring a line down a shaft, a bucket and string measurement is not one that can be accurately relied upon, a bucket of water, or bucket of oil—a bucket of oil is better than water. There is an instrument now that has a small telescope arm that is at right-angles to the other line, and you can sight with that; this instrument is much more accurate than using a string with a plumb or a bucket of oil or water, let down to the bottom.

Mr. Alber: If the County Surveyor runs a line that is wrong, it does not bind the land owner. If the engineer can locate the lines from the Government Notes, that is the best evidence. He has the law on his side.

LIEUT. R. C. McCALLA, JR.: Johnson's new work on Land Surveys has a very exhaustive discussion on this question, and perhaps these gentlemen would be interested in reading over his statements.

MR. ALDRICH: Possession of 20 years of a piece of land, if it is fenced in, gives a man a title. That would give a man a title, no matter where the lines are; in other words, you have to make a survey of that fellow's fence line.

Lieutenant McCalla is engaged in the work at Tuscaloosa for the Government, the improvement of the Warrior River, and he has been asked to make a few statements in regard to the work going on there.

LIEUT. R. C. McCALLA, JR., then gave a short account of what had been accomplished up to date at Tusaaloosa.

MR. ALDRICH: I would like to ask if there has been any appropriations made to improve the River below Tuscaloosa.

LIEUT. McCALLA: $1,000,000. The work below Tuscaloosa has been confined to cutting down trees, making jetties, etc.; no permanent improvements have been made yet on that part of the River.

MR. ALDRICH: Some years ago Dr. Smith and myself made a pilgrimage up and down that River, and Dr. Smith could give us a great many facts in regard to the River at that time. I would like to hear from him on the subject of the River below Tuscaloosa.

DR. E. A. SMITH then gave a short account of this trip.

LIEUT. McCALLA: The Warrior River below Tuscaloosa is navigable more days in the year than the Ohio River above Pittsburg.

DR. E. A. SMITH: There is a motion handed in by Col. J. A. Montgomery, who is a member of our Society. (Reads motion). "I move that a committee of three or five be appointed by the President, for the purpose of preparing and presenting a Memorial to our Senators and Representatives in Congress, showing forth the advantages that would accrue to the Gulf States, and more particularly to Alabama, by the building and completion of the Nicarauga Canal."

Mr. Aldrich: I think both political parties have endorsed this measure, it is not a question of politics, and not being a political question, it is one this Society could take cognizance of without any trouble. (Dr. E. A. Smith seconds the motion). The motion is read and seconded, and is now before the Society. I would like to hear from the members upon this subject. If you will excuse the Chair from speaking on the subject, I will state that the Cahaba Coal Mining Company is furnishing the Nicarauga Canal Company with coal right now, and there can be no doubt how I stand in the matter. We have had considerable correspondence with the authorities,and they tell us they have been offered money by great English Syndicates to take hold of this canal and put it through to completion, and they are only waiting on Congress to decide whether the United States will undertake to take hold of the Canal or not. We have pledged ourselves to wait on this term of Congress, to see whether the United States Government will take hold and practically finish this Canal. In case of any trouble, in the way of a foreign war, the United States would probably take possession of the Canal anyway, and there is every incentive for the Government to furnish the means to complete this Canal. I have had a talk with parties who have this business very much at heart; I have seen several of the engineers and several members of a committee that went down to examine the line of the Canal; they all think it is feasible. There is only one great difficulty, and that is cutting through a hill, going from the Lake to the Pacific side; the Atlantic side of the business is only a question of money. The Atlantic side has an outlet to the Lake; on the Pacific side there is a sharp hill to cut through; the discharge of the Lake is towards the Atlantic side. They have already done a great deal of work.

and claim to have spent about $4,000,000 up to date; their Harbor has not been completed, but from 4 to 5 feet of water, they have 14 feet by building a pier out and changing the current, so that it has washed out an entrance to the old Harbor, before they attempted to start the Canal afresh. If the Canal is started soon, most of the lumber, coal and iron, and probably a great many of the explosives used will come from Alabama. It is the nearest State to it, except Florida, of course; it is the only point where they can get coal promptly. I do not know exactly how much we have shipped them, but what little they have used has come from Alabama, and a large amount of the timber from Alabama and West Florida also. You have heard the resolution, and I would be glad to hear from any of you. Motion was put and unanimously carried. I will appoint on the Committee, Col. J. A. Montgomery, Mr. Thos. Seddon, and Dr. E. A. Smith.

Dr. Smith: I move that the Vice President, Mr. Aldrich, be added to this Committee; he is better qualified than almost any one else. Motion seconded and carried. Maj. Geo. H. Fitzhugh was also added to the Committee.

Mr. Aldrich: Dr. Smith has some specimens here he would like to show the Society, in the way of minerals, from Coosa County, Alabama; it will make you feel a great deal better about Alabama when you see all these things.

Dr. Smith exhibits some cut beryls of golden yellow color to the Association. He says in substance as follows: It is the same mineral that makes the emerald, that stone is merely a clear, green beryl. I showed one of these beryls to Mr. Geo. F. Kunz, Tiffany's gem expert, and he said some pretty jewels could be made out of it. From this beryl he cut some little brilliants; they are very pretty and valuable, but not quite as valuable as emeralds, because the color is not so good. (Shows some exquisite brilliants that were cut from this beryl).

Mr. Aldrich: I can tell you another thing; diamonds have been found in Alabama; they are found either in Coosa County or Randolph County, but I think it is Coosa. I knew a gentlemen who found a diamond from there worth about $300 or $400, and it has been tested by experts who said it was a diamond. The diamond matrix in South Africa is a carboniferous slate, and from this you get the diamond; the same mineral has been found in Kentucky, but there don't seem to be any diamonds there,

Mr. Aldrich: I would suggest a meeting at night at our next session. I would also suggest that Maj. Fitzhugh prepare a paper for our next meeting, in May, on "Manganese." Mr. R. Thomas assigned a paper on "Coke." And the subject of the "Birmingham Water Works and Tunnel," was given to a member to prepare for the ensuing meeting.

At 1 P. M. the Meeting adjourned.

Eugene A. Smith, Secretary.

THE ULTIMATE COMPOSITION OF SOME ALABAMA COKES.

By William B. Phillips, Ph. D.,

Chemist to the Grand Rivers Company, Grand Rivers, Ky. Late Professor of Chemistry and Metallurgy in the University of Alabama.

(A continuation of the paper on "The Ultimate Composition of some Alabama Coals," in Proceedings of the Alabama Industrial and Scientific Society, Vol. I., No. I.)

If one were asked for the correct definition of the word Coke, I dare say that he would have to reply that it depends upon circumstances. It is a generic term, including several species which are differentiated according to the method pursued in their production. Thus we have Natural Coke, a product of the slow distillation of bituminous coal *in situ* and occurring in the earth, as for instance in some portions of West Virginia. Retort Coke, the residue remaining in retorts used in the manufacture of illuminating and heating gas. This is generally termed Gas Carbon.

Open Air Coke, produced from bituminous coal in heaps and mounds erected in the open air or under a slight shelter.

Thomas Coke, produced in the Thomas Coking Oven.

Coppee Coke, produced in the Coppee Oven.

Simon-Carves Coke, produced in the Simon-Carves Oven.

And lastly, a kind of Coke produced the world over in enormous quantities, amounting to perhaps 99 per cent of the total coke output, and termed Bee-hive Coke, from the shape of the oven in which it is made. So extensively are these ovens used for the production of coke, that unless expressly stated to the contrary the term Coke means Bee-hive Coke.

In spite of the extreme wastefulness of the Bee-hive oven, almost the whole of the gas and smoke evolved in the coking process escaping into the air, it holds its own disgracefully well. This is due, perhaps, in the main to two causes, its cheapness of erection and superintendence when compared with Recuperative Ovens, and a suspicion that the coke it yields is better adapted for blast furnance purposes than any other coke. It is not likely that either of these notions is well founded, but for the present at least they are operative, and we deal with things as they are. It is remarkable how persistent is the belief that the only coke fit for blast furnace use is the bee-hive, and the only charcoal the old fashioned pit or meiler coal. It seems to me that the principal reason therefor is the difference in cost between the old and the new methods. The bee-hive oven can be built for $200 to $250 apiece, the recuperative oven costs from $800 to $1000 apiece. An hundred bee-hive ovens can be built for $20,000 to $25,000, an hundred recuperative ovens will cost from $80,000 to $100,000. This difference seems at first glance to be entirely too great for economy, but when we consider that the products from the latter are worth from five to six times as much as the products from the former, this difference is merely apparent, not real. There are in Alabama now between 5500 and 6000 coke ovens, all of the bee-hive type, except 64 Thomas ovens at Coalburg and 18 at Broken Arrow ; these latter, however, have not been in operation for some time. At the Anniston Meeting of this Society, April, 1891, I presented a paper on the Ultimate Composition of some Alabama Coals, containing twenty-two analyses of the principal varieties, with the exception of the Montevallo Coal, the Mary Lee and the seams near Warrior Station on the Louisville and Nashville Railroad. The Walker County Coals were also not included in the list. The paper will be found in full in the Proceedings, Vol. I, No. I. From this paper it will be seen that while the value of the coke per ton of coal is about $1.62, the total value of the by-products per ton of coal is about $18.00. The bee-hive oven is among the most wasteful of all wasteful metallurgical appliances, for, allowing that one-half of the value of the by-products is, like so many new towns, "on paper," still we have left $9.00 as against $1.62.

It was promised in that paper that the investigation into the nature of the fuels used in Alabama would be extended to cover the cokes. This work, interrupted by illness and by change of residence, has finally been brought into such a shape as that it can be given to the public. I submit herewith a table containing fourteen analyses of the principal Alabama Cokes, made on samples furnished by the coking companies. As the analyses of the coals were made so as to show not only the proximate but the ultimate composition as well, the analyses of the cokes were made in the same way, so that we now have seventy-two analyses representing the composition of the Alabama coals and cokes.

It must be stated that the writer cannot assume the responsibility of asserting that these analyses truly represent the composition of the cokes as delivered at the stock-houses of the furnaces. There may be discrepancies, more or less serious, between these and stock-house analyses, but it is fair to assume that they are uniform, and that they press on all the companies alike.

The crushing strain tests were made on pieces of one cubic inch size, sawed from larger pieces, and were conducted by the writer and R. C. McCalla, C. E., on a stardard Riehle Testing Machine, in duplicate. The figures given are averages.

The following cokes were examined :—

Black Creek, (Experimental. Not used commercially.)
Berry Mountain, " " "
Pratt.

Black ends of Pratt.

Cahaba.

DeBardeleben, 48 hour.

DeBardeleben, 72 hour.

Mary Lee.

Coalburg, Thomas Oven.

Standard, (Milldale, Brookwood and mixture of the two).

Gas Carbon from Birmingham and from Mobile.

Unless expressly stated to the contrary, the cokes are 48 hour cokes, that is, the coke was drawn 48 hours after charging.

NAME OF COKE.	Proximate Analysis.						Color of Ash.	Ult. Analysis			Crushing Strain. Pounds per square inch.
	Number.	Moisture.	Vol. and com, bust. matter.	Fixed Carbon,	Sulphur.	Ash.		Carbon.	Hydrogen.	Oxygen.	
Black Creek	1204	0 30	0 90	94 90	0 79	3 90	reddish brown	84 87	5 52	4.62	Cracked at 400; broke at 1000.
Berry Mountain	1206	0 10	1 10	97 00	0 90	1 80	pink	85 84	4 90	6.46	Broke suddenly at 944.
Pratt	1219	0 90	1 40	89 80	0 82	7 90	reddish brown	77 86	7 10	5.42	Began to break at 350; broke at 540.
Black Ends of Pratt	1220	0 25	0 85	85 45	1 65	13 45	reddish brown	74 61	6 07	3.97	Broke at 300,
Cahaba	1224	0 10	0 60	93 20	1.05	6 10	reddish brown	83 18	6 43	3.14	Broke suddenly at 445.
DeBardeleben, 48-hour	1232	0 40	0 70	86 00	1 23	12 90	reddish brown	76 23	6 18	3.06	Began to break at 486; broke at 750.
DeBardeleben, 72-hour	1233	0 05	0 90	87 25	0 99	11 80	reddish brown	78 27	7 38	1.51	Began to break at 720; broke at 1100.
Mary Lee	1329	0 90	3 10	86 45	0 93	9 55	buff	80 32	5 65	2.65	Broke at 486.
Coalburg, Thomas Oven	1239	0 70	2 55	81 15	2 21	15 60	reddish brown	75 25	4 25	1.99	Broke suddenly at 550.
Standard (Brookwood)	1244	0 20	1 10	82 15	1 43	16 55	buff	69 18	5 57	7.07	Broke suddenly at 320.
Standard (Milldale)	1245	3 05	2 50	86 80	1 47	7 65	buff	76 63	3 56	7.64	Broke gradually at 545.
Standard (Mixture)	1246	0 30	1 00	82 10	1 49	16 60	buff	71 25	4 70	5.63	Broke gradually at 800.
Gas Carbon, Birmingham	1226	0 20	0 70	93 20	1 23	5 99	reddish brown	84 27	4.61	3.79	Broke at 690.
Gas Carbon, Mobile	1235	2 90	3 25	83 05	1 45	10 80	dark grey	71 74	7.40	5.71	Broke at 700.
Bearpark, Clarence Works, England		0 20	.	.		7 52		91 28	0.30	0.70	

The per centages of Sulphur and Ash are to be added to the figures for the Ultimate Analysis. The Oxygen is in every case determined by difference.

The most remarkable result in this table is the slight difference between the chemical composition of the DeBardeleben 48 and 72 hour coke, and the considerable difference in the strength, the one breaking at 750 pounds, the other at 1100 pounds. As the two samples were made from the same coal under the same conditions, this difference must be referred to the length of time of the coking process. The bituminous matter has in each case been thoroughly expelled, as is shown by the small per centages of Volatile and Combustible Matter, the 48 hour coke containing 0.70 and the 72 hour 0.90 per cent. It would appear that after 48 hours the Volatile and Combustible Matter does not diminish, but the strength of the coke shows a marked increase. Whether this increase of strength influences the consumption of fuel per ton of iron, the quality of the iron or the output, I have no means of judging, as the fuel ratio was not given nor any information upon which one could base an opinion. I am, however, inclined to think that beyond a crushing strain of 700 pounds per square inch there would be no economy, so far as this single point is concerned. A strength considerably less than this is amply sufficient for all ordinary blast furnace work, even when dealing with ores much harder and more refractory than those of the Clinton Formation.

The betterment of the cokes of this district is not to be attained by increase of the time of coking so much as by a close attention to the mechanical and chemical composition of the coal charged into the oven. Of the two, the mechanical condition is by far the more important, inasmuch as it to a very great degree influences the other. By crushing and washing the coal, preparatory to coking, a great improvement in the coke can be attained not only as regards the per centage of ash and sulphur, which may be termed the chemical betterments, but also and especially as regards the more homogeneous distribution of the ash, which may be termed the mechanical betterment.

I have understood that the fine crushing of the coal as practiced at some establishments, as for instance at Cahaba and Mary Lee, has resulted in a marked improvement in the coke, and the results reached by Mr. Stewart with the Luhrig Washer at the Sloss Furnaces are full of promise. This gentleman informs me that with Coalburg coal he has succeeded in reducing the per centage of ash by fifty per cent, with an equally good result in sulphur and that the mechanical condition of the coke has been much improved. It seems to me that this district must ultimately come to some such system,for when the manufacture of steel is begun on a commercial scale, it will doubtless be found that one of the chief difficulties to be overcome is the unsuitable quality of the coke.

It is, I think, much to be regretted that no one of the large iron companies in Alabama has seen fit to undertake exhaustive investigations into the all-important question of the improvement of the coke used. That the condition of the coke is susceptible of improvement no one will deny, as no one will deny that it is being brought into a better status, slowly it may be but none the less surely. The most favorable time for making experiments is when the iron market is a bit dull, as the most sanguine "bull" cannot but acknowledge, has been and is the case now, for when everything is pushed to its utmost capacity we are apt to lose sight of the future in our efforts to seize the opportunities of the present. When the yard is being rapidly depleted of its stocks and profits are fairly good, we do not pause to consider whether we might uot improve the quality of some one of the materials employed. The celebrated inhabitant of Arkansas could not put a roof on his house when it was raining, and when lhe weather was good he did not need one. Some such principle has operated to bring the iron trade into its present unsatisfactory condition, and until we realize that true economy consists in improving everything that enters into the production of iron I fear that we may anticipate the recurrence ot periods of depression which will cause us to wish that we could make iron still more cheaply.

ALABAMA BAUXITE.

By Henry McCalley.

Bauxite, a most important ore of aluminum, the coming metal, is, comparatively speaking, a new mineral. Its first mention as hydrated alumina, of Baux, France, dates back to 1821,* but it does not appear to have been known as Bauxite, a commercial product, until about 1868. Since that time it has been found in several other countries of the old world, as in Ireland, Austria and Asia Minor, and in several of the States of the Union. The Engineering and Mining Journal in its statistical number for 1891, says that bauxite occurs in abundance in Tennessee, Virginia, North and South Carolina, Georgia, Alabama and Arkansas, but I have not been able to find any account of its occurrence in any of the States with the exceptions of Georgia, Alabama and Arkansas. In Georgia, the known deposits do not cover much area, and are of unknown depth, and in Arkansas they are said to cover about 160 acres, and to be from a few feet to forty feet in thickness, with an average thickness of some fifteen feet.

Its first discovery in this country seems to have been in 1887, in Pike County, Georgia; then in Cherokee County, Alabama, in 1889, and lastly in Pulaski County, Arkansas, in 1891.

The honor of its first discovery in Alabama, from the best information at hand, is due to Mr. J. R. Trotter, the mining boss of the Dykes limonite banks, of the Bass Furnace Company, Cherokee County. Mr. Trotter, so he says, had for a long time noticed in and near his ore banks what was to him a peculiar rock, and so in the spring of 1889 he sent a sample of it to Mr. J. M. Garvin, Superintendent of the Bass Furnace

* Dana.

Company, Rock Run, to have it analyzed for him. Mr. Garvin sent the rock on to their chemist, in Fort Wayne, Ohio, and in due course of time, so the story goes, the report came that the peculiar rock was bauxite, a valuable ore that carried nearly 30 per cent of Aluminum, a metal that was then worth 300 times as much as iron or about $3.00 per pound. After the reception of this letter, many outcrops of the ore were found in the neighborhood of the Dykes Bank. †

The next or second beauxite find in Alabama was at the Walker limonite banks near Jacksonville, Calhoun County, and since then a third deposit has been found at the Laney maganese old banks, in the edge of Cleburne County. some two and a half miles to the south-west of Rock Run Station. Two other deposits, it is said, have lately been found in Calhoun County, near Anniston. Other deposits will doubtless still be found in this and perhaps other sections of the State.

These bauxite deposits of Alabama are all of the lower part of the Lower Silurian Rocks.

The Cherokee deposits and the Calhoun deposits, near Jacksonville, like those of Georgia, are near the bottom of the Knox Dolomite Rocks of Safford of Tennessee. These bottom Knox Dolomite Rocks are now believed to belong to the Upper Cambrian. The Cleburne deposit is in the upper part of the Weisner Quartzites, Middle Cambrian, believed to be the same as the Chilhowee Sandstones of Safford. The location of the two other outcrops in Calhoun County, near Anniston, are not known to the writer.

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† Mr. R. S. Perry, General Manager Southern Bauxite Mining and Manufacturing Company, Piedmont, Alabama, writes, since the above was written, that the Bauxite of Cherokee County was not known as such until the fall of 1890, that before then it was known by the miners, etc , as *iron ore blossom.* He says that he is entitled to the credit of the first discovery or identification of Alabama Bauxite; that he first discovered or identified it in April or May, 1890, in a deposit in Calhoun County some 8 miles south of Piedmont, and that on June 7th or 8th, 1890, he identified the ore of the deposit near Jacksonville, which previous to this time had been called, by the people of Jacksonville, *Clinton fossiliferous iron ore.*

The Arkansas deposits are supposed by Dr. Branner, the State Geologist, to be of Tertiary age, though related in their origin to the granites near them. There are seemingly no reasons why bauxite deposits may not be of any age or of any geological formation. The Alabama deposits are in a section of country that has been badly broken up by sharp folds and great thrust faults, and in which the character of the rocks have been greatly changed doubtless by the heat that was produced in their folding and faulting. This same heat, it is believed, has had a great deal to do with the formation of the beauxite deposits.

The Alabama deposits are in pockets, though they occur along regular "*leads*" or follow the lines of outcrops of certain rocks, and show more or less stratification in all of the cuts that have been made upon them. They occur about as do the limonite and clay deposits with which they are closely associated, though seemingly more straified, in fact they are so closely associated with these limonites and clays that they appear to be greatest where or near where the limonite and clay deposits are greatest.

The Cherokee bauxite deposits appear to be along two parallel "*leads*" or lines of outcrops that run in a general north-east and south-west direction (N. 35 deg. to 40 deg. E.), and are from 150 to 200 yards apart. These lines of outcrops seem to follow the crests of two sharp anticlinal folds with a synclinal between them. It is probable therefore that some of the bauxite deposits of these two lines of outcrops, as irregular stratified seams, are continuous under the surface across the synclinal from one line of outcrop to the other. It may be, however, that in places there is a fault along the north-west edge of the north-west line of outcrops or anticlinal. The structure of the rocks however hereabouts cannot be spoken of with any degree of certainty, as they can only be seen at intervals, and even then very imperfectly, the whole country being covered by debris. This debris is nearly altogether of the Weisner

Quartzites, the nearest bedded rocks of which are some half of a mile to the south-west of the known bauxite deposits. The largest limonite and clay deposits known of in this immediate section are between the two lines of outcrops or are within the synclinal trough. It is believed that future developments will show the largest bauxite deposits to be also within this synclinal trough.

The bauxite of these deposits appears to occur in places, at least, over a white or yellow friable sandstone that sometimes is hard and cherty, and under or in the lower part of an unctuous clay that is usually white. The limonite ore is commonly on the top or in the upper part of this white unctuous clay. The bauxite however in places seems to be on the top of the limonite ore. In places it is in the clay, as large masses or as small nodular concretions, and in other places it appears to gradually pass or change into a clay.

The Calhoun deposit, near Jacksonville, in the few shallow cuts that have been made upon it, also appears to be on the top of a sharp anticlinal. The Cleburne deposit, so it is said, has never been dug into and shows only as a few boulders on the outcrop, and this is most probably the case as to the two bauxite outcrops that have been lately found near Anniston, Calhoun County.

Though the Alabama bauxite deposits as yet have not been sufficiently developed to enable one to form even a rough approximate estimate of the amount of ore which they carry, still enough has been done on the Cherokee deposits to show that they alone have in them an immense amount of ore. There is no doubt about the Cherokee deposits being large and valuable. These deposits have been dug into in about a dozen places; in some of these places, limonite old diggings, the bauxite has been laid bare from a depth of a few feet to that of 75 feet. These deep holes, together with the large outcrops, makes it certain that the ore is in very large quantities, and future developments, it is believed, will show the ore to be in even larger quantities that it now appears to be. I have seen out-a distance of about one and a half miles, and Mr. Trotter says that he has seen it on both lines at intervals for a distance of nearly five miles, or from near the Georgia line to near Rock Run. It most likely exists on both of these lines of outcrops in places that have never been seen, being covered up in these places by debris. *

In the north-east end of the Dyke's Bank proper, or the deepest of the limonite old diggings, the bauxite forms an irregular seam of about 60 feet in thickness. It shows from the top to the bottom of this old digging which is about 75 feet deep. The seam here is about vertical, though in other limonite old diggings about 200 yards to the north-east, the dip is about 60 deg. to the south-east. In one of these last diggings, the bauxite has been exposed to a thickness of 15 feet, though it still forms the floor of the digging, and hence it may be as thick here as it is in the big pit or some 60 feet thick. These diggings are all just on the south-east edge of the north-west anticlinal, and hence they are just within the synclinal. To the north-west of the big digging some 200 yards is a fine outcrop of bauxite that must be on the north-west side of the north-west anticlinal. To the south-east of the big digging or Dyke's Bank proper about 200 yards is the bauxite bank of the Republic Mining and Manufacturing Company, of Hermitage, Georgia. The bauxite of this bank is in two irregular seams that are separated from each other by averaging thickness (0 feet to 15 feet) of unctuous clay. The top one of these bauxite seams is about 30 feet thick ; the bottom one, when last seen, on September 29, 1892, had not been gone through though it had been dug into to a depth of about 20 feet. The separating clay is of white, blue and mottled colors. This bank

* It is stated in a special to the Engineering and Mining Journal of February 25, 1893, that the superficial area of the Dyke's district carrying Bauxite, including the spaces between the known deposits, does not exceed one and one-half miles in length by one-half mile in width; that, unless the demand for the mineral increases, the quantity of ore in sight in this district alone will more than supply the market.

crops of bauxite at intervals on both of the lines of outcrops for is on the north-west edge of the south-east anticlinal, though it may be said to be in the top of this anticlinal, for it is so near the top that the top bauxite seam, which here forms the undenuded crest of the anticlinal, shows within the bank a dip of about 30 deg. to the north-west, and also a dip of about 30 deg. to the south-east. To the north-east of this last bank some 300 yards, on the same or south-east line of outcrops is the Gaines Hill bauxite bank of the Southern Bauxite Mining and Manufacturing Company, of Piedmont, Alabama. This bank is in solid bauxite, and on September 29, 1892, it had been dug to a depth of about 20 feet. So there is no telling how thick the bauxite is in this bank. Still farther to the north-east, some half of a mile, on the same south-east line of outcrops, is the Warhoo bank of the same company as the last. This bank is just on the north-west edge of the anticlinal, though very near the top as it shows the north-west dip and the flattened strata on the top of the anticlinal. This bank is also solid bauxite, and, on September 29, was about 20 feet deep. So there was no way then of telling how thick the bauxite is in this bank. It looks more like, strictly speaking, a pocket of ore than do the other banks. Still farther to the north-east, about one-half of a mile, are the two Carr bauxite banks, one on each of the two lines of outcrops. These banks had not then been dug into to any depth. To the south-west of the above bauxite bank of the Republic Mining and Manufacturing Company is another bauxite bank of this same company. This bank also appears to be just on the north-west edge of the south-east anticlinal as its bauxite shows both the north-west dip and the flattened strata of the top of the anticlinal. Its floor is of solid bauxite, and its sides show a thickness of about 15 feet of ore; how much thicker the ore is in this bank there was no way of telling when visited. The bauxite of this last bank is covered by an unctuous mottled clay, without grit, that on being trimmed with the knife has very much the appearance and feeling of common castile soap.

This mottled clay in turn is covered by a deep red unctuous clay that is also free from grit. To the south-west of this last bank for some 200 yards the surface is covered with boulders and nodules of a deep red bauxite that have very much the appearance of old overburnt bricks. To the north-west of this last bauxite bank some 150 yards, there is on north-west line of outcrops in a limonite old bank, a small showing of bauxite in boulders in a mottled clay.

The Calhoun bauxite, near Jacksonville, shows at intervals in a general north-east and south-west course for some 250 yards. Several shallow pits have been sunk on its outcrops, but not of sufficient depth to prove anything as to the thickness or quality of the ore. These pits appear to be near the top or along the north-west edge of the anticlinal. In one of them the bauxite is exposed to a thickness of 12 to 14 feet, and in another to a thickness of about 25 feet, though in neither of these cases is it exposed to its full unknown thickness. The Cleburne deposit. as has been stated, has never been dug into and shows only as a few boulders on the outcrops, as is likely the case with the two reported outcrops in Calhoun County, near Anniston.

The bauxites of all the Alabama deposits are hard on the outcrops, especially the red varieties. though as a general thing, they become comparatively soft and crumbly on being dug into. The red coloration in many places on and near the outcrops is due partly to seepage water. These bauxites are mostly pisolitic or concretionary, though some of them are earthy or clay like. In the pisolitic or concretionary varieties, the eyes or pea-like concretions are for the most part uniformly diffused throughout the masses. These eyes or concretions are usually filled with a reddish dust or powder. They are often soft enough to be mashed between the fingers, though sometimes they are very hard. They are usually of the size of a small pea though they occasionally get to be a couple of inches in diameter. These large ones are merely irregular concretionary nodules. The earthy or clay-like bauxite has often a metallic ring. The Alabama bauxites are of white, grey and red colors, though other bauxites are said to be also of pearl-grey, ochre-yellow and brown colors. Pure bauxite is very light having a specific gravity of about 2.40.

Bauxite, chemically speaking, is hydrated or soluble oxide of aluminum, but commercially speaking it is a double hydrated or soluble oxide of aluminum and iron with some silica and other accidental impurities, as titanic (oxide) acid, phosporic acid, carbonic acid, lime and magnesia. It is a dihydrate, and chemically speaking, has the formula $Al_2 H_4 O_5$, or $Al_2 O_3 H_2 O_2$, or is made up of 73.9 per cent of alumina $Al_2 O_3$, (or Aluminum 39.3) per cent.), and 26.1 per cent of water, but commercially speaking, it can have no regular formula as no two pieces of it have exactly the same chemical composition. Immense banks of it however may be uniform enough in chemical composition for all commercial purposes. Bauxite therefore differs essentially from kaolin or a pure clay in that its alumina exists as a soluble oxide instead of as an insoluble silicate, as it does in the kaolin or clay.

Bauxite as it occurs in nature or as it goes to the manufacturers is represented by the following partial analyses:

	(1)		(2)		(3)	
Alumina - -	52 7	per cent.	55.26	per cent.	57.03	per cent.
Ferric Oxide,	19.1	"	5.58	"	8.74	"
Water of Comb.	16.4	"	25.59	"	24.69	"
Silica, - - -	7.1	"	11.64	"	3.78	"
Titanic Acid,			3.13	"	3.12	"

(1) An average of 14 partial analyses. Localities—France, Austria and Ireland. *

(2) An average of 8 partial analyses. Locality—Pulaski County, Arkansas. *

(3) An average of 5 partial analyses. Locality—Lloyd County, Georgia. †

* Am. Geol., Vol. VII., No. 3, page 183.

† Trans. Am. Inst. M. E., XVI., page 908, and XVIII., page 562.

The following is said by Mr. J. M. Garvin, Superintendent of the Bass Furnace Company, Rock Run, Alabama, to be approximately an average analysis of car load samples, as sent to the manufacturers, of the bauxite from Cherokee County, Alabama:

Alumina, from - - - - -	56 to 60	per cent.
Ferric Oxide, about - - - -	2.75	"
Water, from - - - - - -	25 to 30	"
Insoluble Matter, principally Silica, about	7	"
Titanic Acid, from - - - -	2 to 3	"

The following partial analyses are also of bauxites from Cherokee County, Alabama:

	(1)	(2)	(3)	(4)	(5)
Alumina,	64.68%	55.73%	61.65%	60.15%	58.25%
Ferric Oxide.	-	-	-	-	1.50%
Water,	-	-	-	-	30.00%
Silica,	-	-	-	-	2.22%

(1) Also contains Manganese Monoxide, trace, Lime 0.50%, and Insoluble Residue 4.98%, and gives Loss by Ignition 30.08%. Locality—Warhoo Bank. Analyst—Illinois Steel Company.

(2) Contains large concretions. Sample by Dr.E,A.Smith, State Geologist. Locality—Gaines Hill Bank. Analyst—R. Swain Perry, Piedmont, Alabama.

(3) Hard ore underlying soft ore. (4) Sampled by Dr. E. A. Smith, State Geologist. Locality—Warhoo Bank. Analyst—Same as (3).

(4) Soft ore over hard ore (3). Sampled by Smith and Perry. Locality and Analyst—Same as (3).

(5) An average sample of ore under shed, shipped May 18, 1892. Locality and Analyst—Same as 3 and 4.

A recent special to the Engineering and Mining Journal states that the hard ore [3] is rapidly rising and cutting out the soft ore [4], and that with a little more digging the hard ore will be the only ore of the bank.

These analyses of Alabama Bauxites compare most favorable with those of the ores of Europe and of Arkansas and Georgia. They show the Alabama ores to be of very fine quality. They show to their credit a larger per centage of alumina and a lower per centage of ferric oxide than do any of the others, a lower per centage of silica than do those of Europe and of Arkansas, and a lower per centage of titanic acid than do those of Arkansas and Georgia. It is stated in a letter of Mr. Garvin's that, as said by the manufacturers, while the Alabama [Cherokee] ores carry some less alumina than do the ores of Baux, France, [not verified, though by the above analyses], they are to be preferred because they are the more soluble. Their greater solubility may be due to the Baux ores carrying more clay or alumina silicate, or it may be due to some other cause. It ought to be said, however, that the Arkansas bauxite analyses are more than likely of surface samples, and it may be that some of the other analyses are also of surface samples, and that the Alabama bauxites immediately on the outcrops appear to be much poorer ores than they are below the surface, and, as indicated by the following analyses, to give poorer analyses than any of the analyses given above. The surface samples, however, from which the following analyses were made, with perhaps the exception of [5], were not from the same localities, as those from which the above analyses were made, and so their inferiority or less per centages of alumina and greater per centages of silica may be due partly to their differences of locality, though they are believed to be mainly due to their being simply surface samples. Why bauxites should have less alumina and more silica in their outcrops than they do below the surface, it is hard to say, but nevertheless it seems to be true, if anything can be judged from their appearances, and from the following list of partial analyses of surface samples:

surface samples:	[1]	[2]	[3]	[4]	[5]
Alumina, - -	40.93 %	45.13 %	45.94 %	39.44 %	53.87 %
Ferric of Oxide,	22.60 "	1.50 "	11.86 "	2.27 "	8.16 "
Water of Comb.	20.43 "	23.41 "	21.20 "	12.80 "	24.86 "
Silica, - - -	8.99 "	22.40 "	18.67 "	37.87 "	4.52 "

[1] An average of 2 partial analyses of the red bauxite on the outcrop. Locality—Calhoun County, Alabamu. Analysts—Chemist of United States Geological Survey and R. Swain Perry, Piedmont, Alabama.

[2] An average of 2 partial analyses of the white bauxite on the outcrop. Locality and Analysts the same as of [1].

]3] A partial analysis of the Calhoun bauxite. Analyst—Dr. W. B. Phillips, University, Ala.

[4] A partial analysis of the white or grey bauxite on the outcrop. Locality—Carr's Bank, Cherokee County. Analyst—Dr. W. B. Phillips, University, Ala.

[5] Taken from a small pamphlet descriptive of Piedmont, Alabama. Locality—A few miles from Piedmont, Alabama. Analyst—R. Swain Perry, Piedmont, Ala.

Along with the bauxite and limonite banks of Cherokee County, Alabama, there are some very large bodies of clay. Much of this clay is very white and appears to be very pure. Some of it is mottled and some is of a deep red color. A great deal of it is without grit and has an unctuous feeling. It appears to lie for the most part on top of the bauxite and under the limonite ore. It is very closely connected with the bauxite as they can in many places be seen to pass gradually one into the other.

The Alabama bauxite has not as yet been mined in any great quantities, and only in surface diggings. Only two shippers have as yet engaged in the business, and both of these are at work on the Cherokee deposits. Both of these shippers are also engaged in the mining of Georgia bauxite. The first miners and shippers of this ore were the Southern Bauxite Mining and Manufacturing Company, of Piedmont, Alabama. They commenced to mine or dig the ore in November, 1891, and up to date have shipped about 3,600 tons, * and now have several hundred tons out under sheds drying. The second miners and shippers of this ore were the Republic Mining and

*J. M. Garvin, Superintendent Bass Furnace Co., Rock Run, Ala.

Manufacturing Company, of Hermitage, Georgia, the pioneers of the bauxite business in the South. They secured a lease of the bauxite property of the Bass Furnace Company in July, 1892, and have up to date shipped about 1,300 tons. * They also have several hundred tons out under sheds drying. The Alabama bauxite shipments up to date therefore sum up to a total of only about 5,000 tons. The Southern Bauxite Mining and Manufacturing Company are not at present mining any Alabama ore, and have not been for some months. The other company are engaged in getting out the ore, but are not now doing any shipping. It is thought, however, that they will shortly resume the shipments of 40 to 50 tons per day. The mining of the ore requires a good deal of care and extra expense, as the ore has to be assorted, and it is very deceptive in its appearance, pieces that are wholly unlike in appearance being very much alike in chemical composition. The ore is hauled in wagons from the banks to Rock Run, a distance of about three miles, and then over the private railroad of the Bass Furnace Company to Rock Run Station, on the E. T. V. & G. R. R., a distance of about three miles more. It is shipped to Philadelphia and Natrona, Penn., and to Syracuse, Buffalo, and Brooklyn, N. Y., and to other places.

Bauxite is used not only for the manufacture of the metal aluminum, but also for the manufacture of several of the aluminum salts, as alum, sulphite of alumina, soda aluminate, etc. It is also valuable as a refractory mineral for the making of crucibles, fire bricks, etc. Bauxite bricks are said to be much more refractory or much more infusible than ordinary fire clay bricks, but not quite so mueh so as almost pure silica bricks. They have the advantage, however, over the silica bricks, so it is stated, of not corroding so easily when lime is the flux. They have, however, the greater disadvantage or objectionable quality, as it is reported, of shrinking very much when highly heated, and of not adhering well to the fresh bauxite that is introduced to stop the shrinkage cracks. The Alabama ore

* J. M. Garvin, Superintendent Bass Furnace Co., Rock Run, Ala.

that has been shipped has been principally used, so it is said, for the manufacture of alum by the sulphuric acid method. This method requires that the insoluble matter shall not exceed 7 per cent, and that the ferric oxide shall not exceed 2.75 per cent. The Alabama ores by the car loads, so it is said by Mr. Garvin, run close to these figures. It is said, however, that one consumer of the Alabama ores, in the use of another method for the manufacture of alum, requires that the ore carry from 7 to 10 per cent of ferric oxide.

Good or pure bauxite for the manufacture of aluminum is said to be worth about $10 per ton at Pittsburg.

The Alabama bauxites, however, on account of the length and cost of haul over railroads, and on account of the cheapness of ocean freight, cannot now, so it is said, be put down in the present markets for them as cheaply as the Baux or France bauxites with which they come into competition. Were it not therefore for the superiority or greater solubility of the Alabama bauxites, and hence their greater value, they could not compete at all in the present markets with those from France. As it is, the profits are said to be small, and this more than likely accounts for the smallness and dullness of shipments. It is not likely, therefore, that the Alabama bauxites will make the owners, miners or shippers of them rich, or will be a source of any great revenue to the State, until a home market is created for them. This, however, it is hoped, will soon be the case, as it is reported that the erection of an aluminum plant is now under way at or near Rome, Georgia, and others of aluminum and alum are anxiously expected.

THE CLAYS OF ALABAMA.

By Eugene A. Smith.

The clays of Alabama which might be used for the manufacture of fire brick and the better qualities of fine ware, belong to several different geological horizons, which in the order of their geological age are as follows: 1. The Crystalline Schists or Metamorphic formation. 2. The Cambrian and Lower Silurian. 3. The lowermost Cretaceous. The Tertiary.

We shall give some details of the materials of each of these formations beginning with the oldest.

I. THE CRYSTALLINE SCHISTS.

The rocks of this formation contain very generally the mineral feldspar as an essential constituent. Upon the decay of teldspar, a hydrous silicate of alumina is left, while the alkaline constituent of the mineral is dissolved out and removed by the agency of atmospheric waters. The composition of this residue in its purest form is as below:

ANALYSIS OF PURE KAOLIN.

Silica,	47.0.
Alumina,	39.4.
Water,	14.4.

Kaolin of this compositson results from the disintegration of feldspar and the removal of the potash or soda or lime in the form of silicate, but owing to the fact that kaolin is one of the most absorbent of substances, it is a rare thing to find in nature any such pure form of clay. The great bulk of our clays consist of kaolin more or less mixed with other materials, especially with silica, and compounds of the alkalies, potash and soda, with lime and magnesia and with iron oxide. Some of these foreign substances do not injure the refractory quality of the clay, while others make it worthless for the manufacture of fire brick. The deleterious matters are the compounds of lime, magnesia, the alkalies and iron.

At many points in the metamorphic region wé find beds of white clay from the decomposition of feldspars, notably near Socapatoy, in Coosa County, near Louina, in Randolph County, in the north-west part of Randolph and adjacent parts of Cleburne County; I have no analysis of the material from the first named locality, but in Tuomey's second report we find an analysis of the Louina kaolin which is as follows:

KAOLIN FROM NEAR LOUINA, RANDOLPH COUNTY.

Silica,	37.29
Alumina,	31.92
Peroxide of iron,	Trace.
Potash, lime and magnesia,	0.72
Water,	15.09
Undecomposed mineral,	14.28

Prof. Tuomey remarks upon the absence of iron as a most favorable circumstance, and the small per centage of the potash, lime and magnesa is no less favorable. If we leave out of account the undecomposed mineral, we find that the kaolin has very nearly the theoretical composition.

This deposit has not yet as far as I am aware had attention from those interested in such matters, notwithstanding the recommendation of Prof. Tuomey, who predicts that "when Randolph has a railroad communication with the rest of the world, the discovery of procelain clay in the county will be properly appreciated, and Louina may one day become the seat of a great procelain manufactory."

In the north-western part of Randolph County there are other important beds of procelain and fire clay. The fire clay, according to information obtained from Mr. Geo. H. Montgomery, lies in the north half of township 19, range 11, and the west half of the northern half of township 19,range 10 east.

The porcelain clay is in township 18, range 11 east, and the south half of township 17, range 11 east, the last named occurrences being in Cleburne County somewhat west of Wood's Copper Mine. Dr. Caldwell, of the Elyton Land Company, writing of these deposits to Mr. Montgomery says, "We have had the kaolin and fire clay thoroughly tested and examined. I know there are deposits of clay there practically inexhaustible in quantity and unsurpassed in quality. The clays have been thoroughly tested, both for pottery and fire brick. The pottery made from this clay took the first prize at the Art Institute Fair in Philadelphia December, 1890, and came in competition with the best pottery of America. The brick made from this clay, after being subjected to five thousand degrees of heat for a week along side of the best fire brick of this country, came out of the furnace unscathed while the others were melted. The party making the test says 'brick made from this clay is practically infusible.' "

If the Elyton Land Company should take hold of this matter with the intention of making first-class pottery or fire brick, there can be no doubt about the result.

2. THE CAMBRIAN AND SILURIAN FORMATIONS.

Very near the base of our fossiliferous rocks there are residual beds derived from the decomposition of these rocks. Prominent among these residual matters are the brown iron ores which lie imbedded in clays of greater or less degree of purity. It is among these beds that we find the *bauxites* and *kaolins* which have lately been brought into notice in Calhoun and Cherokee counties. Perhaps the first analysis of a kaolin of this character is given in Tuomey's second report. It is not easy to identify the locality, which is given simply as "a few miles north of Jacksonville."

KAOLIN FROM NEAR JACKSONVILLE.

Silica, - - - - - - -	44.60
Alumina, - - - - - -	38.92
Peroxide of Iron, - - - -	0.78
Lime, Potash, etc., - - - -	1.03
Water, - - - - - -	13.88
Undecomposed mineral, - - -	.90

Prof. Tuomey in describing this locality, speaks of the beds of white and mottled clay, and remarks that the white clay is almost pure kaolin, or porcelain clay.

In Cherokee Conuty at the ore banks of the Rock Run Furnace Company, there is a magnificent bed of white kaolin or porcelain clay laid bare by the raising of the ore. I have no analysis of this material, but the appearance of the bed and its great breadth and thickness, not less than 30 feet by 100, make it one of the most extensive and probably the most valuable in the country.

During the last few years, examinations have shown that some of the so-called white and mottled clays of this section are to be classed as bauxites, since they contain a very considerable per eentage of uncombined alumina and iron oxide. In this form the alumina is in condition to yield the metallic aluminum, and for this purpose it has been extensively mined both in Georgia and in this State.

Theoretically bauxite is a hydrated oxide of aluminum, or else a mixture of the hydrated oxides of aluminum and of iron, for both these compounds have been described by the mineralogists under the name of bauxite. This composition would be expressed by the following per centages :

Alumina, - - -	74.1
Water, - - -	25.0

For the first variety, and for the second, containing the iron

Alumina, - - -	50.4
Iron Oxide, - - -	26.1
Water, - - - -	23.5

As a matter of fact, we do not get the bauxites of this composition, for they always contain some silica, probably from admixture with kaolin, also occasionally titanic acid, lime and other substances. The per centage of water is also usually a little higher in our bauxites than in the model above given probably from the great avidity with which the bauxite absorbs moisture.

Mr. McCalley's paper above will give a number of analyses made of the varieties of bauxite from Calhoun and Cherokee counties, from which it will be seen that the constituents vary between wide limits. It must be borne in mind, however,that this mineral has been thorougly tested only in Cherokee County, and that the Calhoun County material has been taken from near the surface and without any great care in the selection.

As an example of the best qualities of this ore, I may give two analyses of the Warhoop ore from near Rock Run, in Cherokee.

ANALYSES OF BAUXITE, CHEROKEE COUNTY.

	(1)	(2)
Alumina, - - - - - -	64.68	58.25
Insoluble residue, silica, etc., -	4.98	2.22
Iron oxide, - - - - - -		1.50
Manganese, - - - - - -	Trace.	
Lime, - - - - - - -	.50	
Water, - - - - - - -	30.08	30.00

Some time ago I had a lot of the bauxite from the Jacksonville locality sent through the courtesy of Col. Montgomery, of the Jacksonville Company, to Mr. Carlyle, the manager of the Bessemer Fire Brick Works.

It was tested by Mr. Carlyle, who makes the following report of the tests. "I have given the bauxite sent me from Jacksonville a very severy fire test. It stood the high heat with no sign of melting. 'It is non-plastic, and to make any grade of fire brick, should have some fusible or plastic clay for a bond." I should think that this well worthy of a trial by those who wish to prove by practical tests the suitability of Alabama materials for fire brick.

3. SUB-CARBONIFEROUS FORMATION.

Near the base of this formation, and in close proximity to the underlying Black Shale, which is the representative in Alabama of the Devonian formation, we find in many localities a bed of white hard clay very nearly of the nature of the *halloysite* of the mineralogists. This is one of the most beautiful materials that occurs within our borders, especially the purer parts of it. There is, as you all know, a quarry or mine of it near Valley Head, in DeKalk County. It is used for fine porcelain ware, and the less pure portions for tiles and all kinds of better grade of stoneware. The locality mentioned is the only one where this bed is worked, so far as I know, yet I doubt not that other localities will be found which will yield equally good material in commercial quantity.

4. CRETACEOUS FORMATION.

The lowermost of the strata of the Cretaceous age in Alabama are in the main sandy, but at various horizons occur beds of clay which, in my opinion, are more promising than any others in the State. These clays are plastic clays, and are disposed in beds that vary from almost paper-thin laminæ to heavy beds almost massive. The clays are marked by an equal variety in color which ranges from pure white, through delicate shades of pink and yellow to red, purple and brown or chocolate color.

The colors are mostly due to the presence of iron oxide, though some of the more delicate pink shades are probably caused by the presence of small traces of munganese. The surface distribution of these clays is very great, for they occupy a belt which will average at least thirty miles in width, stretching from Columbus, Georgia, to the north-west corner of this State, through Wetumpka, Centerville, Tuscaloosa, Fayette Court House, Vernon and Pikeville. Of course not a tenth of this area is occupied by the clays themselves, but they are found at intervals all through the area described. The formation has been called the Tuscaloosa formation from the city of that name, and it can easily be followed far beyond the limits of Alabama, for it extends along the foot of the Appalachian chain to the north-east, certainly to the Hudson River. These clay beds contain in places beautifully preserved impressions of leaves and other remains of plants, which have served to determine their geological age, which is as above mentioned, the lower Cretaceous. These beds have been named Potomac by Mr. McGee, of the United States Geological Survey, and were called many years ago the Raritan clays by Prof. Cook, State Geologist of New Jersey. Our Tuscaloosa plant-bearing beds have been found to be the geological equivalents of the Amboy clays of New Jersey. This circumstance ought to direct the serious attention of our enterprising brick makers to these clays, for it is well known that the New Jersey people have found a fortune in their clays, and ours are of the very same nature. There is hardly a variety among the New Jersey clays that cannot be exactly matched here in Alabama.

Prof. John C. Smock, the present State Geologist of New Jersey, writes me as follows: "That plastic clays can be used successfully for the manufacture of fire brick and other refractory products, is proven by the practice in this State. Some of the most noted fire brick makers in the country use these clays and no others."

Although the Tuscaloosa clays extend entirely across the State, they are purer and in greater abundance in that part of the belt extending from Bibb County to the Mississippi and Tennessee borders, but a fine bed of this clay has lately been examined in Chilton County,near Mountain Creek, and traced up to the Louisville and Nashville Railroad.

Last year Dr. George Little made for the Geological Survey a pretty thorough reconnaissance of these clays from Tuscaloosa northwestward, with the result of finding a number of localities from which good commercial clays of many varieties may easily be mined and shipped. We all know that they are gotten up at this time near Woodstock, and below Bibbville, and sent to Bessemer, for mixing with the imported clays. The brick works at Bibbville use material of this horizon, and Mr. Cribbs, at Tuscaloosa, was for a long time engaged in working this clay into first-class stoneware. Near Fayette Court House is a fine bed of nearly white clay of this age, and a light gray clay with many plant impressions is found about Shirley's Mill, not many miles south of Fayette Court House. At Glen Allen, on the Kansas City road, there is a great cut through these clays exposing fifteen or twenty feet vertical thickness of them. Above Pikeville, at Chalk Bluff, there is a great abundance of fine white hard clay of this age, called chalk from its purity. This clay has the following composition :

CLAY FROM CHALK BLUFF.

Silica, - - - - - -	47.20
Alumina, - - - - - -	37.76
Ferric oxide, - - - - -	.91
Lime, potarsh, etc., - - - -	Trace.
Water, - - - - - -	14.24

This is astonishingly close in composition to pure kaolin as above shown in analysis. I know of no locality that shows better promise, when we consider the quality and easy accessibility of the material. The exposure at Chalk Bluff is about ten feet vertical thickness, but inasmuch as nothing has been done to exhibit the whole bed by removing the cover of debris, we cannot say how much thicker the bed really is. No railroad passes very near Chalk Bluff—the Sheffield and Birmingham being at the nearest, about ten miles off.

At my request, Dr. Wm. B. Phillips, last year, made some comparative fire tests of a number of these clays, using the Mount Savage clay as a standard. His results show that there are many localities in Tuscaloosa, Lamar, Fayette, and Colbert counties, where clays occur that fuse with difficulty before the oxhydrogen blow-pipe, and are about as refractory as the Mount Savage material. Very few chemical analyses have been made, owing to the departure of Dr. Phillips from the State, but enough is known to enable me to say that we have in our Tuscaloosa formation the greatest abundance of materials of similar nature with the New Jersey clays, and of the same geological age, and I am certain that there is no application of these clays made in New Jersey that we cannot equally well make with our Tuscaloosa clays. It is the most inviting field for those who are interested in seeing manufactories of fire brick, tiles, and all kinds of pottery, established in this State. The material is here ready to hand for those who will utilize it.

5. TERTIARY FORMATION.

In what has been called the Buhrstone division of the Alabama Tertiary, there is a hard silicious clay that breaks with conchoidal fracture like the Chalk Bluff clays above mentioned, and like the Mount Savage clay. It is, however, very light, or has low specific gravity as compared with the latter. A sample of it was analyzed for me by Dr. Phillips, as below:

HARD CLAY (TERTIARY) CHOCTAW COUNTY.

Silica, - - - -	36.30.
Alumina, - - -	5.12
Oxide of iron, - -	1.60
Lime, - - - - -	.46
Water and volatile,-	6.60

Mr. Carlyle, at Bessemer. made up some of this material into a brick which was subjected to the highest heat at his command. It showed no sign of melting, and in his opinion was all right so far as its refractoriness was concerned, but it lacked the weight that ene looks for in fire brick. I am bound to believe, however, that, with proper mixing with suitable bond, this material will be available for fire brick, and if this should be the case, it can be had in unlimited quantity along both Alabama and Tombigbee rivers. The analysis shows that this is rather a mass of silica mixed with a little clay, and as it contains very little iron, lime, or other base for combination with the silica, it is practically infusible—i.e., nearly as infusible as silica itself.

In the latest tertiary formation of South Alabama, in the counties of Washington, Mobile, Baldwin, Escambia, and Covington, there are also beds of fine plastic clays of considerable extent, that deserve attention, for they are undoubtedly suited to the manufacture of the coarser kinds of pottery, tiles, drain-pipes, and similar products.

From the above sketch, it will be seen that Coal and Iron are not the only great mineral productions of our State, for we have clays of quality suitable for the manufacture of every kind of brick and stoneware made in any part of the world. Our great lack is the skilled and experienced workmen who know how to properly mix and temper these clays to fit them for the various processes. It will, of course, take time to convince the users of fire brick, and similar material, that brick made from our clays will serve their purposes as well as those from other States. They are not willing to make costly experiments with unknown and untried products, but the manufacture of every kind of ware from Alabama material is only a qusstion of time.

SURVEYING AND OPENING MINES---HOW TO PREPARE WORKING MAPS.

By George H. Montgomery.

In treating the subject of engineering, I want to consider especially that branch of engineering termed mine engineering, and so essential in developing the mineral wealth of a country. The civil engineer takes a very prominent and important part in finding and building highways to a market for these same minerals. The mechanical engineer is required for the economical handling of these minerals in their preparation for market, and thus the mining, civil, and mechanical engineer necessarily go hand in hand in all mining and developing enterprises. I wish, however, at this time to treat solely of the duties of the mining engineer in the

COAL MINES OF ALABAMA.

The increasing mineral development of this State calls for increasing care and accuracy on the part of the mining engineer on whose judgment and accuracy not only the funds of his employers are involved, but the lives of all those engaged underground.

Mining operations in the South have, comparatively speaking, just begun, and are now in their infancy, and now is the time to form safe rules and accurate foundations for the more extensive and more complicated work of the near future. This is the time to profit by what has been learned in the mines of the North by the thorough and rigid school of experience, and the demand for systematic and accurate work has shown itself to be an absolute necessity in the Northern States engaged in mining enterprises. This new country and these new mining industries can start right and save not only thousands of dollars but innumerable lives.

The amount of mine engineering done is regulated to a great extent by the State laws on the subject, and every year these laws are becoming more and more exacting. To take the history of mine engineering in Pennsylvania, where more capital is engaged in mining than in any other State in the Union, the progress made is an interusting story.

In the early mining of Pennsylvania's coal deposits, the mining engineer was never required except to blaze out the land lines, more with a view to cutting the timber on the company's property than to confining mining operations to the company's land. The engineer was confined to a jacob's staff, compass and chain, for this work, and was only occasionally required underground to line up some slope or inside workings. The result was that properties were mined out by the early owners regardless of their land lines, as they went it blind under the surface without maps, and all was guess work. The workings were abandoned as exhausted or deserted for what were considered more profitable tracts, and in many cases these old workings have filled up with water or with gas, and so badly caved that they are now impassable, and millions of tons of coal that good mining should have secured, is now lost forever in these old abandoned workings.

The first mining was done, as well as can be ascertained, at that time, on the choicest, easiest mined, and consequently most profitable tracts, with the idea that the supply was simply inexhaustible, and, like the small boy, they ate their pie first.

As the years have advanced, mining methods as well as everything else have progressed, and that which was considered impracticable years ago is now practicable, as necessity has fostered invention, and what at one time in Pennsylvania was supposed to be inexhaustible is now limited and described by time boundaries, and with the rssistance of thorough mine engineering, economy is being practiced. There are many tracts that were exhausted years ago, according to the old school of mining methods, that have yielded golden rewards to those who secured them and were able to reopen and operate them on later day methods. But even now, throughout the coal fields of Pennsylvania are buried millions and millions of tons of valuable fuel that never can be utilized, owing to imperfect mining methods of the pioneer operators when the supply was considered inexhaustible.

The necessity of economy in mining is becoming more apparent every day, and every operator should have a true and faithful delineation of all his workings underground. It is often found necessary in coal mines to re-enter abandoned workings to secure a certain quality of coal and the expenses of such operations are often increased many times the cost of accurate surveys, by the fact that correct maps were not made while these same workings were in operation.

Because certain coal or mineral deposits indicate inexhaustible supply when first opened is no excuse for careless waste in apparent cheap mining by selecting the cream of the deposit. This is more than likely to prove very expensive in the end.

Every mining engineer has his peculiar hobby as to best method to conduct a mine survey, and whatever that hobby is, it should have accuracy for its foundation; accuracy first and then economy should be stunied in all mine surveys, and every one engaged in any way in a mine survey should be known by the engineer in charge to be reliable and to have assistants who will follow his instructions implicitly.

The corps should consist of five men wherever it is possible and of this corps of five men, three cheap men can be secured about the mines to perform the duties assigned them by the engineer in charge. One method that I can recommend for rapid, accurate and economical work, is for the engineer in charge to run the transit, and under no consideration should the needle be depended on, except to check the angle read from the vernier, or for short lines through rooms or chambers where accurate transit work is impossible, and then frequent ties to transit lies should be made, and care taken to set up instruments where there is as little attraction to needle as possible.

TO START THE SURVEY OF A MINE

it is first necessary to locate accurately the boundary lines of the property, establish stone or iron monuments at the corners, and always start surveys on true meridian if possible, and in establishing true meridian or assuming a base line on magnetic meridian, have two, and, if possible, several points on the surface that are not movable, and which can be termed permanent stations of the survey, and that can be found and used at any future time.

Make the base line as long as possible, and from it calculate all courses inside and outside of the mine. If the opening to mine er slope, drift or tunnel, the line should be run twice, unless another outlet is made for the same, which is generally necessary for ventilating purposes, and in that case run lines in one opening and out the other, so as to make a tie or closed survey.

If the only opening is one shaft which is divided into hoistways and airways, then set two wires on head of shaft on certrain line, ascertaining course of line on surface and descend to bottom of shaft and drop lines of fine copper wire with heavy plumb-bobs attached, on this same line. Then after these lines have become steady and no vibration occurs in either, set up the transit and shift it into line until the vertical hair intersects both wires. You then have starting course inside or under the ground to correspond with meridian true or assumed as established on the surface, and on this inside base line turn your angles and make your inside surveys.

In the case of two shafts to one mine, drop a wire down each shaft and make a tie survey on the surface and calculate course and distance between two weres on this survey. Then inside make another tie survey betwen the wires, calculate course and distance between them, and if distance agrees with outside distance, then correct inside courses to outside courses and continue the surveys, thus having same meridian inside and outside—and establish permanent and lasting stations under ground from which to run surveys at any future time.

It is frequently a difficult matter to establish stations in coal mines that can easily be found, and that will last for any length of time, owing to low or wet roof. When the roof will permit of it, an excellent way

TO ESTABLISH STATIONS

is to drill a small hole about ½ inch in diameter and to the same depth, and around this with white paint put a circle, square, or triangle, and paint the number of station near it on the roof. Stations in notched ties of tramroads are short-lived and unreliable, from the fact that cars constantly passing over cause track to shift. Ties are constantly being renewed and pushed out of place by cars jumping off the track, etc.

Another method for roof stations is to drill a small hole with one-fourth inch bit and shoulder brace in the roof, drive in this hole a plug of wood that fits it tightly and in the wood drive a spad. The spads, as we call them, can be made very cheaply from horse-shoe nails by flattening the heads and punching small hole through them and cutting off point of nail so that spad will be about 1½ inches long. In workings that are heavily timbered spads are very useful and every corps should have a supply on hand, and these like the small drill holes should be painted and numbered. In the use of spads a long string with plumb bob attached can be suspended from the hole for the fore and back sight, and with aid of a true bob, point can be accurately set on the bottom to set the transit over, or the bob can be suspended over top of transit while it is being set up. But this last practice is not very safe so far as safety of transit is concerned as through carlessness, I have known the bob to be dropped on the transit, badly damaging the instrument.

All measurements inside and outside between stations should be made with a reliable steel tape, graduated every foot. I consider one 300 feet long as most convenient for mine work. The chain should never used, and all steel tape measurements between stations on transit work, should be read to the one hundreth part of a foot. Great care must be exercised in having the tape level when measuring and being perfectly straight between the two points to be measured. This can be accomplished best by taking all measurements at time of doing the transit work and having the tape always between the instrument station and fore sight station, or between back sight station and instrument.

Every instrument on the pitch should have angle carefully measured by vertical arm on circle of the transit, and if vertical angles are taken between all stations,. elevations can be readily and very cheaply worked out, and levels in this way can be taken accurately enough for all practical purposes at a very slight cost.

It is a false idea of economy to have a cheap boy to read the measurements. Accurate measurements are as necessary as accurate angles, and an error in either makes the survey valueless. While the transit is being set up, the tape should be stretched on line from one station to the other, and ribs of gangways, rooms, etc., occurring between the two stations, accurately located inside, noted by the man in charge of the tape, and after sights have been taken and angles recorded by transit man, he can assist in making the total measurement, and then move ahead to next station with his instrument.

A 50 foot metallic or linen tape should be furnished the side note man, for taking his off-sets, as guessing at side measurements in gloom of a coal mine is decidedly inaccurate, and the faithful representation of pillers on the map is very necessary.

I prefer to keep the tape between the transit and foresight station, so that one cheap man or boy can assist either the side note man or the foresight man, or both if necessary. Arrange to have a reliable boy or cheap man in advance to put up stations and give sight, then side note man, with a boy assistant, as a boy is much more active than a man for such work as measuring off-sets and assisting foresight, etc. Then the transit man and for back sight a boy or cheap man to give sight when called for to hold light in setting up instrument, attending doors, carrying oil, and in fact a general utility man.

With this arrangement, and good men in above positions, surveys can be made rapidly and accurately. System must be observed, and everyone must have his duties to perform, so that nothing in the survey is forgotten or neglected while on the work. Side notes and transit notes should be kept in separate volumes, and all notes should be made full and comprehensive and on the simplest plan possible, but do not spare a line to describe any part of the survey. The station numbers should never be repeated in the same mine,and in that way much trouble and confusion in locating workings, courses, etc., can be avoided.

Notes properly recorded should be so plain that any other engineer could pick them up and utilize them at any time in the future, if necessary, and the memory should never be trusted to locate anything on the map after leaving the mines.

THE WORKING MAP

of the mine should show land lines. surface improvements, any and all streams or water ways, and not more than one vein should be platted on one sheet. The scale of 100 feet to the inch is a very convenient one, and all the stations as run in the mine should be shown on the map and neatly numbered to correspond with those painted inside. In this way the mine superintendent can more readily locate his workings, and locate instantly, or describe pillars that appear too large or too small, etc. If an elevation is taken by vertical angles on each station, the contours of the mines can readily be established, and is a great aid at very slight additional cost.

Surveys should be connected both inside and outside the mines as frequently as possible, and thus keep them constantly checked up. The platting requires careful work, and the engineer should guard against extremes in accuracy over certain portions of the work. For instance, I recall one man who kept his transit in excellent adjustment and read his vernier to a nicety, and was a regular fanatic on making tie surveys to close his angles, yet he measured all his distances with an old worn out chain usually badly broken and patched, guessed at his sub-divisions of feet, and then platted his work with a magnifying glass to insure accuracy.

Another man went to the other extreme by measuring with 300 feet steel tape, and trying to put a certain pressure on each 100 feet of tape out in measurements, and allowing for the expansion of contraction of his steel tape under atmospheric changes; read his vernier to half minutes, splitting hairs on his instrument work, and yet when he reached the office these surveys would be platted with a ricketty T square and protractor on a table with a rainbow edge.

Extremes should be avoided and careful systematic work should be observed in every department, and the duties of the mining engineer cannot be done lightly or carelessly.

As much or more care should be taken with the surveys of a mine as is taken with the books of the operating company, and as the operator or manager of the company is able to take up his balance sheet each month, and see the financial condition of his company, so should he be able to take up his mine maps at certain periods, and see exactly the shape and condition of his workings.

PROCEEDINGS

OF THE

Alabama Industrial and Scientific Society.

VOLUME III.

1893.

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SECRETARY'S OFFICE,
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ALABAMA

BURTON & WEATHERFORD, TUSCALOOSA, ALA.

OFFICERS.

1893.

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SECRETARY.

EUGENE A. SMITH, - - - University, Ala.

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PROCEEDINGS OF THE ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

SPRING MEETING.

OFFICE OF T. H. ALDRICH.,
No. 1916½ MORRIS AVENUE, BIRMINGHAM, ALA.,
MAY 30, 1895.

The meeting was called to order by the President, C. A. Meissner, at 8:30 P. M. There were present, Messrs. T. H. Aldrich, C. A. Meissner, W. B. Phillips, Richard Thomas, Herman Alber, J. B. McCormack, H. F. Wilson, Jr., E. A. Smith, J.H. Pratt, Thomas Seddon, C. Cadle, J. DeB. Hooper, H. Friel.

The reading of the minutes of the last meeting was dispensed with, since these have already been printed in the Proceedings and distributed among the members.

The President then read his address. (This is printed in this volume of Proceedings.)

ELECTION OF NEW MEMBERS.

Mr. Aldrich proposed the name of Mr. A. E. Barton, who was elected by acclamation.

Mr. Seddon proposed the following which was adopted :—

Resolved, That it is the sense of this Society, that every effort should be made to build an export and import trade in the Gulf Ports.

Mr. Seddon also moved that the Secretary be relieved from payment of the annual dues, as an offset for his services. Carried.

READING OF PAPERS.

Mr. H. F. Wilson, Jr., who had been requested at the last meeting to prepare a paper on the Birmingham Water Works, stated that he had been obliged to excuse himself because of the impossibility of doing this work in addition to what he has had to do in the office. He was requested to prepare the paper for the next meeting, which he thought he could do.

He, however, placed before the meeting some accurately measured and platted sections across Red Mountain. These sections were constructed to scale, from actual measurements and levels, and showed a striking variation in the dip of the strata cropping out on Red Mountain and of those cropping out in the Sub-Carboniterous chert ridge.

In the discussions which followed the examinations of these sections, Mr. Seddon called attention to the importance of the dip in the economical relations of the ores of iron.

Dr. Smith spoke of the fact that a cross section of Murphree's Valley showed a correspondingly greater dip in the strata of the Red Mountain, than in the beds of the overlying Sub-Carboniferous.

Mr. Aldrich called attention to the want of parallelism of the fault of Grace's Gap with the trend of Red Mountain. The fault was nearly north and south, while the trend of the mountain is northeast and southwest.

Mr. McCormack, at the request of Mr. Aldrich read some statistics which had been prepared by Mr. Ramsay, showing the increase of the percentage and gain in quality of coke made at Pratt Mines from coal that had been washed. This paper was returned with the request that Mr. Ramsay furnish the Secretary, for publication, a complete account of the experiments made.

Mr. Seddon, in remarks on this paper, gave his experience with ten ovens, in each of which there was a difference of 1.6% per ton in favor of washed coal over the unwashed.

Mr. McCormack remarked that the washed coal could be recognized at the door of the oven, by the difference in the amount of braise.

Mr. Seddon said that the coke of the washed coal can be much more easily drawn, hence there should be either a reduction of the wages of the oven men or an increase of the charge, keeping the wages as they are. The latter had been adopted by the Sloss Company.

In discussing the question whether the wetness or dryness of the coal when charged into the ovens had any effect upon the quality of the coke, Mr. Aldrich said that there was a slight deterioration in the coke near the door, but the coke as a whole showed very little injury from being coked wet. Mr. McCormack sees no difference. Mr. Meissner thought that at Mary Lee Mines the coke that had been coked too wet was not so good. The process of washing was probably the cause of the trouble. Mr. Barton did not think there was much difference in the quality of the coke, whether coked wet or dry. Mr. McCormack thought that the coke from washed coal was harder. This matter was, also, further discussed by Messrs. Aldrich, Dr. Phillips, and Mr. Thomas.

Mr. Barton, then by request gave a short account of some experiments made by him for concentrating Red Mountain ores. Mechanical methods had been tried without success; but it was found that by heating the ore in producer gas or in the gas from the coke ovens, it was made magnetic and could then be separated from the silica by means of a magnet. It was found possible in this way to magnetize large pieces which could then be crushed and in small fragments easily separated by the magnet. The hard caleareous ores when similarly treated, and then made wet would slake and crumble to pieces, making the concentration by the magnet easy. The process promises to be successful economically, and the Tennessee Coal & Iron Co. will put up the apparatus for testing this on a large scale. Dr. Phillips gave an account of the concentration of magnetic ores in the Northern States and illustrated his remarks with specimens.

Mr. Thomas then read a paper on coke which will be found in the proceedings of this Society for the current year. This paper was discussed by Mr. Aldrich who exhibited some samples of coke made from washed coal and from disintegrated but not washed coal.

ELECTION OF OFFICERS.

The ballots which were sent by mail from members not present and the ballots of those present were next counted and the result announced as follows:

OFFICERS FOR 1893.

President, Ershine Ramsay.
Vice-President, F. M. Jackson.
Vice-President, L. C. Harrison.

The result of the vote was announced,and owing to the lateness of the hour, and the necessity of catching the last dummy by some of the members, the reading of the synopsis of the minutes of this meeting was dispensed with and the meeting was adjourned, to reconvene at the call of the President some time during the autumn months.

EUGENE A. SMITH, Secretary.

AUTUMN MEETING.

BIRMINGHAM, ALA., November 24, 1893.

Meeting was called to order at 8:20 P. M., and in the absence of President E. Ramsay, Cornelius Cadle occupied the chair. The following were present:

Barton, Wilson, Aldrich, Cadle, Squire, Prochaska, Phillips, Smith, Murray, A. G. Davis, Frank Smith, Mr. Sayler and Mr. Boyer.

Minutes of last meeting read and approved.

Mr. J. Weidman Murray read a paper on the "Generation of Steam by the Use of Blast Furnace Gases," after which a general discussion ensued. (The complete paper will be found in this volume).

Dr. Phillips then read a paper on the "Improvement of the Iron Ores of this District," which was discussed, as follows: (Dr. Phillips is still posecuting these investigations and withholds his paper from publication at present, with the expectation of presenting the complete paper later.)

T. H. ALDRICH: I would like to say that there are some things that Dr. Phillips did not bring out in his paper. For some years we have only been mining from twelve to fifteen feet of ore out of twenty-two feet, and we have twenty-two feet for an average for some miles more or less. We have now somewhere in the neighborhood of a million tons, more or less, of iron ore, exposed, stripped and ready for loading, but have no use for it, it running twenty-five to thirty-four per cent in silica. For this reason we have never been able to put it in a blast furnace. The ore will average fully forty per cent in iron and the cost of this ore delivered at the furnace, we will say, is fifty-five cents per ton before concentrating. I have been offered contracts to deliver it at this price. This being the case, and taking Dr. Phillips' figures, we see that the concentration will at once make available a vast amount of low grade or rather high silica ore.

At Lone Pine Gap Ridge, the vein of ore is sixteen feet thick, and as it goes down towards Bessemer gets less silicious and improves in quality. In the large vein opposite Birmingham, it is 16 feet thick in the main ledge and contains 40 per cent of iron and 40 per cent of silica. With this concentrated to 62 per cent of iron and 12 per cent of silica, the process would be of immense value, and every bit of this iron can be utilized. The process is a great deal more valuable than the Doctor has brought out in his paper.

C. Cadle: I think there are some present who have not read of the magnetization and concentration process. Will Dr. Phillips explain it?

Dr. Phillips: Mr. Barton is here and will explain the Barton-McCormack process.

Mr. Barton: The Barton-McCormack process of magnetization of ore consists in passing any reducing gas, preferably, Carbonic oxide over red hot, or white hot ore, when the sesquioxide is reduced to magnetic oxide. This can be done in any suitable furnace.

Mr. Aldrich: The Tennessee Company is now starting to build a roasting furnace and experimental plant at Bessemer for the purpose of testing this roasting and concentration, and intend to make a practical experiment on a large scale, and at same time, will probably see whether the roasting of hard ores is worthy of consideration. We shall probably be in position at our next meeting to announce some results.

Dr. Phillips: Another great advantage in the process would be the manufacture of low silicon iron for use in open hearth steel plants, because the low silicon character of the burden will enable us to use two-thirds concentrates and the burden will only contain from ten to twelve per cent of silica, while now it is more like 16 to 17 per cent.

Mr. Aldrich: In a talk I had with Mr. Woodward a short time ago, he said that one of our great difficulties is the variable character of our raw material, which was bound to give us a great variation in our product, and that with a high grade ore we could calculate much better what kind of results we were going to get. The process would make our ore more uniform.

During the reading of Dr. Phillips' paper, President Ramsay came in and relieved Mr. Cadle from presiding.

Mr. A. E. Barton next read a paper on the "Grading of Southern Pig Iron." (Printed in full in this volume,) This was followed by remarks, as follows:

Dr. Phillips: I think it is a very excellent paper and directs attention to a matter which is very important. I had a talk with a representative of Mathew, Addy & Co., about selling iron on analysis, and he stated that the sellers would be in favor of such a proposition, but that the consumers would be opposed to it, and a great many causes of dispute would be avoided I think if the analysis accompanied the shipment as suggested in Mr. Barton's paper. I heard Mr. Kenneth Robertson read a paper here, at a meeting of the American Institute of Mining Engineers, on the grading of pig iron, and he stated there was too much of a multiplication of grades in our pig irons here, and that some of the grades should be eliminated, and the grades should be based on analysis. This is coming about now, and now-a-days when silicon estimations can easily be made in the laboratory, there is no longer any reason for not knowing the composition of iron. It formerly took from two to three days to make silicon estimations, but now it can be done in a few minutes, frequently in fifteen minutes, and Mr. Ford, of Pennsylvania, has made one in twelve minutes by his method. Three silicon estimations can easily be made in one and a half hours, and ten to twelve in a day, going to work at eight and knocking off at four or five. Thus are the improvements in mechanical analysis bringing about the possibility of knowing exactly what you are doing in every cast.

Mr. C. Cadle: Is it not a fact that a great many of the smaller manufacturers and foundrymen know very little about the analysis, knowing only something about sulphur?

Mr. T. H. Aldrich: It has been my misfortune to find that makers can refine things to such a point that customers would not pay for it, and the question is, whether it will pay to do this? This is the great question, but I think customers may be educated to that point, where they would be willing to pay something for a guaranteed analysis and the extra expenditure to give them what they want.

Mr. E. Ramsay: They pay now different prices for different grades.

Mr. T. H. Aldrich: It is impossible for a man to know exactly what kind of iron to ship, unless he knows what the iron is to be used for, and a good practical seller of iron who gets around among his customers finds this out, and is consequently very successful in sending the right kind.

Mr. H. F. Wilson, Jr., next exhibited some drawings of "Sections through Red Mountain," and explained them to the meeting. Mr. Wilson prepared no paper, but it was the sense of the meeting that the maps should be made a part of the proceedings.

Mr. E. Ramsay read a paper on the "Generation of Steam from Waste Heat and Gases of Coke Ovens." Printed in full in this volume.

Mr. T. H. Aldrich: Mr. President, I would like to ask the danger of explosive mixtures.

Mr. Ramsay: Have had no trouble at this plant, but at No. 3 plant, we attempted to burn the gases and we went to a good deal of trouble and expense, and found explosions would take place every second and the gases rush back into this large flue.

Mr. T. H. Aldrich: Did you not get better results when you got every thing tight?

Mr. Ramsay: Yes sir. I arranged to mix the air with the gases as freely as possible as they do under a blast furnace boiler, and found that I had the best results when everything was tight. I almost despaired of success, and was on the point of abandoning the whole thing, and as a last resort stopped up all the leaks and holes with mud, and from this on it began to work and make plenty of steam.

Mr. H. F. Wilson: How is the Standard Company getting along with their experiment of making tar at their coke ovens?

Mr. T. H. Aldrich: I understand they have abandoned it.

At this point, the President stated as it was growing late and he had a little business to bring before the meeting, he thought it best to stop the discussion and take up the business.

The following were proposed for membership in the Society:

C. E. Bowron, Mining Engineering, T. C. I. & R. R. Co., Tracy City, Tenn.

J. G. Moore, Asst. Supt. T. C. I. & R. R. Co.,Pratt City,Ala.

J. W. Minor, with Pioneer Mining & Mfg. Co.,Thomas,Ala.

J. H. McCune, Asst. to Pres. Sloss I. & S. Co., Bgh'm, Ala.

H.W.Perry, Mgr. Coal Mines S. I. & S. Co., Coalburg, Ala.

P.H.Haskell,Asst. Chemist,T. C. I. & R. R. Co.,Ensley, Ala.

E.A.Uhling,Supt. Blast Furnaces, S. I. & S. Co.,Bgh'm,Ala.

S. Boyer, with Sloss Iron & Steel Co., Birmingham, Ala.

J. Weidman Murray, Supt. Linn Iron Works, T. C. I. & R. R. Co., Birmingham, Ala.

The President stated that as there was not a sufficient number of the Council present to act on the applications, he would suggest that the by-laws be suspended and the gentlemen elected at once, and would like to have a motion to this effect.

Mr. T. H. Aldrich: I move that the by-laws be suspended and the gentlemen be elected by viva voce vote. Seconded and carried.

At the request of the President the Secretary made a few remarks as to the financial condition of the Society. He stated that there were $30.00 in bank and that he had collected $20.00 this evening, making a total of $50.00.

On motion adjourned.

Eugene A. Smith, Secretary.

ADDRESS OF THE PRESIDENT, C. A. MEISSNER.

GENTLEMEN OF THE INDUSTRIAL AND SCIENTIFIC SOCIETY:

Since you did me the honor of electing me President of this Society, it has been my misfortune to meet you so little that I have often felt it had perhaps been better for the Society to have conferred this honor on some one more able to attend to its duties. The great interest and high capabilities of our worthy Vice President have, however, so efficiently replaced the enforced lack of co-operation on my part, that it is a question in my mind whether such lack was not rather beneficial than otherwise to the Society.

While the last year has perhaps not been a very prosperous one for the Society, yet I feel that in these times of industrial depression, we must be well content if we have held our own. It is always a difficult matter in times like those passed through in the last year to keep up the interest of members and hold them together. As one member expressed it to me the other day, there is so much mental and physical effort needed to keep body and soul together, attended by the inevitable worry, that the mind is not sufficiently clear and willing to readily take up matters of a purely scientific or experimental nature, yet I must sincerely and earnestly urge all members to hold together, and remember that when better times do come, we then have the members fully organized and ready to make this Society one of the weight carrying and influential organizations in the world of industrial and scientific activity and thought.

The last year has been one of peculiar hardship to the iron trade, yet it has shown the wonderful strength and reserve force of this section of it. While some of our smaller concerns have preferred to lie idle rather than attempt to compete with the present markets, yet the material improvement in the iron plants of this section has been very marked. The plants have been improved, the method of management drawn closer to scientific lines. Where formerly white and mottled iron were manufactured in larger quantities, these have now become exceptional makes and are scarce articles; yet I am constrained to say, we are still far behind our Northern competitors in scientific effort and attainment. How many plants use their laboratories to full advantage, and analyze their raw materials with anything like regularity? And yet there is hardly a Northern plant that does not find this very necessary and very profitable. In our laboratories we should employ the latest, quickest, and most accurate methods, so as to meet any demand on the work. Progress in these scientific departments is as absolutely essential to our success down here as in the practical departments.

In manufactured iron, the year has been a fairly prosperous one. It has shown material improvement in plants, and the rolling of Birmingham steel into boiler plate has become one of the standard products. The question of steel is, I think, practically and technically settled, and now only depending on its financial phases in order to be a completed one. The many experiments made here have shown plainly that good steel can be made at a profit out of Birmingham iron, with or without scrap—steel that is soft, strong, and works well. How economically this may be produced is, in my opinion, merely a question of size of plant and facilities, and can only be developed by the investment of the necessary capital.

As to raw materials, there are some material improvements to be noted. Attempts have been made at various times to concentrate our ores. I consider this a question of vital importance, and would call the attention of our scientific men to it. We have an immense vein of ore, thirty to forty feet thick, of which only about four feet can average 50% of metallic iron; yet the mixture is such that it is more a question of mechanical difficulties to overcome than of chemical ones. I sincerely trust an effective and economical method may be found to accomplish this concentration, as success in this respect means perhaps more than we realize at present. In the competition with our Northern friends, a richer ore, running from 60 to 65% in iron, and correspondingly low in silica, would give us a tremendous advantage over a large portion of other iron districts.

In coal washing, considerable progress has been made, though there is still room for improvement. The success attained in this direction by those who have undertaken it, has been very encouraging, The coke consumption per ton of iron has already been very materially reduced, and we can look for decided further changes in this respect, as soon as our furnaces use all washed coke.

I think this covers the ground, as far as it is my province to-day to go. We have started on the line of improvement in almost every branch of our industries. If this has been due to the hard times, they may prove a blessing in disguise; and I sincerely trust that the next few years will put us on equal footing in these respects with other competitors.

As to the Society, I can only repeat, let us hold together under all circumstances. The time will come when we will all feel more willing and able to help it with papers on topics of general interest, and the beneficial results that can be accomplished in this way will fully repay the struggles through which we have now to go. The Society has done good work in the past, and I sincerely trust will do good work in the future.

A PAPER ON COKE.

BY RICHARD THOMAS.

Before going into the subject of coke, and coke making, perhaps it would be as well to glance over the composition of the coal used in the manufacturing of coke, as the South Wales coal fields have more changes from the one class of coal to the other, than any of which I am acquainted, I herewith append a chemical analysis make by Playfair and others, of the four classes, viz: Anthracite, Semi-anthracite, Semi-bituminous, and the regular Bituminous, or coking coal. The South Wales field, near the center, is in two troughs, two synclinals, and one anticlinal. The largest is about sixteen miles wide, and the smallest about six miles wide; the two about twenty-two miles wide, by about seventy in length, from east to west. I have selected the east half of the field, commencing on the north crop of the lower measures, starting on coal No. 1, in the tables, which is Anthracite; No. 2, Semi-Anthracite, on the same side, then following the crops eastward to Aberdare and Merthyr district, to coal No. 3, Semi-bituminous; then to the eastern end, where comes in coal No. 4, or bituminous coal; then rounding the east end, and following the crop on the south side, in a westerly direction, we come to coal Nos. 5, 6, and 7, which is on the south crop of the same measure as the No. 1, which is on the north crop, or the opposite side; all the veins being the same measure and age. For comparison, I have used the tables of some of the North-of-England coal. I have failed to get hold of a chemical analysis of Alabama, and some of the other American coals, in separate forms, but have another table, showing the amount of volatile matter in each of the varieties, to correspond with your table of American coal, substituting volatile matter in the place of chemical analysis, in separate forms.

I will call your attention first, to

Coal No. 1—or Welch Anthracite. This coal will not fuse, neither will the lump coke like the other coal. The analysis shows 92.9%, of coke from the coal. In appearance, it is more like a drying up coal, than coke. In place of cells, it looks more like cracks. By disintegrating the coal, and using about 6% of pitch, the latter being about 12 of hydrogen to 88 of carbon, the two combined make a very strong coke. The fracture did not show the cells the same as the coking coal, but was granulated in appearance. They claim that it worked well for foundry purposes and commanded a price from three to four shillings per ton more than the coke made in the same locality from the Bituminous coal. The loss in volatile matter in this coal was very small. The difference in carbon from coal to coke was less than 1%. The analysis shows 3.46 of hydrogen, and 2.58 of oxygen. It seems by the proportion of volatile carbon to the amount of oxygen that the two had combined into carbonic oxide. Had the carbon and the hydrogen combined, it would have formed the light carbide of hydrogen, which is composed by the weight of 75% of carbon to 25% hydrogen. In that case, there would have been a loss of over 10% of carbon. On the other hand, if the amount of oxygen had combined with the hydrogen, and formed water, the amount of hydrogen would not have exceeded 0.32 of 1%. It is very clear that the hydrogen, in the Anthracite, must have escaped almost in a pure state from the coal, and mixed with the oxygen of the air and formed water.

Coal No. 2—has a little more hydrogen, and like No. 1 it will not fuse; neither will it coke, only when mixed with pitch, or some of the other solid volatile carbon. This coal would have to be treated the same as No. 1 to make coke. The coking of No. 1 was discontinued for a time, owing to the advance in the price of pitch, there being such a demand for the article to mix with the dry non-fusible coal, to make patent fuel.

Coal No. 3—This coal is known, the world over, as the Aberdare and Merthyr Smokeless Steam Coal. This is 2.33 less in carbon than No. 1, but higher in hydrogen, by a little over 1% than No. 1. It has only 1.65 of oxygen, and it shows a loss of carbon, in coking, of 8.14, the oxygen being so low. The carbon, in this instance, must have formed gas, most likely the light carbide of hydrogen. This coal has not sufficient hydrogen and carbon to fuse, but the lumps make a good furnace coke, and is used very extensively. The slack of No. 3 will coke when disintegrated with richer coal, being in proportion about half and half; or when the hydrogen would be about 5% in the coal—or, say, 1 of hydrogen to 17.5 carbon. The two combined will yield about 75% of coke from the coal.

Coal No. 4—Will fuse and make a strong coke, and is a coking Bituminous coal. I have noticed that whenever it gives, sap 75% of coke from the coal, the color of the coke is dark grey, and shows the cells very clearly; but it will not have a smooth, silvery gloss on it. None of the dry coals have.

Coal No. 5—This coal shows 8.06 less carbon than No. 4, but it has 7.74 more oxygen in it, and has also 0.61 more hydrogen. The hydrogen is 1 to 16 of carbon. This will make a bright coke, of silvery appearance.

Coal No. 6—Makes a good furnace coke, and shows the cells a little darker grey in color; the yield being rather high to be glossy.

Coal No. 7—This coal cokes more like the Connellsville, of Pennsylvania, than any I have ever seen. This coke, in appearance, has a very smooth, silvery gloss, when cooled in the ovens. The best coke in this series is made from a vein called the Crepwrvein. It makes a good, strong, furnace coke, and is largely used for foundry purposes. Owing to a slate roof, some of which falls in mining, the slack in some of the mines is washed, but the vein is free from all impurities, and averages about eight feet thick.

Table 1—Showing Composition of Welch Coal.

No.	Carb.	Hyd'g'n.	Nit'g'n.	Oxy.	Sulph.	Ash.
1	91.44	3.46	0.21	2.58	0.79	1.52—100
2	84.87	3.84	0.41	7.19	0.45	3.24—100
3	89.01	4.49	1.16	1.65	1.03	2.66—100
4	89.78	5.15	2.16	1.02	0.39	1.50—100
5	81.72	5.76	0.56	8.76	1.16	2.04—100
6	87.48	5.06	0.86	2.53	1.03	3.04—100
7	82.75	5.31	1.04	4.64	0.95	5.31—100

Composition of English Coals.

No.	Carb.	Hyd'g'n.	Nit'g'n.	Oxy.	Sulph.	Ash.
8	81.81	5.50	1.28	2.58	1.69	7.14—100
9	83.71	5.30	1.06	2.79	1.21	5.93—100
10	80.07	4.92	2.15	9.95	1.11	1.80—100
11	82.61	5.86	1.76	7.44	0.80	1.53—100
12	79.71	5.16	0.54	10.65	0.52	3.42—100

Table No. 2—Showing the amount of Coke left, and what was volatile.

No.	Coke left from coal.	Hydro. Volt.	Nitro.	Oxygen.	Carbon carried off		Hydrogen to Carbon.
1	92.9	3.46	0.21	2.58	0.85	100	H.1 C.26.4 Anthra.
2	85.5	3.84	0.41	7.19	3.06	100	H.1 Semi- C.22.1 Anthra.
3	84.55	4.49	1.16	1.66	8.14	100	H.1 Semi- C.19.8 Bitu.
4	77.5	5.15	2.15	1.02	14.18	100	H.1 C.17.4 Bitu.
5	68.4	5.70	0.56	8.76	16.58	100	H.1 C.16 Bitu.
6	72.94	5.06	0.86	2.53	18.61	100	H.1 C.17.1 Bitu.
7	67.10	5.31	1.04	4.64	21.91	100	H.1 C.15.6

Coke left, and Volatile Matter carried off by Coking,

8	64.61	5.50	1.28	2.58	26.03	100	H.1 C.15	Bitu.
9	61.38	5.30	1.06	2.79	29.47	100	H.1 C.15.8	Bitu.
10	61.70	4.92	2.15	9.95	21.28	100	H.1 C.16	
11	64.00	5.86	1.76	7.44	20.94	100	H.1 C.14	
12	58.10	5.16	0.54	10.65	25.55	100	H.1 C.15.4	

Composition of English Coal, after distillation, or coking.

Solid	Coke	68.925
Liquid	Tar	12.230
	Water	7.569
Gases	Light Carbide and Hydrogen	7.021
	Carbonic Oxide	1.155
	Olephiant gas	0.753
	Sulphuretted Hydrogen	0.549
	Hydrogen	0.499
	Ammonia	0.211
	Nitrogen	0.035
		100.

The question was given in a former meeting, "What made coal coke?" I think that the analysis of the Welch coal shows very clearly that when the hydrogen is combined with the carbon, in proportion of 1% of hydrogen to 18% of carbod, that coal will fuse. I don't think it would be out of place to give a table of distillation of the tar taken out of the coal. This has been divided into three classes. First, the light oil of tar; next, the heavy oil of tar; and lastly, solid. Whichever of these three predominates in the tar, affects the coke in its size and appearance. When the coal, as No. 4, has hydrogen 1 pr.ct. to 17.4 carbon, the solid matter in the tar predominates. On the other hand, when the hydrogen is 1% to 15.5 carbon, we have the silvery coke. But when the volatile matter carries the light oils in excess, we have a coal too high in volatile matter, and if it will coke, the product is a soft, light coke, and has a tendency to run into small, fingery pieces. The amount of either of these three in excess, shows a corresponding difference in the amount of carbon carried off from the coal, and what is left in the coke.

Composition of coal tar when distilled.

Light Oils,	Benzol, - - -	C. 12 H. 6	pr.c.	H. 9.
	Tuluol, - - - -	C. 14 H. 8		C. 91.
	Cumol, - - -	C. 18 H. 12		
Heavy Oils,	Anilin, - - -	C. 12 H. 7		H. 7.47
	Picolin, - -	C. 12 H. 8	pr.c.	C. 83.5
	Lucolin, - - -	C. 18 H. 8		N. 9.03
Solids,	Naphthalin, - -	D. 20 H. 8		
	Paranaphthalin,	C. 30 H.12	%	H, 5.55
	Pyren, - - -	C. 36 H.12		C.94.45
	Chrysen, - - -	C. 42 H.14		

Table showing the fixed carbon and volatile matter in the Welch and English, compared with some of American coals.

No.	Welch Coal.	Specific Gr.	Fixed Carb.	Volatile matter.	Sulphur.	Ash.		Locality.
1	Anthra.	1.375	91.09.	6.60	0.79	1.52	—100	Llanelly.
2	Semi-Anthra.	1.300	81 81	14.50	0.45	3.24	—100	Swansea.
3	Semi-Bitu.	1.325	80.86	14.75	1.67	2.72	—100	Aerdare Merthyr
4	Bitu.	1.315	75.61	21 50	1.39	1.50	—100	Eblbwvale.
5	Bitu.	1.320	65.20	31.60	1.16	2.04	—100	Abercarn.
6	Bitu.	1.280	68.87	27.06	1 03	3.04	—100	Llynvi
7	Bitu.	1.299	60.84	32 90	0.95	5.31	—100	Taibach.
8	Eng. Bitu.	1.290	55.78	35.39	1.69	7.14	—100	Hartly, N. Eng.
9	Eng. Bitu	1.270	54.24	38.62	1.21	5.93	—100	Wallsend.
10	Eng. Bitu.	1 311	58.80	38.30	1.10	1.80	—100	Park Gate.
11	Eng. Bitu.	1.272	61 67	36 00	0.80	1.53	—100	Inch Hall.
12	Eng. Bitu.	1.257	54.14	41.92	0.52	3.42	—100	Haydock Lit. Delf
13	Pennsylvania.		60.33	31.38	1.05	7.24	—100	Connellsville.
14	Pennsylvania.		71.75	21.60	1.03	5.62	—100	Big Mashondu v,
15	Pennsylvania.		61.92	30.91	I.06	6.11	—100	Walston Coal.
16	Tennessee.		62.07	27.11		10.82	—100	Tracy City.
17	Tennessee.		57.02	39.91	0.20	2.87	—100	Coal Creek.
18	Tennessee.		64.39	28.92		6.69	—100	Sewanee.
19	Alabama.		59.58	33.71	0.66	6.05	—100	Helena.
20	Alabama.		63.01	33.12	I.04	2.83	—100	Pratt Seam.
21	Alabama.		59.89	28.73	0 46	,10.92	—100	NewCastle Seam.
22	Alabama.		64.71	33.15	0.32	1.82	—100	Black Creek.
23	Alabama.		61.78	34.62	1.11	2.49	—100	Watts C. & C. Co.
24	West Virginia.		69.89	24.77	0.36	4.98	—100	Quinimont.

I have experimented, a great deal, in trying to get rid of the sulphur from the coal. They claim that they can get rid of a considerable quantity by burniug the coke on moist ground, in clamps, or milor. It is more reasonable that they can, if we examine the process. The flues made of lumps of coal or wood, then the smaller flues, at intervals, acting as chimneys, we get the strongest heat in the bottom of the pile. This would decompose the hydrogen of the water. The hydrogen would have a chance to take up some of the sulphur, and the two could then escape through the upright flues, or chimneys, as sulphuretted hydrogen, and the oxygen would then form C O. or CO_2. In burning in the beehive ovens, if the hydrogen and sulphur would unite, they would have to pass through the layer of fusible coal, when most of the sulphur would be taken up in this fusible carbon, and the balance carried off as sulphuretted hydrogen gas, or in the liquid tar, and ammonia.

My impression is, that the fusible paste, preceding the burning into coke, holds the sulphur, and prevents it from escaping with the other gases. I have tried steam through pipes, under the floor of the oven, with holes, at intervals, for the steam to pass up through the charge, but it failed to carry off the sulphur, and there was no improvement in the coke. I have tried slack lime mixed in the coal, also thick lime water. The furnace man was under the impression that the sulphur would unite with the lime, and be carried off with the cinder. There was no improvement in the iron by the process, and we discontinued it. We tried washing the slack with salt water from the sea. That did no good in that coal. I have experimented since then, by washing some of the Illinois coal in the water running from the salt works, and the sulphur would take up the oxygen, so quickly that it formed sulphurous acid, and as it acted on the coal, it gave out a large volume of gas. The ovens would light up, and the gases would burn and bring the ovens into a white heat, but the coal would not fuse and coke. We made a change and used water from an old mine, and the coal would fuse, and coke right along, I think it is very clear to be seen, that in the piles of slack exposed to the atmosphere, the sulphur leaves the coal, and forms sulphurous acid. This is again carried off by the water, but the trouble again, is, that the coal is so heated by the action of the sulphur it will not coke. The only way to reduce sulphur in the coke, that I know of, is washing the coal before you put it into the ovens.

When sulphur is in pyrites of iron, or layers, distinct from the coal, we can wash out the greatest part of it; but when we meet sulphur, combined in the coal, the case is hopeless. We can neither wash it out, nor burn it out. The like has been mentioned before as sulphuretted hydrogen gas, and what is taken out in the liquid tar.

The next point is, can we, by any method, make a larger and denser coke in our ovens. I think that the size of the coke has a great deal to do with the percentage obtained from it in the blast furnace. Suppose we take a piece of coke of the following dimensions, viz: 4 by 4 by 12 equals 224 inches of surface exposed to the action of the hot gases in passing downward to reach the tuieres. Suppose we break the same into two inch cubes, we thus make it 24 in number, each of which would have 24 inches of surface, or the pieces as follows: 24 by 24 equals 576 inches, or over 3-5 more surface exposed to the action of the furnace gases.

The open top ovens would make coke, in depth, in the oven, but it broke to the ordinary size in handling. In fact, no oven would coke that depth without flues through the pile, consequently such depth would be in layers, and would have more fracture in it than the ordinary layer.

I saw an experimental oven, built on the bee-hive principle, with four doors. The oven was very high, and would take a charge of forty tons of coal; but in this, the same as the open top, they made flues, with lumps of coal across the oven, the charge being from 6 to 8 feet deep, and took some ten days to burn the coke. After being raked out on the ground, it was not denser, nor quite so large in size, as the coke made in layers of about 52 inches, in the drag ovens that were running in the same yard and on the same coal.

To get a uniform coke, the coal must be coked either from the top, downwards, or from the sides, inwardly. Any attempt to use flues in the sides of the bee-hive ovens, does harm to the size of the coke, as the ovens would coke around the walls inwardly, and meet a short distance from the sides—the crest burning downward to the point of meeting. There would be a fracture in the coke, thus doing more harm than good. There could be no benefit in getting the sides coked in a shorter time, unless the whole oven would come ready at the same time. We would lose lose considerable of the fixed carbon of one, in waiting for the other part to come ready.

I have tried the rolling of the Illinois coal, to make it closer. I have fixed a chain, one from the front end, the other attached to the roller from the back end, in the Thomas Ovens, and would pull the roller through several times over the top of the charge, but failed to make the coke denser. I have made quite an improvement in the size of the coke by rolling first, then attaching to the roller, the last time, a piece of plank lengthwise across the oven. In this I inserted spikes, to pass through the plank, six inches long, something like an arrow, which we pulled through, after the last rolling, as the spikes, penetrating the coals, would loosen them. In the way they traveled the gases would flow freely upwards through the crevices, and the crust would form solidly the width between the spikes, thus leaving the ovens, when ready to draw, with coke about six inches wide in size.

In the whole length of the oven the coal was high in volatile matter. The coal carries 51 per cent fixed carbon, and the coke 90 per cent when the coal is so high in volatile matter. The coke, as a general rule, is very light, taking 3030 inches to make a bushed of forty pounds.

I tried several other ways with the Illinois coal. I managed to coke the Big Muddy coal in a drag oven, 24 inches, in 24 hours, by having flues in the bottom, covered by a two inch tile. The gas would pass down through two flues, in the end wall of the oven; then pass through two flues, one on each side under the bottom, and return through the middle, into the chimney in the back end of the oven. The oven had so much heat in the bottom that it coked upwards, at the same rate as the top charge would coke downwards. Where the two met, there would be a break in the charge, each layer, about twelve inches deep. The top coke was not so good as that which was made in the usual way. I accounted for this from such a large volume of gas passing upward in such a short time; the bottom coke was larger and denser, but in cooling the charge inside the oven, the bottom coke would not clear. It looked black, and the color condemned it.

I built some ovens, and passed the heat of an oven in full heat over the top of the oven newly charged. They were constructed by making a flue in the back end of drag ovens, a damper was fixed in the flue, which was closed when an oven was drawn and charged. The chimney was reversed and put on the front end; thus the heat of the oven, in full work, would pass from back to front, over the coal, newly charged. My aim was to try to coke in less time, but I found that the burnt up gases of one seemed to retard the burning of the other. worked and came ready the same as the other ovens, in 48 hours, but there was no gain in the operation.

My experience has convinced me, that the only way to make a uniform coke, is by the single batches, of one depth, and let the coke start from the one end, and burn one way, until it reaches the other end.

All coke for the present high furnaces should come ready about 20 hours before it is drawn, and the oven luted up close to prevent the burning of the fixed carbon; or put the lid on, or damper, but care should be taken that the oven is not in too much heat when putting on dampers. By closing the ovens up, in white heat, they are liable to bring down arches. When the charge is allowed to cool down, by degrees, before it is drawn, it gives the coke the anilin process, which mskes it much stronger. If, on the other hand, the charge is cooled down with water, when it just comes ready, the coke in the middle of the pieces being at almost white heat, the contraction of the outside of the pieces, when cooled, and the force of the expansion from the inside, would have a tendency of fracturing the walls of the cells of the coke, and reduce its strength considerably, making it more liable to break up in handling, and reduce its strength to with stand the burden in the blast furnace.

The next thing is, how and what can we do to improve the coke of Alabama? If we take our Warrior Coal Field, the coking veins are few in number. The Pratt seam of coal is of good quality for coking, but should be washed to reduce the sulphur, which is very easily done, as the bulk of the sulphur is pyrites of iron. Next, to wash out the bone coal and slate, for when not clean, the latter does not fuse with the other coal ; consequently, it acts like slate, and has a tendency of deflecting the joints in coking, so that when a charge is withdrawn it crumbles into small pieces. And to make a No. 1 coke from the Pratt seam I would first wash it. I would run the coal from the washer over a wire gauze with,say, 6 meshes to the inch, and this would take eut nearly all the water. The coal then would drop into the disintegrator. The coal would give a better yield, being damp and fine ; the gases would not carry so much of the carbon out of the coal. I would have a dense coke, and in good size for furnace use, also, by getting the slate and bone out of the coke,as it would be much stronger to resist the pressure in the furnace, and it would be much higher in carbon.

The Black Creek coal would only require disintegrating. The one that Alabama must depend on for coke, in the Warrior fields, will be the New Castle seam. This is high in ash, but low in sulphur. The ash, in this vein, can not be reduced very much by washing, as it is combined in the coal. But the size, and the strength, will make up a great deal in its favor, in standing the pressure of the furnace. The mixture of either the Black Creek, or the Pratt seam, with the New Castle vein, would be beneficial in making a strong furnace coke.

Crushing or disintegrating of coal, when we have such coal, as the Connellsville, of Pa., or No. 7, in table of Welch coal, there is no need of. Such coal will fuse and make paste. This is generally the case with coal of cubical fracture, as it will melt and run together under a certain amount of heat. Coal, again, that shows the thin layers intersected with mineral carbon, gives quite a different result, as the latter will not fuse together. This is to be noticed when such coal is burnt in a household grate. Some of the layers, when on the fire, will fuse and run into bladders, and not where the heat is greater, but often out of a middle lump. The reason of this is,that some of the same lumps of coal require a larger amount of heat to fuse, than others, consequently a large amount of the volatile carbon is carried off before the other parts have fused. This is what I believe to be the cause why some coal will not coke, when the percentage of hydrogen, is the same as the coal that makes a No. 1 coke. The latter, a great amount of the hydrogen would be carried off before the other would fuse, consequently when the first would come to a fusible heat, the other would have lost its volatile carbon, and there would not be sufficient hydrogen left to combine with the carbon and make a paste to run together and make coke. If an oyen is opened at any time when the coking process is going on, it will show the following results, if the coking is done on the beehive principal of burning: The top crust will be coke,the bottom of a black end, with one to two inches of thick paste or fusible carbon under it; then a layer of oily or tarry substance, and next, a sweat or moisture. All of these precede the coking until it reaches the bottom, but there is quite a difference to be seen in these layers of coal. Some coal will dry up and form cracks, and let the gases pass through freely, while another will fuse and run in a thin layer under the coke, and close up the cracks. This retards the flow of gases from the coal, it forces its way spontaneously through the layers, and by doing so, carries the fusible carbon in fine threads into the joints or crevices of the coke. In some coke it will be found in bunches resembling fiue roots or coarse hair. The oxygen admitted into the oven had been taken up with the gases and the volatile carbon would be left unburnt between the lumps of coke. All coal that gives out the latter, or coal of high volatile substance, should be disintegrated. When such coal is reduced very fine it retards the escape of the volatile carbon, and it is not carried off until the whole mass comes into a fusible heat. The following analysis will show the result of a Tennessee coal that was washed in a flume washer, and run off the wire gauze into the disintegrator:

The first was made from half slack, washed, mixed with half nut, disintegrated, but not washed.

By Slocum, of Knoxville.

Fixed Carbon, - - - - -	81.16
Vol. Com, - - - - - -	1.70
Ash, - - - - - -	16.95
Moisture, - - - - - -	0.25
Sulphur, - - - - -	1.94
	100.00

Levi, of Embryville.

Carbon, - - - - - -	86.578
Ash, - - - - - -	12.800
Sulphur, - - - - -	0.372
Moisture, - - - - - -	0.250
	100.000

The latter was made from washed slack. It will be seen by the above that 80% of the sulphur was washed out by a common flume washer. The analysis of lump coal shows 6.85 of ash. The coal is high in volatile matter, and the percentage of ash in the coke shows that the dirt, mixed with the coal, had been washed out very clean. Disintegrating and washing the coal shows a great improvement by the amount of sulphur taken out, and, also, in the size and density of the coke.

THE GENERATION OF STEAM BY THE USE OF BLAST FURNACE GASES.

BY J. WEIDMAN MURRAY.

The utilization of blast furnace gases in the generation of steam, has never received the attention and study, at the hands of either the blast furnace engineer or the blast furnace manager that its importance would justify.

The furnace that has an adequate amount of steam, even under normal conditions, without resorting to firing, is the exception rather than the rule.

There are many reasons for this condition of things, but there are several that have so frequently come to my notice, that I deem them worthy of mention at this time. The first is the faulty method of introducing the gases. The second is the improper combination of same.

In many cases, the gases are introduced through burners in each of the forward corners of the battery on the ground level. By this means, the gases are allowed to travel a distance of from ten to twelve feet, before they come in contact with the heating surface of the boiler, thereby causing the loss of that much valuable surface. Then, too, locating the burners as described leaves an inadequate space for grate surface; which latter is indispensable, either when blowing in the furnace or at such times when the gases are thin.

The best results have been attained where the gases are introduced inadequately under and close to the boiler, in a broad thin flame, admitting the air for combustion around the nose of the burner, either by means of small registers, or by making the slots in the fronts, where the burners are inserted, large enough to allow all the necessary air for combustion to pass in on all sides and mix with the gases at the nose of the burner.

The quantity of gas can be regulated by means of a sliding damper where the burner is fixed, or the use of the Spearman-Kennedy Gas Burner, these latter having proven very satisfactory wherever tried.

Several years since, I was obliged to dismantle a worn out battery of boilers at the Alice Furnaces, consisting of two 46 inch diameter return flue boilers, 34 ft. long. Being short of steam much of the time, I was extremely anxious to secure the greatest amount of generating surface that the limited space would admit. The available floor space for those boilers was fixed,as they had to be placed between two other batteries then in service. Their elevation, too, was limited, as we had to be governed by the position of a continuous breeching running along the entire length of the boiler plant, to which we were obliged to make connection for the conveying off of the waste gases.

The idea struck me that in designing the new boilers, it would be well to build them as large as circumstances would admit, in order to gain generating surface. Then to still further increase the latter to suspend a plain cylinder heater under each boiler. By this means, we would utilize the major part of the heat thrown out from the super heated wall (much of which was going to waste) as well as put to use what usually is a dead space under the boilers.

This battery, as built, consists of two 54 inch diameter return flues. Immediately under and conneeted to each of these boilers, is a plain cylinder heater 36 in. diameter by 31 ft. 2 in. long. These heaters start eight feet from the front end of the boilers, thereby giviug ample space for grate surface and bridge wall, which latter is run up high enough to prevent the incoming gases from striking direct against the forward heads of the heaters. These heaters pass through and beyond the rear walls of the battery a distance of two and one-half feet. From the under side of these at the extreme rear ends, is suspended a 20 in. diameter mud drum. The heaters are hung so as to give them, a fall of 6 in. from the forward end to the points to which the mud drum is suspendəd. The object of extending these heaters through the rear walls of the battery, was to secure a point for hanging the mud drum away from the heater where there would be no agitation, and at thə lowest point in the heater, thereby forming a natural point of deposit for the sediment. In our experience with these boilers, our hopes in this direction, have been fully realized, all sediment collected in the boilers having deposited itself in the mud drum and in that portion of the heater not subjected to the burning gases, and the at a point where its presence does no material harm. The mud drum is conneeted to the under side of the heaters by means of 10 in. diameter built legs. A 30 in. diameter steam drum lies across the top of the boilers and is connected to the latter by means of 14 in. diameter built legs. These drums form perfect equalizers to both the steam and the water between the two boilers.

The same settiugs, hangings, and about the same amount of brick were used in constructing this battery as that used in the dismantled battery.

The double deck boilers gave us 1,660 sq. ft., of generating surface as against 1,040 sq. ft. in the dismantled boilers, or a gan of 61%. The supplementary heater affords us a gain of 59% over that we would have by simply using the 54 in. diameter return flue boiler. Without any additional cost to the plant other than the absolute cost of the heater with its connections, which is but 12% of the cost of the finished battery.

Our experience with this, the first battery of this type of boiler, taught us, that better results could be attained by introducing a fet of gas under the heaters, in addition to the one under the boilers. So when we found it necessary to still further increase the boiler capacity of the Alice Furnaces by two additional double deck batteries of boilers, I designed a duplex gas burner. The upper burner is covered by the Spearman-Kennedy patents. The connection for the lower burner is made to the stationary base of the upper burner,. leading. the gas through a 9 in. by 9 in. cast pipe, located immediatly under the grate bars, to a cast nozzle built in the bridge wall, and measuring 24 in. by 3 in. at the nose. The air for combustion is admitted from either side of the battery, through the super-heated walls to a small chamber encircling the burner nozzle. This chamber is reduced, giving one inch of space on all sides of said nozzle, at which point the air mixes with the gases and causes combustion.

Our experience, as well as that of some of our neighbors has been very flattering, both with the duplex boilers as well as the duplex burners.

I very much regret that the limited time has prevented me from giving you a more minute description of the construction of the boilers as well as their hangings. I should have liked, as well, to give you descriptive drawings of same and would have been glad to do so but the reason as given above.

THE PROPER GRADING OF SOUTHERN PIG IRON.

BY A. E. BARTON.

When requested by oar President to prepare a paper to read at the present meeting of the Society, I felt that I had not sufficient time at my disposal for such a task; but was told that all that was necessary was to bring forward some subject for discussion.

The question as to the proper grading of Southern Pig Iron is an important one in these times of depression, and it is necessary that the maker should take into consideration the special needs of the customer more than has hitherto been done.

Many consumers are now calling the analyst to their aid, and look more to the chemical constituency of the pig than to fracture. Some, however, still remain in the old groove, and are guided altogether by the strength of the iron and appearance of the fracture when broken, which guide is often misleading.

If we look back some twenty-five years, we find many firms in Scotland and in the Muddlesboro district of England, offering only two grades of iron—Foundry and Forge—the iron all being shipped "long," and only an occasional pig being broken. The requirements of customers soon called for an extension of these grades, and six grades were recognized—three of Foundry, i. e., 1, 2, and 3; and three of Forge, i.e., Grey Forge, Mottled, and White. Under certain conditions in the working of the furnaces, a light colored weak iron was made, which the furnace men called "bright iron." This iron was at at first very little in demand, and when sold brought a very much lower price than the Foundry grades proper.

Occasionally, when the stock used was of inferior quality, and the fuel consumption high, a still weaker iron would be made, which, from its peculiar fracture, was called "glazed pig," and was generally put back in the furnace as being unsaleable. It was noticed that when this pig was used as scrap in the furnace, the quality of the iron made seemed to improve and become more open in grain. Prof. Turner, of Birmingham, Eng., gave this matter considerable attention, and discovered that when a certain proportion of this glazed pig was mixed with a hard iron, and melted in a cupola, it had a tendency to open the grain and make the iron softer, and that bright iron brought about the same result in a modified degree. After another research, it was found that the large amount of silicon contained in the bright and glazed pig was responsible for the result, and it was found that by the use of these irons a considerable amount of scrap could be used in Foundry mixture which, by repeated melting, had become too hard to use alone, and only in small proportions when mixed with Foundry iron. After this, bright and glazed pig found a ready sale, and several grades of bright and silvery iron were established.

Some six or seven years ago, there were fifteen recognixed grades of Southern iron, as follows: Open and Close Silvery, Open Bright, Medium Bright, Close Bright, 1 Foundry, 2 Foundry, 2½ Foundry, 3 Foundry, Ex. 1 Mill, 1 Mill, 2 Mill, Silvery Mill, Mottled and White. About five years ago, it was decided, at a meeting of Southern Ironmasters, that a revision of grades was necessary, and that the South had too many grades, and the following change was made: Open and Close Silvery were continued and called Silver Grey; Open Medium and Close Bright were condensed into two grades, and called Nos. 1 and 2 Soft; No. 2 Foundry was called No. 1, and the old No. 1, which was a very open iron and seldom made, was mixed in with the old No 2; No. 2½ and No. 3 were mixed together and called No. 2; Ex. 1 Mill became No. 3 Foundry; Nos. 1 and 2 Mill were continued and called Grey Forge; Silvery Mill was no longer recognized as a grade, and Mottled and white remained the same.

This alteration in the classification caused a good deal of confusion and many complaints from customers. Old buyers of Southern iron complained that the Silver Grey shipped was "mixed," and to any one grading by fracture alone, it certainly looked mixed. The two irons, however, are practically identical in composition chemically, the close flaky iron generally running slightly the highest in silicon, which will vary from 4 to 5½ per cent, and both are somewhat low in total carbon. To meet the wishes of a certain class of customers, the old method of grading Silver Grey has gradually been adopted by producers, and we have now two grades of Silvery Iron, recognized, Nos. 1 and 2, corresponding to the old open and close.

In soft irons, the openest pigs of Medium Bright were thrown into 1 Soft, and the remainder called 2 Soft. The latter cannot be graded so uniform as to fracture as could be desired for this reason, and is considered by many buyers as an off grade. Soft iron should contain fron 3 to 4 per cent of silicon, and be practically free from sulphur, whilst the carbon, though not so high as in the Foundry grades, runs higher than Silver Grey, combined carbon being usually about the half of one per cent, and graphite 2 to 2¼ per cent, in 1 Soft, and ¾ of 1 percent, and 1½ per cent. respectively in No.2 Soft. Soft iron is used as a softener in mixtures, and to use up scrap, and is essentially silicious. One mistake often made by the grader, is to class as No. 2 Soft, the pigs from a Foundry cast that have been chilled during their course down a long runner, and have from this cause a light colored appearance, with a close edge. These pigs generally run about 2% in silicon, and should be graded either as 2 or 3 Foundry. Care should also be taken with the grading of 1 Soft, for the same reason. Recently a pig was graded by three competent graders as 1 Soft, by fracture alone, without seeing the pig broken and on analysis it showed 1.12½% of silicon, and was not a soft iron at all. Many buyers, however, would have rejected a car of such iron on sight, if shipped to them as 2 Foundry, and would have used it as 1 Soft probably with disastrous results.

The grading of the three straight Foundry grades does not require much comment. The standard amount of silicon in each grade should be about as follows: 1 Foundry, 2.75%, 2 Foundry, 2.50%, and 3 Foundry, 2.00, and these contents should be maintained as nearly as possible by repeated analyses and changes in the burden of the furnace when necessary.

It was in Forge iron that the change in the grading caused the greatest trouble. Until lately, the furnaces of the district made sufficient Grey Forge iron in endeavoring to make Foundry irons to meet all demands, and the Forge iron thus made was apt to be high in silicon, and very wasteful for rolling mill use, though suitable as a mixture in pipe works and foundries, and complaints from rolling mills that had been using No. 2 Mill came in thick and fast. Pipe works would also get a car of said iron occasionally, and the furnace would generally hear about it.

Graders soon saw the impractibility of having only once grade of Grey Forge, and tacitly made two grades in their yard, though only one was recognized; ascertaining before making shipment if the Grey Forge was to go to rolling mill or foundry, and shipping accordingly 2 Mill or 1 Mill. These two grades are now generally recognized, being called Grey Forge and Foundry Forge, the former being a much harder iron, lower in silicon, and higher in combined carbon than the latter, with a different crystal.

As blast furnace practice improves in the South, and the iron making materials are more carefully selected, the furnaces will be kept more steadily in one grade of iron, and the iron will become, and is now becoming, more improved; and should the demand justify it, the furnaces will be run with the express purpose of making low silicon Grey Forge, similar to Northern practice.

A considerable proportion of this paper will be ancient history to many here, but it brings forward a very important subject—a subject which until lately has hardly been given the attention it deserved, that of giving customers uniform iron, and iron best suited to their special needs, and removing the stigma that a buyer of Southern iron never quite knows what he is going to get. There are many gentlemen here well versed in Southern iron, and this Society is for mutual instruction, and the object of this paper was to bring forward the views of other members.

THE GENERATION OF STEAM FROM THE WASTE HEAT AND GASES OF COKE OVENS.

BY ERSKINE RAMSAY.

Mining Engineer Tennessee Coal, Iron and Railroad Co

Much has been written and said since the coking of coal has been carried on to any extent, as to the great loss of the valuable products of the coking process, known as the by-products, and considerable time and money have been spent in providing the ways and means which make it possible to utilize these products. Up to this time, very little has been accomplished in this direction on this side of the Atlantic. In England. Scotland, and Continental Europe much more headway has been made. That such should be the case is quite natural, from the fact that our brethren across the sea have been in the business a much longer time and have had better opportunities to study and put in operation economies which, in a great measure, were forced upon them by fierce competition, accompanied with the consequent low prices. As the line representing revenue dropped lower and lower, and sometimes exchanged places with that of expense, the time to act had come, and in this case, as in many others, with necessity the mother of invention, a way was found to save much which had heretofore been wasted. In a number of cases, ovens of the Bee-Hive, Simon-Carve, Coppee, and other forms, designed to recover the waste gases and heat for the generation of steam, have been in successful operation for years. At the Browney Colliery, in England, an arrangement of this kind is in operation. No coal whatever is used at this mine for boiler purposes, and the product of the shaft is drawn from a depth of 600 feet, and the water pumped from the mines, whereas before the system was put in operation about 1200 tons of coal per month were used to generate steam to do this work.

Dr. Percy, in his work on fuel, pages 485 to 490, speaks of an application of the waste heat and gases from coke ovens in the raising of steam at Seraing. In the plant he describes, the boilers are placed directly above the ovens proper, which are of the tunnel pattern. The location of the boiler in this position gives, of course, the full benefit of the initial heat generated in the coke ovens during the process of coking as practically none of it can radiate, there being no long flues to allow of such a loss.

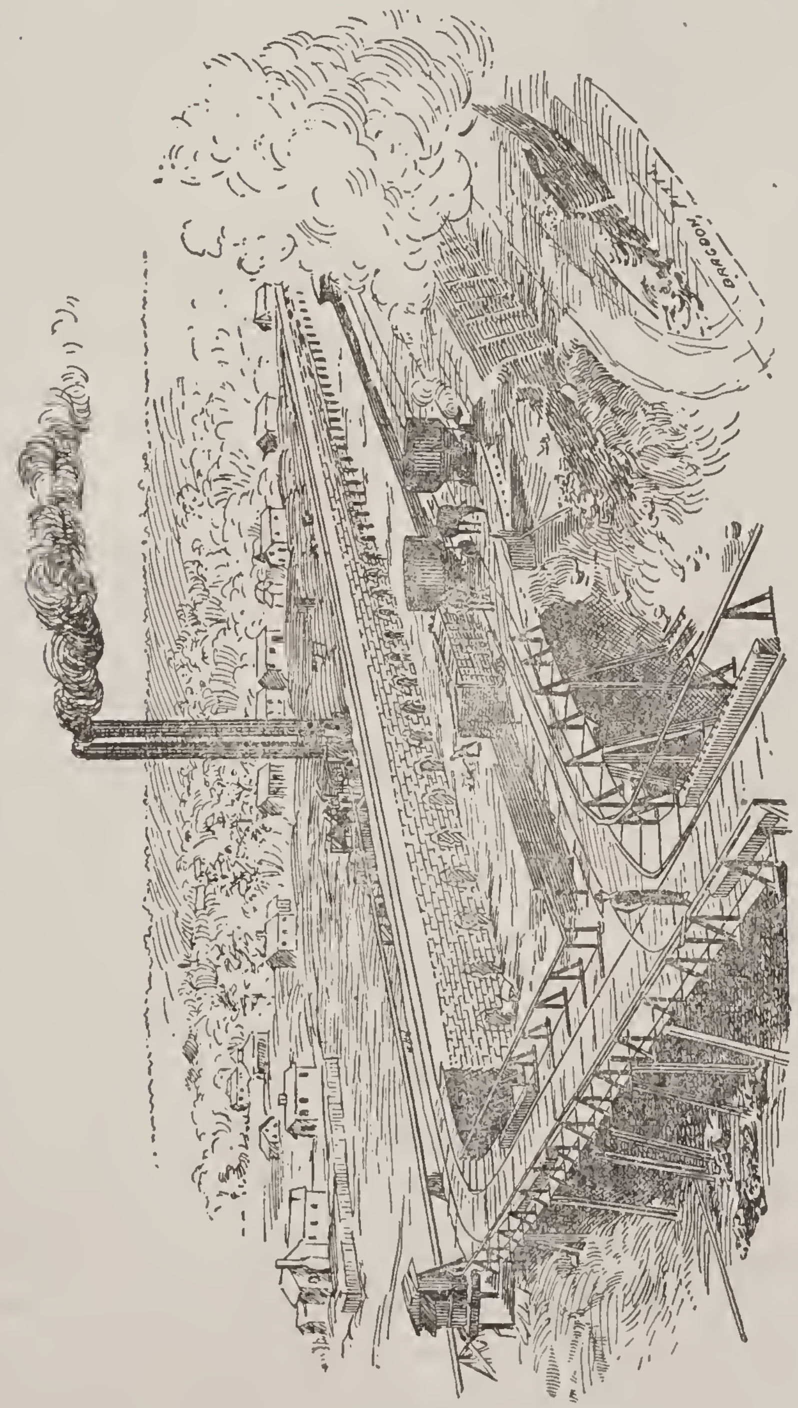


FIG. I.—GENERAL VIEW OF PRATT MINES OVENS.

In a letter from my friend, James S. Dixon, president of the Mining Institute of Scotland, under date of December 29th, 1891, he described a plant built in connection with bee-hive ovens, which at that time had been in operation, at the Kilsyth collieries, some 18 months, and had been a complete success, resulting in a saving of 500 tons of coal per month at this one colliery. He says: "Besides supplying all the machinery at the ovens with steam, it is carried a distance of about 200 yards from the boilers to a pit, and drives the winding engine and other machinery there." The gas is led from the ovens to the boilers, a distance of about 160 feet, in brick tunnels, and there burned without any admixture of air, giving an intense and uniform heat.

Two plants are now and have been for some time in operation at Tracy City, Tenn. The type of oren in use is the bee-hive, built in double rows known as "block" ovens in contradistinction to the single row which are known as "bank" ovens. The gas is led from the ovens in a flue which is located between, and well up on, the ovens. The flue is built parallel to the line of ovens. The plant has been a success from the start, and has resulted in a great saving to the company. The first experimental plant consisted of 6 ovens, and gave results of such a satisfactory character as to induce the erection of a second and larger plant. The boilers of this plant consist of 2 "double-deckers," each one consisting of 1 48-inch by 24 feet with 2 14-inch flues, joined to a 32-inch by 24-foot cylindrical lower boiler by 4 12-inch legs. A longitudinal flue delivers the gases from 34 ovens to the boilers. The flue is of rectangular section with arched top having a sectional area of 8 sq. ft. In order not to interfere with the oven walls, this flue was built above the domes of the ovens, being connected with each oven say 1½ feet above the coal line by a circular opening 18 inches in diameter. Before reaching the boiler house, which is about 50 feet from the end of the block of ovens, the flue is tapped by a short brick stack or "bleeder," and beyond the stack is a damper of boiler iron cooled with a constantly flow-

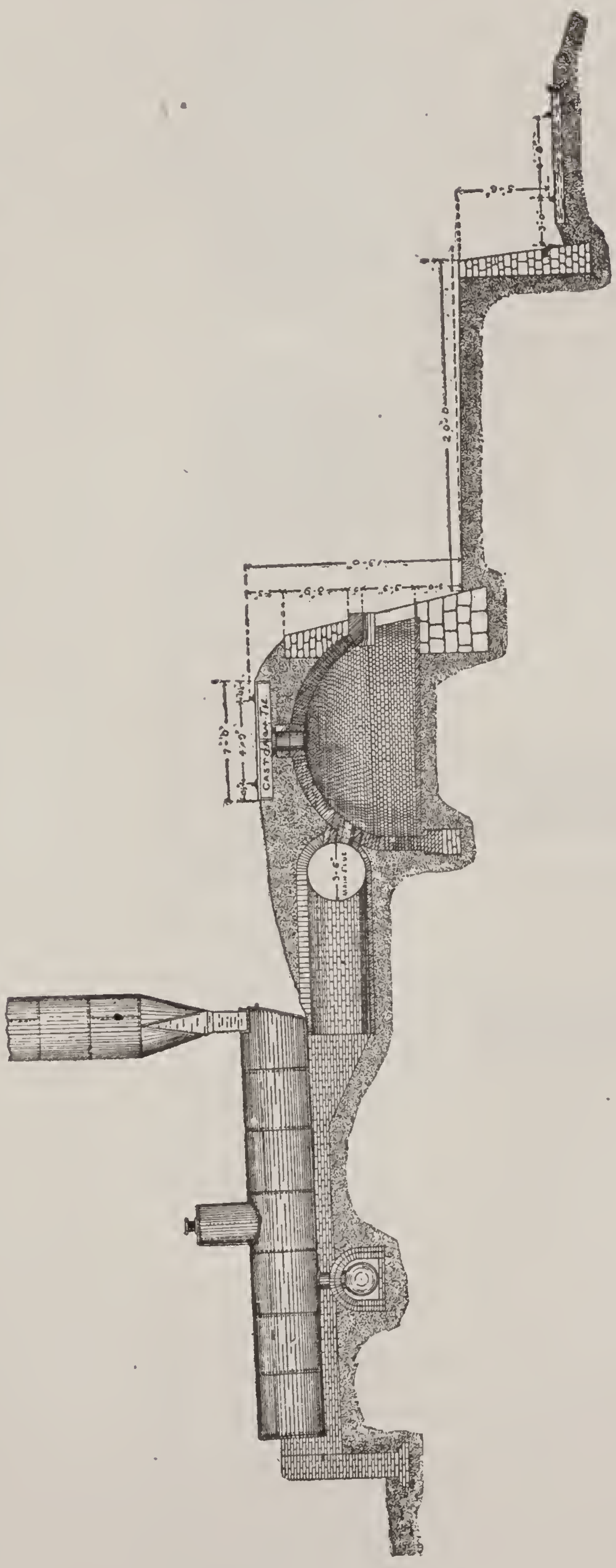


FIG. 2.—TRANSVERSE SECTION.

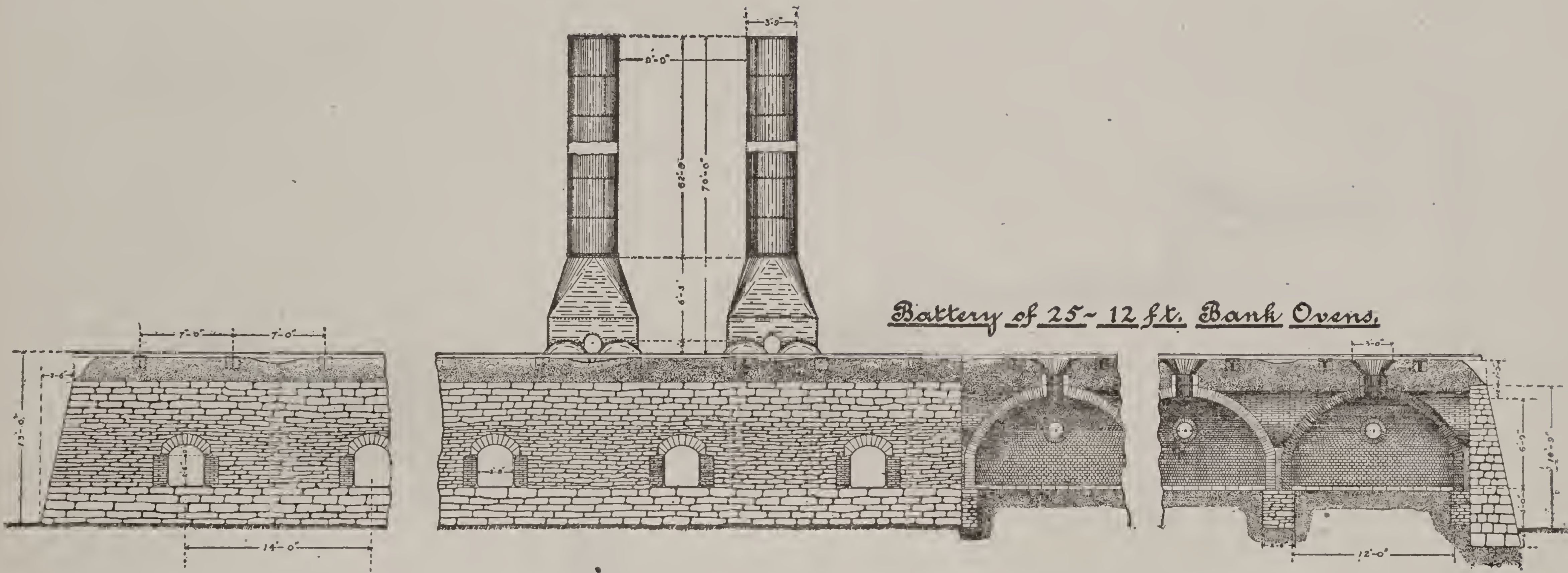
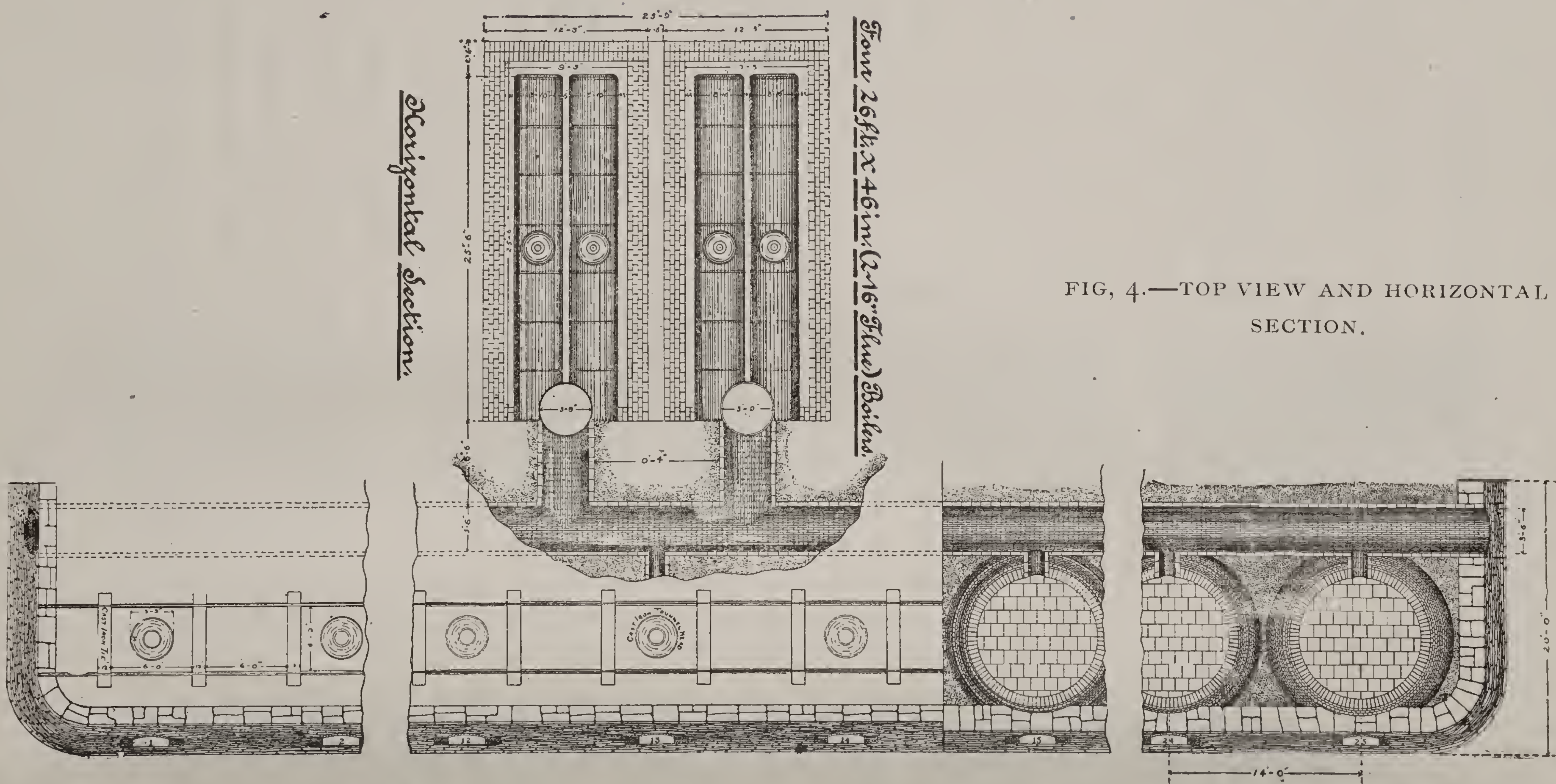


FIG. 3.—FRONT ELEVATION AND LONGITUDINAL SECTION.

ing stream of water. The flue is split in front of the boilers so as to give a separate flue to each, and operating independently. As at first constructed, the heat was allowed to pass around the lower and under the upper boiler, at one pass, and back through the boiler flues to the wrought iron stack, but this arrangement did not prove as satisfactory in steam generating qualities as it was desired, and to remedy it, it was determined to change it so as to allow the heat and gases (1) to pass under the lower cylindrical boiler, (2) back over it and under an arch half way between the upper and lower boilers, (3) over the arch and under the top boiler, (4) through the upper boiler flues to the stack, making in all 4 passes. This rather novel arrangement contemplated the extraction of all the useful heat before it reached the stack. It has since been concluded that so large a number of passes with so great a proportion of friction surface to area, retards the draft too much, and so the arrangement has not been entirely satisfactory. Doubtless a larger stack would do much to remedy this trouble. The practical working of this kind of a boiler setting has developed another objection in that there is a hard carbonaceous crust deposited on the outside of the boiler shells, as well as in the flues which is quite difficult to remove.

The ovens at this plant are draughted the same as ordinarily, are charged the same, 3¼ tons, and yield the same amount of coke, about 2 tons, as usual. No material difference in the quality one way or the other has yet been noticed. The coal probably cokes a little sooner in the flue ovens than otherwise. For the above data concerning the plants at Tracy City I am indebted to Mr. Chas. E. Bowron, Mining Engineer, of Tennessee Coal, Iron & R. R. Company, at that place. This gentleman made a test of the boiler plant described above and found it to evaporate 5 1-10 gallons of water per minute to a pressure of 50 pounds. A test made of their other plant gave about the same results.

To compare this with the boilers which are fired with the



FIG, 4.—TOP VIEW AND HORIZONTAL SECTION.

same kind of coal as that from which their coke is manufactured a test was made of two 44-inch by 25-foot boilers with two 14-inch and two 12-inch flues, and they were found to give an evaporation of 10 1-5 pallons per minute to a pressure of 75 pounds. This boiler plant uses 3⅔ tons of coal per 12 hours and evaporates 8⅓ pounds of water per pound of coal. Another test by Mr. Bowron, of Tracy City, on another boiler gave an evaporation of 9⅓ pounds of water per pound of Tracy City coal. By calculation he found that 15 per cent of the total heat units given out in the coking process find their way into the water in the boiler.

I now come to a consideration of the steam generating plants at Pratt Mines, Ala., which are the principal subjects of this paper. In the latter part of 1887, we built 75 bee-hive ovens of the "bank" pattern, at Pratt Mines, and I asked for permission to build flues to 6 of these ovens in order that they might be used as a test of the power of the waste heat and gases given off from Pratt Mines coal to generate steam. The main flue was placed just slightly to the rear and below the level of the floor of the ovens and parallel with the front wall or line of ovens. The branch flues connecting each oven to the main flue started at the trunnel head, which was practically a fire brick tee, and was carried on the outside of the oven wall proper down to an intersection with the main flue. After the flue was built, nothing further was done for some time. Then a small boiler was located within a few feet of the main flue, from which two branch flues led under the boiler from either side immediately above the grate bars. A test run of several weeks was made, and an accurate record kept of the number of ovens charged, water evaporated, etc.; but, as the plant was so very small, it would not pay to keep it in operation, so, after it demonstrated conclusively that the system would be a success on a large scale, with our Pratt coal, it was abandoned. The main flue spoken of above is now in daily operation as a part of our No. 1 plant.

As noted, the flues discharged the gases just above the grate bars, and the heat generated was so intense as to rapidly melt these cast iron bars, making it a necessity to abandon the use of the bars in this position, or devise some other arrangement of placing them where the heat would not be so great.

After this practical demonstration of what could be done, work was commenced on a plant at No. 3 ovens, Pratt Mines, to make steam necessary for operating a water works pump and a direct acting steam lift which is used in elevating loaded coal larries from the level of the bin tracks to the level of No. 1 ovens. Some years previous to this, a large flue 4 feet wide and 4 feet high to the spring of the arch, had been built at No. 3 ovens for the purpose of keeping the bottoms hot, and also, if practicable, enlarge the size of the charges coked by means of an induced draught. This flue was placed between, but under, the ovens, and was connected to each oven by two flues which left the rear of the oven about one foot above the coal line, passed down and under the oven bottom to a point near the door of the oven, where they turned back and entered the main flue near the rear of the oven.

From what I can learn, this plan was not seccessful, for the reason, among others, that the coke adhered so to the oven bottoms, that it was with great difficulty the ovens could be drawn. In the construction of the boiler plant at these ovens, this large flue was utilized by dispensing with the flues under the bottoms, and making a direct connection from it to the oven at a point about two-thirds of the distance up on the oven from bottom to top. The boiler was enclosed by plain brick walls. with a connection at one end to the main flue from the ovens. To begin with, rather complete arrangements were made to admit just the proper amount of air from the atmosphere to burn the gases, somewhat after the plan of the gas burners under blast furnace boilers. This was not a success, and after several days' trial it was abandoned, and everything was made as nearly air-tight as possible, after which no further trouble was experienced, and steam was generated in sufficient quantity to do the work desired. The plant gave perfect satisfaction, and was continued in operation until the ovens supplied by the hoist were blown out and the plant abandoned. It will be put to work again as soon as business improves sufficiently to justify the relighting of the No. ovens.

In order that the construction and mode of operation of the plants now in operation may be readily understood. I have prepared plans of one of the plants to which will be made in this paper. As noted heretofore, the ovens from which the gases and heat are derived, were built some years ago and were in operation at the time work was commenced. The first part of the work undertaken was the construction of the longitudinal main flue which is cylindrical in section and placed immediately to the rear of the ovens. A few ovens were blown out at a time, and as the flue was built and connection made to each oven, these ovens were again put in blast and others blown out, and so on until the flue had been built and connections made to the entire battery of 25 ovens. This main flue is 3 feet 6 inches internal diameter, has 4-inch walls on bottom half, and 9-inch walls on top half, and is built of fire brick furnished by the Bessemer Fire Brick Company, of Bessemer, Ala. At first sight, it may seem that the walls are too light for a flue of such diameter, but when one reasons that this flue is cylindrical in shape, which gives the greatest possible strength for the amount of material used, the objection does not have the same force. At all events, it has given no trouble except on two occasions, when a few bricks fell out of the walls and into the flue at the juncture of one of the small flues which connects it with the ovens. When the clay and earth filling was removed from the ovens to make room for the main flue, it was found, as was expected, to be quite hard burned, and especially that part resting on the oven walls proper, which was as hard burned as an ordinary red brick. This hard material was nicely cut out to a section equal to the half circle of the external diameter of the flue, the bottom half of which was laid in it, using the cut-out section as a form, and a loamy clay as a mortar. The upper half of the flue was then laid, using the ordinary wood centers, which were moved along as the flue was completed. Over the upper half of the flue, a layer of about six inches thick of well puddled clay was put on, which, when the heat was turned on, was burned to the hardness of a red brick. This plan was adopted as a cheap means of reinforcing and adding strength to the walls of the flue, and making it so that if a brick or two did fall out, it would be quite probable the flue would do duty until a convenient time for making repairs could be had. In both of the instances where the flue gave way, work was continued for several days before repairs were made. As is shown by the plan, in transverse and longitudinal sections, the main flue is built in contact with the rear walls of the ovens, and a connection is made to each oven at the point of contact by a cylindrical brick flue 12 inches in diameter and about 20 inches long.

There are two boilers plants of the design, size, and construction shown in plan, in operation at Pratt Mines, and each one receives the heat and gases from its individual battery of 12-foot bank bee-hive ovens of the usual American construction. Each plant consists of two batteries of 46-inch by 26-foot boilers, with two 16-inch flues each, and is situated midway and to the rear of the ovens in such a position that the transverse center line which passes through the center of the thirteenth oven, counted from each end, is also the center line of the boiler plant. The boiler were placed in the center of the bank of ovens, for the reason that the closer they were placed to ovens the less the distance would be which the gases would have to travel, and consequently the less would be the loss of the initial heat of the gases by radiation. To illustrate: the boilers might be placed so far from ths ovens as to cause the gases to part with all the initial oven heat before arriving at the boilers, and in such a case the benefit derived would be alone in the combustion of the gases at the boilers with the proper admixture of air, in a manner similar to the burning of gases from the blast furnaces under boilers and in hot blast stoves. This being the case, it is apparent that unless the conditions will not admit of it, the boilers should be placed as close to the ovens as possible. The boiler settings, as will be seen from the drawings, ore of the ordinary type, with the boiler fronts and grate bars omitted. To have used grate bars in order to allow of hand firing with coal, would have complicated the plant to an extent which the benefits to be derived would not have warranted. As noted in a previous portion of this paper, grate bars were used in the first experimental plant erected at Pratt Mines, and in that case they were rapidly destroyed by the incandescent gases passing over them. To have obviated this trouble, it would have been necessary to admit the gases back of the grate bars, and in such a case that part of the boiler immediately over the bars would have been practically dead space; or a furnace might have been built, to one or both sides of the boilers, in such a manner as to admit the heat and gases at the same point as they are now admitted in the plant described in this paper.

In order that each battery might be worked separately or both at one time, an independent flue from the main flue, and discharging under the battery, is provided, as shown in the plan, and in each of these branch flues, which are of the same diameter as the main flue, a damper was placed in the first plant built, but after working practically for several months, it was found to be almost nnnecessary, as the opening of the breeching and cleaning doors at once stops the draft, and consequently the flow of gases, and if the shut-down was to be for any length of time it would be an easy matter to close one of the flues with a temporary brick wall, such as is used in closing coke oven doors at each drawing. That it is only a matter of a few minutes' work to open these doors and take off the oven dampers has been demonstrated on several occasions when it was desired to stop the flow of gas and heat to the boilers. In fact, this can be done as expeditiously almost as a damper, large and unwieldy as it would necessarily be, could be manipulated.

The foregoing description, together with the accompanying plans and photographs, will, I hope, enable you, with but little trouble, to understand what the plant is like and how it is built and operated.

I will now undertake to explain the *modus operandi*, so far as it relates to the coking operation. The ovens are charged in the same manner as any well managed bee-hive ovens, and then levelled and the doors closed up as rapidly as possible, in order to reduce to the minimum the amount of cold air which rushes through the oven and into the flue. After this has been done, the damper is put on the trunnel head and some fine dirt thrown around its edges to prevent the oven drawing in any air at this point. So far as the plan relates to the trunnel head, there is somewhat of a deviation from the original plant in so far as it shows a funnel-shaped cast iron top to it, which as yet does not exist, the plan for same having but recently been finished. This trunnel is designed to make the use of a much smaller and lighter damper possible, which will make a practically air tight joint without the use of a dirt filling on the top. It would also prevent the scraping into the oven at every charge of a lot of clay and dirt, which of course increases the ash in the coke to some extent.

The burning of the coke is done in exactly the same manner as with the ordinary bee-hive oven, i.e., enlarging or restricting the air inlet at the top of the oven door, as the proper coking of the coal may demand. In the case of our two plants, the draught through the ovens produced by the boiler stacks is greater than it is in those ovens which discharge to the atmosphere their volumes of flame direct from the trunnel heads, and such being the case it is necessary to maintain a smaller air inlet opening at the top of the oven doors than is usually the case, but in this we experience no difficulty, as the air supply can be, and is, regulated just as easily one way as the other. It is found, however, and quite naturally so, that larger charges can be burned off in the regular time by admitting more air, and this without injury to the coke produced.

It is found in some cases that shortly after the charge of coal has become well ignited, the connecting flue from the oven to the main longitudinal flue will become choked up with unconsumed carbon in the form of soot, and completely cut off the draft. In such a case, all that is necessary is the removal of the damper from the trunnel head, after which the carbon will be rapidly burned out. After the flue has been cleaned out by thus merely removing the damper, it is again replaced, when the coking process proceeds as before.

After the coal has been burned the proper time, the ovens are drawn in the usual manner and recharged promptly. Now that the drawing of the ovens has been thoroughly systematized, they are all (12 or 13) drawn on each battery of 25 ovens at practically the same time, and recharged as quickly as possible, the object being to reduce the time that the ovens remain empty to as short a space as possible. In practice it is found that the ovens on one battery, 12 or 13, can be drawn and charged in the space of two hours. Nos. 1 and 25 ovens (for these Nos., see plan) are the first ovens cooled before drawing, and it is quite interesting to note the effect on the generation of steam. In the space of 15 or 20 minutes after water is first thrown into the oven, with a hose used for that purpose, the steam pressure will rapidly increase as many as 20 pounds. This pressure is maintained until the opening and cooling of a number of ovens allows cold air to rush in, which reduces the steam pressure, and it remains so reduced until the ovens have been drawn, recharged, levelled and ignited, when the heat will again raise the steam pressure, and keep a constant but, towards the end of the coking process, gradually declining pressure, uhtil the following day, when the other half of the battery is drawn. In order that a constant pressure of steam may be maintained as perfectly as possible, the ovens of one battery (12 or 13) are drawn and charged, and given time to ignite, before the evens of the other battery are molested. This is accomplished with practically no inconvenience. The steam is carried from No. 2 battery to No. 1 battery in a 6-inch pipe about 400 feet long, and from there the combined steam of both batteries is carried to shaft No. 1, where it is used in operating hoisting and haulage engines, air compressors, engines, and pulsometers used at the coal washers, and steam pumps both on the surface and in the mine. Some of the steam used under ground is carried down the shaft 225 feet, and thence to a haulage engine an additional distance of 200 feet, thus making in all from No. 2 battery of boilers, 1425 feet. We are not troubled to any great extent with wet steam. It may be said, however, that the temperature in the shaft and mine is so hlgh as to reduce the condensation of the steam very materially. This high temperature comes from the fact that the engines and pumps exhaust into the return air-way, keeping it hot, and thus very materially assist the ventilation.

The amount of steam actuated machinery at this mine (shaft No. 1) is very large, and requires a great amount of steam for its operation. Before the utilization of the waste heat and coke oven gases in the making of steam, this plant used monthly about 1500 tons of coal, or 7½ per cent of the entire output of the mine, for boiler use. This, at $1 per ton, represented a monthly loss of $1500 for boiler coal, or about 7½ cents per ton of coal on the entire output. As long as the selling price of coal was reasonably remunerative, this large outlay for boiler fuel was not felt so much, but as the selling price constantly became less and less, it was imperative that something should be done. Then work was commenced on fhe boiler plants at the bank coke ovens, and so successful has been their operation that the coal used at the old boilers has been reduced to 300 tons per month. When the amount of labor used at the coal fired boilers for firemen and ash wheelers, together with the expense of grate bars and general wear and tear, is considered, it is no exageration to say that the coke oven boilers have effected a monthly saving of $1500, or $18,000 per annum. By utilizing the gas from another block of 25 ovens, the entire plant could be supplied with steam without using any coal whatever, except a little on Monday mornings, when the ovens are cold from standing over Sundays; and even this could be obviated by drawing and charging a few of the ovens on that day.

In carrying the steam from No. 2 to No. 1 battery, advantage is taken of the heat radiated from the coke ovens and flues to prevent condensation, by burying the 6-inch wrought iron pipe in the earth filling nearly over the main flue, and covering it with a layer af old brick bats, over which mud is plastered, and then covered with earth filling. By this means, the pipe is kept hot, certainly above the boiling point, and at the same time not hot enough to injure the pipe. The loss from condensation where the pipes are thus located is practically nothing, and indeed I should not be surprised if the water which enters the pipe from the boilers with the steam was not reconverted into steam. In many locations, this plan of treating the steam pipe to prevent condensation, would no doubt be found of great service. The steam pipe leading from No. 1 battery to the point of consumption, Shaft No. 1, is covered with wool felt, which gives fair satisfaction; but in long lines of pipe exposed to the weather, too much care cannot be taken to insure the delivery of dry steam to the engines, pumps, and other steam consuming apparatus.

As might be expected, we have found that the temperature maintained under the boilers is comparatively uniform, and contrasts very strongly with that of coal fired boilers, where it is subject to rapid and great fluctuations, owing to the supply of the fuel being intermittent. The change in volume of flame and gases, as fed to the boilers from the ovens, is found to be gradual, decreasing by slow degrees from the maximum sometimes after the charges have fairly commenced to coke, to such times as the ovens are burned off or "around." This difference is not as great, however, as might be imagined, for the reason that the battery of ovens supplying the boilers are not all drawn on the same day, but the same rule of drawing alternate ovens every other day, as is the common practice at most bee-hive ovens, is followed here, which has the effect of always giving heat enough to generate steam fairly well. The comparatively uniform temperature under the boilers has a very beneficial influence on the boilers, as they are not subjected to rapid change from high to low temperature, and vice versa, accompanied, as it would be, with great strains from expansion and contraction of the sheets. Another benefit to the boilers is, the absence of draughts of cold air which rush in when the doors of coal fired boilers are opened to rsceive a fresh supply of coal, and thus injure the boiler plates.

When any of the ovens require repairing, the same can be done without in any manner interfering with the operation of the other ovens in the same battery. It is only necessary in such a case to close up the 12-inch flue at the rear of the oven, which connects with the main flue, in order to prevent the air from rushing into the main flue and cooling the gases, but if an oven were to fall in to such an extent as to injure the main flue, then the repairs would probably interfere with the working of the main flue between that point and the end of the block of ovens.

As noted previously in this paper, the boiler stacks at each point are of sufficient height (about 75 feet) above the level of the top of the ovens as to cause a greater draft and consequently more air to pass through the ovens for the same size air inlet at the door, than passes through the ovens which discharge through the trunnel head to the atmosphere. This is not found to cause any trouble, as it is a matter which can be regulated at the door of the ovens with no inconvenience, but should it be desired to maintain no greater draft, it is a matter which could be arranged by either reducing the height of the stacks or by the addition of a damper to each one, which could be regulated at will. In such a case, the coking condition would be almost identical with that of the ordinary bee-hive oven, discharging direct to the atmosphere.

Reference to the plan will show that when it is not desired to use the heat and the gas at the boilers, the only means for their escape from the ovens is through the tunnel heads, as is done where the heat and gases are not utilized but allowed to pass direct to the atmosphere. This change is effected, when necessary, in a short space of time, say 5 minutes, and if the gases are not again turned under the boilers, it would be necessary, in some cases at least, to increase the size of the air inlet at the oven doors. Such a contingency with us, however, is very rare. Should it be desired to arrange a plant which would not be subject to this contingency, all that would be required is the placing of the stack in such a way as to enable the fireman, or other person in charge of the boilers, to open and shut the dampers in such a manner as to send the gases direct from the ovens to the stack, or from the ovens to the boilers and then to the stack, as might be desired.

The use of the plant under question, of course, does away with all smoke about the ovens, and to that extent renders the work of drawing and loading coke much more agreeable for the workmen. This point is shown plainly in the general view, Figure 1.

Monitor injectors are used for supplying the boilers with water. This could be improved upon by using steam pumps instead, and in such a case I think it would not be difficult to so arrange the plant as to utilize some of the heat radiated from the the ovens and flues, through the earth filling, to heat the feed water after it has left the pumps and before it has reached the boilers.

Granting that the operation of the plants we have at Pratt Mines produce no bad effects upon the coke made at the ovens, it seems to me that there are many places where the ovens could be made to furnish a cheap fuel to take the place of coal burned under the boilers,but which might just as well be sold. And in these days of the transmission of power long distances by electricity,there is no reason why much of the flame and smoke from coke ovens, now being allowed to go to waste, should not be utilized, converted into electricity, and used in towns and cities not too far removed from the ovens, in the operation of electric railways, the lighting of streets, etc., as well as for many other uses. The greatest field for a thing of this kind is the Connellsville region of Pennsylvania, which has, roughly speaking, 18,000 ovens, receiving a daily charge, when all are in operation, of about 50,000 tons of coal. Assuming that the heat and gases from the ovens in the Connellsville region would make as much steam per ton of coal charged into the ovens as our Pratt Mines coal, we find it would be equivalent to the the daily consumption of 18,000 tons of coal under steam boilers. I will say nothing as to the saving in dollars and cents which this would effect, as that can be estimated readily by those who are interested. The same would be true of the Alabama ovens, but to a less extent.

As is well known to blast furnace men, the question of steam is often a very serious one; and many furnaces, finding tbe supply of furnace gases insufficient, are compelled to use coal, more or less, at the boilers. Such a practice is expensive in proportion to the degree in which it is practiced, and, during these times of low prices for pig iron, has a telling effect upon the earnings of a furnace. In such cases, it would be economical to have the coke ovens sufficiently near to the furnaces as to permit of the utilization of the waste coke oven heat and gases in the generation of steam for the blowing engines and other uses; and I can see no reason why the hot blast stoves, also, could not be heated by the waste from the ovens. With such an arrangement, there would always be an abundance of steam and gas, and, consequently, air and heat for the blast. That there are many localities where it would not be expedient to locate the ovens at the furnaces, I grant, but, on the other hand, there are existing plants, and others which will be built in the future, where such an arrangement could be installed.

The following statement gives the result of a test made in July, 1893, of the coal fired and coke oven gas fired boilers, at shaft No. 1, known as No. 1 battery. The test of the coal fired boilers extended over a period of 17 days, and that of the gas fired 11 days. The coke oven boiler plant consists of four 26 feet by 46 inch boilers with two 16-inch flues each, and the coal fired boiler plant of four 26 feet by 42 inch boilers with two 16-inch flues each.

	Coal fired boilers.	Coke oven fired boilers.
Minutes required to lower water 1 inch in boiler, - - - - - -	10.2	9.9
To lower water in boiler equal to cubic inch,	11,856	12,960
Water evap. per boiler per min., cubic inch,	1,160	1,310
Water evaporated per boiler per min.,gallons,	5.0	6.7
Water evaporated per boiler per hr., gallons,	300	342
Water evaporated per boiler per hr., cu. ft.	40	46
Water evaporated per boiler per hr., lb. -	2,500	2,856
Pounds of coal charged to 12½ ovens for four boilers, and pounds consumed at four coal fired boilers, per 24 hr., - - -	32,000	125,000
Pounds of coal charged to ovens and cons'md at coal fired boilers, per hr. per boiler,	333	1,302
Pounds water evaporated per hour per boiler per pound of coal charged to ovens and consumed at coal fired boilers, - -	7.5	2.2

As shown by the above tests, the coke oven boilers evaporated more water in a given time than the coal fired boilers. This, to a great extent at least, is owing to the comparative size of the boilers, but it should have no appreciable effect upon the capacity of the boiler to evaporate water per pound of coal, either charged to the ovens on the one hand, or consumed under the coal fired boilers on the other. As noted, the coal fired boilers evaporated 2 2-10 pounds, thus showing that for each 3 4-10 pounds or tons of coal charged to the ovens, as the case may be, we get the same effect from our coke oven boilers as we would were we to burn one pound or one of coal under a coal fired boiler.

During this month I have had daily tests made, for each day in a week, of the amount of water evaporated, the results of which are as follows:

No. 1 Battery.

Date, Nov., 1893.	5	6	7	8	2	3	4	
Day of week—	Sun.	Mon	Tus.	Wd.	Ths.	Fri.	Sat.	Av. for week.
Minutes required to low'r water 1 inch in boiler or to evaporate 12,960 cu. in. in 1 boiler, or 51-840 cu.in. in 4 boilers.	13.9	9.0	7.0	7.0	8.4	8.4	9.2	8.8

No. 2 Battery.

Date, Nov., 1893.	5	6	7	8	2	3	4	
Day of week—	Sun.	Mon	Tus.	Wd.	Ths.	Fri.	Sat.	Av. for week.
Minutes required to low'r water 1 in. in boiler or to evaporate 12,960 cu. in. in 1 boiler, or 51,-840 cu. in. in 4 boilers.	13.0	9.1	7.7	6.7	7.5	7.8	9.6	8.3

It is fair, however, to say that the larries are too small to put in as large charges on Fridays and Saturdays as can be burned off, and when this is remedied, as it will be soon, the Sunday record will be more favorable.

By comparing this table with the previous one, it will be observed that No. 1 battery has raised its record from an evaporation of 12,960 cubic inches per boiler in 9 9-10 minutes to 12,960 cubic inches in 8 8-10 minutes, while No. 2 battery does the same work in 8 3-10 minutes.

The better work of No 2 battery is no doubt due to the fact that it is provided with a main flue from 3 feet by 6 inches in diameter its entire length, whereas the main flue at No. 1 battery is smaller towaads the ends, and especially that portion which was built for the experimental plant in 1888, and which is now used as a part of the main flue. This teaches us that the main flue should be of ample capacity to freely carry off the gases from the ovens without in any degree retarding the proper coking of the coal in the ovens. To the better present arrangement of the drawing, charging, etc., of the ovens,should be given no small portion of credit for this improvement.

Taking the work of No. 2 battery as the standard and comparing it with the coal fired boilers we find that the former evaporate 2 6-10 pounds of water for every pound of coal charged to the ovens while the latter evaporate 7 5-10 pounds for each pound of coal burned under the boilers, and, carrying the comparison still further, we find that for each 2 9-10 pounds or tons of coal charged to the ovens the same effect is produced, in other words the same amount of steam is generated, as when one pound or one ton of coal, as the case may be, is burned under the coal fired boilers. This is a record which I think we will be able to maintain without much effort and certainly without any extra expense to the coking operation, and with much less expense so far as the working and care of the boilers is concerned, as compared with those fired with coal and generating as great a quantity of steam.

A study of the foregoing table reveals the fact that the boiler evaporates more water on Tuesdays and Wednesdays than on the other days of the week, Sunday being the lowest.

I had hoped to be able to present with this paper the results of the tests of physical and chemical qualities of the coke made in our boiler coke ovens, as compared with that from the ordinary bee-hive oven, which discharges it heat and gases direct to the atmosphere, but in this I have been disappointed as I have not had the time to go into the matter as thoroughly as the subject demands. I think I can safely say, however, that there is no difference in the cokes made from either oven, I have come to this conclusion after carefully watching the operation of the ovens. So far as can be judged from looks, no difference exists.

PROCEEDINGS

OF THE

Alabama Industrial and Scientific Society.

VOLUME IV. NO. 1.

1894.

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BURTON & WEATHERFORD, TUSCALOOSA, ALA.

OFFICERS.

1894.

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VICE PRESIDENTS.

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F. M. Jackson, - - - - Brookwood, Ala.

Geo. B. McCormack, - - Pratt City.

Ernst Prochaska, - - - Birmingham, Ala.

TREASURER.

Henry McCalley, - - University, Ala.

SECRETARY.

Eugene A. Smith, - - - University, Ala.

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* Vacant by resignation of J. M. McKleroy, Anniston, Ala.

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REPORT OF PROCEEDINGS OF ANNUAL MEETING

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY,

HELD IN BIRMINGHAM, ALABAMA, MAY 31, 1894,

Meeting was called to order at 8:30 P. M., with President Ramsay in the chair. There were present the following: Messrs. Thomas Seddon, E. A. Smith, E. Ramsay, H. Alber, T. H. Aldrich, A. H. Carpenter, P. H. Haskell, J. W. Murray, W. B. Phillips, C. A. Meissner, T. H. Spencer, E. A. Uehling, H. McCalley, A.E. Barton, Frank Smith, R.F.Manly, and Mr. Smith, of the Evening News.

Mr. Ramsay, President of the Society, then read his Address, which will be found in the Proceedings.

On motion, it was resolved to dispense with the reading of the minutes of the last meeting and to adopt them as shown in the printed pamphlet, a copy of which had been sent each member.

The President stated he had received an invitation from the Commercial Club of Birmingham for the members of this Society to be present at their banquet to be held this evening. It was resolved to accept the invitation, and, in order to give our members a chance to be present, that the business of the Society be dispatched as quickly as possible. To this end, it was thought best to dispense with a discussion of the papers to be presented this evening.

The Secretary reported two applications for membership in the Society—one from James Bowron, Secretary Tennessee Coal, Iron, and Railroad Company, Nashville, Tenn., and the other from R. F. Manly, of Birmingham, Ala. The

Council having recommended them, on motion their election was made unanimous.

The Secretary then read his Annual Report (which will be found elsewhere in the proceedings), which was received, and the recommendations contained therein acted on as follows: 1st, It was moved and seconded that the recommendation of the Secretary, that papers be sent only to active members of the Society, and that the decision as to who are active members be left to the discretion of the Secretary, be adopted. This was carried. 2nd—It was moved and seconded, that the Secretary exchange, at his discretion, reports of proceedings of this Society with other Societies to the number of active members in this Society. This motion also carried.

The Treasurer, Mr. Henry McCalley, read his annual report, which will be found in full in the proceedings. The report was received and accepted, and the Committee appointed by the Chair, consisting of Mr. J. W. Murray and Dr. Wm. B. Phillips, to audit the books of the Treasurer, reported that they found everything correct. On motion the report was received and ordered spread on the minutes and the Committee discharged.

The next thing in the order of business was the reading of papers, and in accordance with the understanding arrived at, at the beginning of the meeting, they were not discussed. The papers presented were, 1st, "Electricity in Mining," by C. E. Bowron. (In his absence, this was read by Dr. Phillips). 2nd, "Dolomite as a Flux for Blast Furnaces," by E. A. Uehling. 3rd, "Analyses of Limestone Formations in the Birmingham District," by C. A. Meissner. After the above papers were read, Dr. Wm. B. Phillips made a talk on "Phosphate Rock in Tennessee."

After Dr. Phillips' talk, the President announced, as result of the vote, that the officers of the Society would be as follows for the ensuing year:

President, Dr. Wm. B. Phillips.

Vice Presidents, G. B. McCormack and E. Prochaska.

The new President was escorted to the Chair, and on motion the meeting adjourned, attending in a body the banquet of the Commercial Club.

EUGENE A. SMITH, Secretary.

ADDRESS OF THE PRESIDENT, ERSKINE RAMSAY.

Gentlemen of the Alabama Industrial and Scientific Society:

Owing to a business engagement which took me out of the State, I was unable to be present at the last Annual Meeting, at which time you honored the speaker by electing him president of your Society. It was an unexpected honor, and while grateful to you for the mark of confidence, I could not keep from feeling that the choice was not a judicious one, as the Society embraced among its members many much better fitted for the position. But be this as it may, I desire to express to you my highest appreciation of, and thanks for,the honor conferred.

The Society has not enjoyed that degree of prosperity and prominence to which it is entitled by virtue of its being the only organization in the State representing its coal, coke, ore, iron, and allied industries. It is a matter of sincere regret that such is the case,but we find the explanation of the cause in the fact that the South has suffered, along with all other sections of the country, in the general depression of business which has characterized the past few years. But as the creation of this Society was for the purpose of mutual good to be brought about by the interchange of ideas and experience of its members, we find that if we are to derive any benefits from such a source there is no time for action like the present, and if we have any information which can properly come before the Society we should not hesitate or hold back in allowing it to see the light of day through the medium of our meetings and "Transactions."

As the degree of success of our Society will be practically in direct proportion to the interest centered in it by its members, we, as individuals, should constitute ourselves, each and all, a special committee of one to solicit additions to its membership in the persons of the many able and competent workers who have to deal with the various problems confronting us to-day as an industrial people. While it is true that the development of the mineral industries of Alabama is in its infancy in number of years, yet we have reached a point where we are by no means at the tail end of the procession and as such we should all feel a personal pride in furthering this advancement to the fullest extent.

Most of us have been slow to come forward and give our fellows the benefit of our experience in the various branches of the industries with which we may be connected. This should not be so. I believe a man loses nothing in letting the world know of the successes and reverses he may have had in his efforts to enlarge the capacity, improve the quality, and cheapen the production of his works. Of course it is expecting too much from frail human nature to ask that the failures without the successes be recorded, but when success has at last crowned our efforts then there is nothing lost in itemizing and stipulating the various steps and gradations leading up to such success, as they will then, like beacon lights, designate the hidden rocks in the unknown waters over which we may be sailing.

It seems to me that the Society should appoint committees, at its regular meetings, who would be charged with the duty of investigating some one of the various branches of mining and manufacturing which are of the greatest interest to its members and the district at large. The scope of these investigations might be of such liberal proportions as to embrace the study of the plans and workings of those branches of industry, with which we come in competition, in other sections of the country. It is worse than folly to shut our eyes to the fact that our competitors are fully alive to the necessity of their adopting everything calculated to give them the least advantage over their competitors and herein lies the reason why we should know what is going on around us and be always in a position to make as great if not greater strides in in the line of improvement.

We are in need of all the information which may possibly be derived from the varied experience and practice of the managers of our mines and furnaces; and, in fact, it is necessary to our industrial welfare that we aid one another in this respect, as by so doing we may then hope to keep pace with the methods of improved practice prevalent north of the Ohio river, where such a condition of affairs has been brought about through the instrumentality of the numerous technical societies of Pennsylvania, Ohio, Illinois, and other States.

As an illustration of this idea, I am free to confess that in the Transactions of the American Institute of Mining Engineers, I have, on more than one occasion, found improved ways of surmounting difficulties which otherwise I would probably not have known.

Owing mainly to the youthfulness of our Society, not many subjects have been brought to its attention in the shape of papers from its members; and, with such a condition, we therefore have nearly the entire field, embraced within the area of our various callings, from which to select our subjects for discussion, and among which may be mentioned in ore and coal mining the following: Prospecting, Shaft and Slope Sinking and the timbering of same; Surface Plant, such as hoisting engines and boilers, air compressors, coal sizing and washing plants; Plans of working various seams; Gases met with in mines, together with the means and appliances put in practice in overcoming the same; Ventilating appliances; Drainage of mines; Disintegration of coal before coking; Utilization of the waste products of the coking operation, and mony other topics topics which it is not necessary here to mention, as I know it is not at all a difficult matter for one to make a selection for the subject of a paper to be read before our Society, and especially, as I said before, as it is still in its swaddling clothes.

For those of our members connected with blast furnaces, I should imagine there would be no trouble in centering upon some part of the practice of to-day as the subject for a paper. Among these may be mentioned: Blast Furnace Ores; Alabama Cokes and Blast Furnace Practice; Blowing Engines; Hot Blast Stoves; Grades of Pig Iron; Ore Refining by Concentration; Magnetization of Non-Magnetic Ores; Dephosphorization of Ores; Steel Making, etc., etc.

While I am perfectly satisfied that every one here knows full well of the existence of the above named subjects, yet I thought it would not be amiss here to put them down in black and white, in order that when a member is asked to contribute a paper it will not be necessary or fair for him to stump the solicitor by asking him what he should write about.

ANALYSIS OF LIMESTONES AND DOLOMITES

OF THE

BIRMINGHAM ALABAMA DISTRICT.

BY C. A. MEISSNER, V. P. & G. M. VANDERBILT STEEL & IRON CO.

I herewith present to you a number of analyses of Limestone Formations in the Birmingham District, showing also some comparisons of Birmingham and foreign Dolomites, that are of interest in connection with our future steel developments. These analysis were almost all made at the laboratory of the Vanderbilt S. & I. Co., by Mr. J. W. Mills, chemist of that company; now chemist of the Woodward Iron Company.

They are reliable, and unless specially stated, are all from large stock house samples, and represent fair averages of the stone.

I will begin with the most prominent formation industrially, that of the Calcite* stone in Murphree's valley.†

The formation here is high and extensive, and can be quarried in a very economical manner. It is located within 26 miles of Birmingham. See analysis, (Set A.)

It will be seen that in general samples it shows considerable regularity and very fair purity for fluxing purposes.

This formation is, however, cut by one or more bands of dark stone, of which No. 10 and 11 are analyses; while the grey stone analyzes below 2 per cent in silica. I believe Mr. Smith, of the Sloss S. & I. Co., can give us some information on this point, as I do not happen to have analyses of the pure grey stone.

* The word Calcite in this paper is used to distinguish between the limestones proper, and the Magnesian Limestones or Dolomites—E. A. S.

† This is from the mountain limestone formation of the Sub-Carboniferous.—E. A. S.

I understand, however, that it is not practicable to separate these layers completely in quarrying, hence the higher analyses of the general samples.

One curious fect developed by these analyses is, that the dark intercalated layers approach the Dolomites, as seen by the much greater per cent of magnesia than the average samples show.

Aluminum is rather high but not excessively so—though somewhat above the average generally used in the north.

The next largest formation, industrially, is found at Gate City, Alabama†; it is located nearer to Birmingham than the previous formation, being within 3 miles of the previous formation; see analyses, (Set B.)

These analyses show very similar results, somewhat lower in silica and alumina than (Set A); but the same fault exists here as in Murphree's valley, the bands of dark stone, high in silica, as shown in analyses No. 8 and 9, which could quickly ruin a shipment if care is not exercised in properly mixing the stone.

These two deposits are the most important producers of flux for the Birmingham furnaces. The next formation is a very large deposit of Calcite stone at Blount Springs, * but its great distance from Birmingham, 35 miles, prevents its being used as a flux at present, see analyses (Set C.) This formation is capable of furnishing a purer calcite than the other two, owing to the fact, that while it also presents the features of the bands of dark stone running through the formation, the analyses No. 6 and 7 would indicate them to be purer and more like the general mass of stone. As freedom from silica is now-a-days the great desideratum in the economic running of our furnaces, it is to be regretted that this formation is not nearer to the district.

Underlying the red ore, separated from it by a layer of sandstone, all along Red Mountain is a heavy layer of curly, pecu-

†This is the Trenton, or Pelham, Limestone.—E. A. S.
* This is also the Mountain Limestone.—E. A. S.

liar looking limestone, of which the following is an analysis. It is occassionally impregnated with iron as shown in No. 2. See analyses (Set D.)

No. 1 would make a very pure stone, but, as it cannot be quarried, but must be mined, it is not available for fluxing purposes at present.

Practically the same formation occurs at Woodstock, Alabama, see analyses, (Set E.)

At Trussville considerable limestone* is found, some outcrops very uniform, others impregnated with occasional nodules of flint.

Where quarried, it is a very fair stone, see analysis (Set F.)

We will now take up the dolomite formations; these underlie the limestone formations above mentioned, and form the bottom of parts of Jones' Valley, for a series of miles east and west of Birmingham. The most important one, and the only one which can be used industrially, is the top layer of the dolomite formations.† This layer lies directly under portions of the city of Birmingham, and runs northeasterly towards Boyles Gap, six or seven miles, when it disappears under the hills. It also runs southwesterly towards Woodward Alabama, for 10 or 12 miles. The only outcrops of any importance are a mile or two from Boyles Gap, at the May & Spencer properties, where it bluffs out and disappears under the hills. There are numerous surface exposures of this formation all through the valley—but at these quarrying has to be carried on in open pits, giving no face, with all attendant disadvantageous circumstances of such a system of quarrying, see analyses (Set G.)

These are taken from various points, viz: At Spencer and May properties; Forest City property; Vanderbilt; along Water Works Canal; North Birmingham and Woodward.

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* This is also the Mountain Limestone.—E. A. S.

† This is near the base of the Knox Dolomite formation.—E. A. S.

This formation shows lower silica and greater uniformity than any of the calcite formations here; it is low in alumina and very uniform in lime and magnesia; phosphorus and sulphur are traces.

As alumina plays a very important part in the furnace economy of this district, this is a factor well worthy of consideration. The average alumina of the limestones in practical use here is 2.81%, that of this dolomite formation 1.05%, considerably less than half. Average silica of the calcites is 3.14% of this dolomite formation 1%, or less than one-third.

Another important feature of this formation is its regularity; there are no high silica layers in it as are found in all the calcite formations here; it contains no nodules of flint or pyrites as is frequently the case with dolomite, especially those used at Joliet, Ill. Nos. 17, 18 and 19, are analyses of rock of different appearance in this formation, and show how little they vary in silica.

Occasional pockets of bright red clay are so easily separable as to figure no more as an impurity than the crevices of yellow clay that occur in all rock formations.

In other words, this formation is the most pure and uniform one in the entire available district, and the only pity is that, instead of appearing as the calcite formations do in high bluffs and large quantities and easy to quarry, there are but two or three outcrops in the whole district where a face of 30--50 feet can be readily obtained.

I am willing to state that did this formation occur here in large outcrops our furnaces would use it, as it is used in Joliet, Ill., by the Illinois Steel Company, as it is used in the Lehigh Valley, and other dolomite districts with perfect success, giving good quantity and quality of iron and causing greater uniformity and regularity in the blast furnace process.

As it is now nearly all of the above named dolomite districts use a purer, lower silica and hence more economical flux, than is now used here in this valley, though we have here a flux even purer than the Joliet stone which, however, we do not avail ourselves of owing to misapprehension of the name dolomite—There are now places in this district where this upper formation could be quarried to some advantage and be made to furnish part of the supply received there, yet there are but two companies here that have so far availed themselves of this material with any degree of regularity; and, that they have done so to advantage, will be evidenced by the paper read by Mr. Uehling this evening.

It is now in place to call attention to some other dolomite formations underlying this top layer and cropping out in various places in Jones' Valley.

Beginning at North Lake on the canal of the Water Works Company, we have a smooth white outcrop at cave showing 4.24 silica, see (Set H.); a little to the south at creek is an outcrop 4.84 silica; a mile nearer to Birmingham is a small outcrop showing 1.54 silica; then comes a large outcrop, cut however, by the canal, which shows 1.26, 1.36, 1.76, silica; we then come to the Spencer and to the May outcrops which are the regular top formations before described.

Underlying all these formations and running to North Red mountain the valley is formed of a blue dolomite * in thin layers running clear up the valley showing silica 5.95, 6.38, 7.02, 8.68 (see analyses Nos. 7, 8, 8, 10.)

Running down the valley we encounter at Thomas 10.84 silica; at Bessemer some of the upper strata appear, but not the top layer; there we find silica 3.25 with lime about 40%, and magnesia about 10%.

The conclusion that all these analyses lead us to is that it is only the top layer of the dolomite formations of this district, which attains to that freedom from impurities necessary for a first class fluxing material equal or superior to that used at some of the most famous iron producing sections of the United States.

* This belongs to the Cambrian formation.—E. A. S.

The question of making steel in the Birmingham district has been uppermost in the minds of all iron men ever since the district took life. Bessemer steel has been out of the question, so far, as we have no ores suitable for this purpose, and whether magnetization and dephosphorization will become economically practicable on the large scale necessary for Bessemer practice, is not sufficiently developed to be considered at this time. The processes to be considered here are either the basic open hearth or the duplex process, i e, de-siliconizing in converters, and dephosphorizing in the basic open hearth furnace. In either of the latter processes steel can be made here of good quality and with sufficient economy to pay a fair profit at even present prices, provided the projectors pursue the course that common sense and past experience would indicate. By this I mean that the first requirement of a successful steel plant, is a first class practical steel manager, and an able trained corps of assistants, who should then have full control and responsibility of the practical management of the plant. I have had opportunity to watch the various attempts made in this district, which have everyone failed disastrously for this one reason alone, and I predict failure for every succeeding attempt if this principal is not followed out. Money can build a plant, but cannot run it unless combined with the highest scientific and technical skill. Basic Steel is the very acme of the science of the iron business; its results are so intimately dependent, and based on chemical composition that none but a scientific and practical steel manager, experienced in his business, and economic in his ideas can succeed in it. Witness all the attempts made here; costly experiments on patent processes and innovations; lack of co-operation between owners and managers; creation of gigantic stock speculations involving the loss of every dollar put into steel—the history of our steel making has been one of uniform, ultimate financial failure, and that wholly because the first principles above enunciated have never been carried out. Not that we have not had good steel makers here, practical, scientific and honest in their endeavor to make good and cheap steel! Not that we have not had good chemists here, capable of correct results, and with knowledge to apply such results! But not once has a good manager with a good chemist, and a good chemist is as essential as a good manager, been given freedom of action intelligently, and not been hampered by stock speculation or lack of confidence!

This therefore is the reason of all our previous failures here in steel making, and not because natural conditions are against us. Conditions are in our favor, for with all the disadvantages, above described, steel has been made here of very fair quality, and, heat for heat, very economically. The various consumers of this steel here and elsewhere, can testify to that, and I append some analyses, made by myself, which will prove this. (See Set J.)

But we have lacked regularity in the results obtained, and financial disaster soon overtook all who made the attempt, owing to above causes.

Therefore I repeat again, we can make steel here as good, as reliable and as uniform as in any other section of the United States, and compete with any other basic steel, but we must go at it in a business-like way, and not as a mere financial speculation.

Taking it for granted therefore that the proper primary conditions are attained, the question of raw materials presents itself. Those to be here considered are pig iron, and the dolomite necessary for making the basic linings of the furnaces. The pig iron made in this district, and used generally with scrap in most all steel made here, shows the following analysis: (See Set K.)

Then a special grade of pig iron was made by Mr. John Dowling at the Bessemer furnaces of the T. C. I. & R. R. Co., a trial lot of 1000 tons being made without the least difficulty, and in continuous runs out of our red and brown ores. See analyses (Set L.)

This once made can be made again, without difficulty in amounts sufficient to supply the demand.

We now come to the dolomites found in this district, and will make some comparisons between them and dolomites used in foreign steel plants. Heretofore magnesite has been used exclusively in this district for the basic material, imported from Europe at a heavy cost, viz: $40.00 per ton, and frequently of such poor quality as to be practically useless. No provision was made to use the dolomite occurring right here in Jones' Valley within a few miles of the plant. That these dolomites can be used and are as pure and purer than many of the European dolomites, the following analyses will show: (See Set G.) for Birminigham dolomites. (See Set M.) for European dolomites. The Penna. and Maryland Steel Co.,also use native dolomites extensively running from 1.50% to 2.50% in silica.

A study of these figures reveals at a glance the great similarity of the basic material used in Europe at old and well established plants, to that which we have here, also, that in most cases our material is purer and more uniform.

As to use of dolomites and magnesites, natural as well as artificial, I would call attention to the excellent translation of Wadding's Basic Bessemer Process, by Messrs.Phillips and Prochaska, of Birmingham, Ala.

There is therefore no reason why we should not use our home products to the utmost extent and cease to import any more than is absolutely necessary for the purposes in hand; it is a question of practical economy, pure and simple, whether we will use a dolomite, which we can control and buy for $1.00 or less, per ton, and burn it well, or whether we will use a magnesite at $40.00 per ton, which is liable to be of poor quality and not under our immediate control, in so far as it is a very difficult matter to adjust a dispute on a large shipment from over the water, as against controlling that which is at our own doors.

TABLES OF ANALYSES.

Set A—Murphree's Valley Limestones.

No.	Silica.	Alumina & Iron Oxide.	Lime.	Magnesia.	Phosphones.
1	2.07				
2	2.53		49.17		
3	2.85		50.67		
4	3.04	2.58	51.13	1.09	
5	3.25	2.94	51.08	.901	.018
6	3.61		50.57		
7	3.95		49.21		
8	4.57				
9	4.79		49.03		
10	9.93	2 78	39.55	6.69	Yellow Stone.
11	9.18	1.03	44.33	4.50	Black Stone.

Average of general samples: Silica, 3.47; Alumina, 2.76.

Set B—Gate City Limestones.

No.	Sil.	Alum. & Iron Oxide.	Lime.
1	2.37		
2	2.43	3.30	50.44
3	3.08		
4	3.29	1.49	51.97
5	3.65	.91	51.84
6	3.74		
7	3 82	1.96	50 75
8	7.06	Black Stone.	
9	6.07	Yellow Stone.	

Average of general samples: Silica, 3.19: Alum., 2.05.

Sec C—Blount Springs Limestone.

No.	Silica.	Alumina and Iron Oxide.	Lime.	Magnesia.	Phophorus.
1	.83	.73	54.10	.48	
2	.85		52.75		
3	1.32		53.15		
4	2 07		52.09		
5			52.25	.78	.0579
6			50.60	1.72	
7			51.15	.88	

Average of general samples: Silica, 1.57; Alumina, 1.14.

Set D—Red Mountain Limestone.

Silica.	Lime.	Iron.
1.78	53.92	
4.47	49.42	2 68

Set E—Woodstock Limestone.

No.	Silica.	Alumina.	Lime.	Magnesia.	Iron Oxide.
1	2.37	.80	51.74	3.15	.16
2	4.31				

Average: Silica, 3.34; Alumina, .80.

Set F—Trussville Limectone.

No.	Silica.	Alumina and Iron Oxide.	Lime.	Magnesia
1	2.16	2.31	50.03	2.01
2	2.50			
3	3.12	3.32	48.19	2.30

Average: Silica, 2.76; Alumina; 2.81.

Set G—Dolomite from upper formation taken from following properties: Spencer, May, Forest City, Vanderbilt, North Birmingham Waterworks Canal.

No.	Silica.	Alumina.	Lime.	Magnesia.	Sulphur.	Phosphorus,	IronOx
1	.64	,42	30.99	20.54	tr.	tr.	.40
2	.70						
3	.78						
4	.81	1.07	31.33	20.08	tr.		
5	.88						
6	.96						
7	1.00						
8	1.04	.68	30.70	20.87	tr.	tr.	
9	1.14	1 06					
10	1.15	1.76	30.79	20.05			
11	1.16	1.37					
12	1.17	1.07	31.22	20 51			
13	1.22						
14	1.26	1.08					
15	1.22	Soft white stone.					
16	1.00	Sott pink stone.					
17	.92	Hard stone.					

Average general samples: Silica, 1.00; Alumina, 1.05

Set H—Formations in Jones' Valley.

No.	Silica.	
1	4.24	Along waterworks canal, outcrop at cave.
2	4.84	Along waterworks canal, outcrop at creek.
3	1.54	Along waterworks canal, outcrop 1 m. s. e. of above.
4	1.26	Along waterworks canal, large outcrop, cut by canal.
5	1.36	
6	1.76	
7	5.95	between Mary Lee and L. and N., — Blue Dolomite forming bottom of Jones' Valley.
8	6.38	west of Bufford's.
9	7.02	west of creek.
10	8.68	east of creek.
11	11.84	at Thomas, Ala.
12	3.25	at Bessemer, Ala.

Set J—Basic Open Hearth Steel made at Birmingham, Ala.

No.	Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.
1	.063	.040	.048	.045	.500
2	.063		.030	.064	
3	.060	.019		.046	
4	.065		.089	.045	.540
5	.068		.087	.040	
6	.062		.020	.053	.280
7	.072		.071	.056	.537
8	.060		.054	.053	.568
9	.077		.054	.052	.500
10	.052		.014	.050	.620
11	.072	.018	.050	.075	.271
12	.095	.015	.036	.060	.416
13	.055	.007	.035	.077	.543

Set K—Pig Iron used in making steel, at Birmingham, Ala.

No.	Grade.	Silicon.	Sulphur.	Phosphorus.	Magnesia.
1	3	2.10	.034		
2	3	2.40	.027		
3	3	3.10	.010		
4	gF	2.25	.038		
5	gF	2.72	.065		
6	2	4.20	.034	.560	.450
7	1S	3.46	.010		

Set L—Special Pig Iron made at Little Bell Furnace, at Bessemer, Ala.

No	Grade.	Silicon.	Sulphur,	Phosphorus.	Manganese.	Cast.
1	gF	.78	.027	.787	.316	in saud.
2	gF	.81	.033			in sand.
3	gF	.52	.010			in sand.
4	gF	.93	.084	.754	.379	in chills.
5	gF		.074			in chills.
6	gF	.84	.014			

Set M—Dolomite used in Europe at Basic Steel Plants.

No.	Silica.	Alumina.	Lime.	Magnesia.	Oxide Iron.
1			30.57	20.99	.086
2			30.79	20-82	.084
3	1.70	.09	31.62	20.19	
4	4.34		29.86	20.17	
5	1.09		32.30	19.35	
6	2.00	1.50	31.86	19.28	
7	1.35	2.05	30.12	19.21	
8	3.04	.07	30.09	19.12	
9	6.52	2.07	28.52	17.56	
10	1.54	1.28	29.40	20.99	

For comparison with Birmingham Dolomites, see Set G.

DOLOMITE AS A FLUX FOR BLAST FURNACE USE.

BY ED. A. UEHLING.

Dolomite is the name given in honor of the French geologist, Deodat-Guy-Silvain-Tancrede Gratet de Dolomieu, to a carbonate of lime and magnesia, in which these two constituents occur in equal, or nearly equal, equivalents.

The atomic weight of magnesium is 24, while that of calcium is 40; but as each of these atoms is combined, respectively, with an atom of oxygen to a molecule of the oxide, and each respective molecule of the oxide is combined with a molecule of carbonic acid to form the carbonate, and as the molecular weight of the carbonic acid is 60 in each case, it follows that an equivalent of carbonate of magnesia will weigh 84, while one of carbonate of lime weighs 100.

In fluxing power, i.e., in the power to combine with silica and form a fusible slag, these equivalents are equal, because the power of a base to combine with an acid does not depend upon its atomic weight, but upon its chemical affinity, from which it further follows that 84 parts, by weight, of magnesia have the same value as a flux as 160 parts of lime.

Pure dolomite is, in round numbers, composed of 46% of carbonate of magnesia and 54% of carbonate of lime, now because the fluxing power, as shown above, is equal, equivalent for equivalent, and because there are as many equivalents of carbonate of magnesia in the 46% as there are equivalents of carbonate of lime in the 54 %, it again follows that 100 pounds of pure dolomite are equal to 108 pounds of pure limestone in fluxing power.

The dolomite which is most available in the Birmingham district, is of exceptional purity, both as to the foreign matter it contains and as to the proportion of lime and magnesia carbonate of which it is composed, viz: 55% of the former and

43% of the latter, with only 2.00% of foreign matter. The theoretically pure dolomite should be composed of 45.65 per cent of carbonate of magnesia and 54.35 per cent of carbonate of lime. The limestone of the district is vastly more irregular. While there are some ledges of exceptional purity, there are others that are entirely worthless for fluxing purposes. The worst feature of these irregularities is, that the impure ledges make their appearance in all the quarries thus far opened. For this reason it has not been possible to get limestone that will average above 96% in carbonate of lime and 94 to 92 and even down to 90% is not infrequently the average of whole shipments.

We will take for granted that with the exercise of sufficient care in the quarries, a limestone of an average of not to exceed 4% impurities can be furnished.

In determining the value of a stone as a flux, it is not only necessary to deduct the impurities it contains, but in addition to that, as much of the base as is necessary to flux these impurities. What remains only can be considered as available flux, and has value in the blast furnace. To get at the available flux we must deduct 2% from the carbonate of lime for each unit per cent impurity contained in the stone. Taking the limestone at 96% of Ca CO_3 and deducting from this 8% to take care of its own impurities we have left available flux 88% of Ca CO_3.

As the average dolomite contains only 2% of impurities and 43 per cent carbonate of magnesia with 55 per cent of carbonate of lime, we will have after deducting for its own impurities 4 per cent from the carbonate of lime we have left available flux 43 per cent Mg CO_3 and 51 per cent Ca CO_3. Reducing the Mg CO_3 to its equivalent in fluxing power of Ca CO_3 we have because the fluxing powers of the two carbonates are to each other as 84 to 100, $\frac{43x100}{84}$ plus 51 equal 102.19.

The relative values of the two available fluxing materials of the district are therefore to each other as 88 is to 102.19. That means that 88 tons of dolomite will do as much work in the blast furnace as 102.19 tons of limestone. Put into dollars and cents, this means that if dolomite can be bought for 60 cents a ton, limestone is worth only 52 cents a ton; or, if limestone costs 60 cents, dolomite is worth 69.5 cents a ton.

There is only one valid objection that can be brought up against the use of dolomite as a flux in the blast furnaces, and that is, that magnesium has less affinity for sulphur than calcium, and dolomite is therefore less efficient as a desulphurizer than limestone, to the extent that caustic lime is displaced by magnesia. This objection, however, becomes quite insignificant where the ores are practically free from sulphur, as is the case in the Birmingham district, especially when a considerable proportion of hard ore is used in the mixture, the lime of which, in connection with what is contained in the dolomite itself, is ample to take care of the sulphur contained in the coke.

One quarter to one half dolomite has been used regularly in the Sloss furnaces for nearly two years, and at intervals as high as three-fourths have been put on with the best of results. The ore mixture being half Hard and half Irondale at the city and from one-fourth to one-third brown with generally equal proportions of Irondale and Hard at the North Birmingham furnaces.

The coke used contained considerably above the average amount of sulphur found in the average coke of the district. The iron was of as good a quality as could have been produced with all limestone as a flux, and the furnaces have worked more regularly than they did prior to the use of dolomite. The assertion that the use of dolomite has a tendency to make light colored iron, is not sustained by fact. Some of the most celebrated foundry irons are made with all dolomite as a flux. In fact there is nothing else used in the whole Lehigh valey. The writer had used it for years, while in charge of the blast furnaces of the Bethlehem Iron Company, prior to coming down here, and experienced no difficulty in keeping the sulphur within the required limits, even with ores containing as high as 1.5 per cent of that element.

The Illinois Steel Co., are also using dolomite exclusively in the furnaces of their Joliet Works. They are doing very good work and have no trouble with the sulphur whatever. The deficiency of dolomite to carry off sulphur is probably very much exaggerated.

There are impure dolomites as well as impure limestones; but when of good quality, and used intelligently and without prejudice, it always gives good satisfaction. In addition to its superior fluxing power, there is decidedly less tendency to hanging with dolomite than with carbonate of lime.

To Mr. C. A. Meissner belongs the credit of having first systematically tried dolomite with the Birmingham ores, and, on the strength of the good results obtained, has developed a quarry, but has not met with the success he deserves in introducing it at all the furnaces. It is certainly worthy of a trial, which, if carried on without perjudice, cannot help but result beneficially to all concerned.

ELECTRICITY IN MINING.

BY CHAS. ED. BOWRON.

An installation of an electric mining plant has long ceased to be a nine days wonder; mining men—always conservative regarding the adoption of new methods or appliances, replacing old and tried ways—after having seen the great adaptability of this mysterious force to their wants, have not been slow to utilize it, and its introduction into every phase of mining practice has taken place with marvellous rapidity in the last few years. While it has not reached that state of economic efficiency which would warrant its general introduction, it has beyond peradventure passed the experimental stage, and its further development and adaptation to the arduous and peculiar demands of mining service will become only a matter of time, as the conditions which surround its utility in this line are carefully studied and applied.

Of all forces at command in the science of mining, electricity seems to be most adaptable and more nearly fulfills most of the conditions demanded, viz:—Safety, efficiency, reliability, simplicity and flexibility on the one hand, on the other, the economic necessity of a minimum of cost in application and production. Risks to life and property are very great in mining and the dictates both of humanity and economy will be best subserved by the adoption of any agent which will tend to minimize these risks. The great ease of production and application in the first instance, then its great flexibility and efficiency give electricity a strong claim for our careful consideration.

Its competitive forces are steam, compressed air, hydraulic power and wire rope transmissions. As to hydraulic power, its application (except as a prime agent) is evidently so costly and limited, while wire-rope transmissions beyond a comparatively short limit are entirely out of the question and cannot be used except for special purposes, that we may limit the discussion to steam, compressed air and electricity.

Considering the demands of a mining plant, we see power consumed in winding, outside and inside hauling, coal-cutting, coal and rock drilling, pumping, ventilation, lighting, signaling and explosive firing. Regarding the prime source of energy for such power it may be either hydraulic or steam power (leaving gas engines out of the question in their present state). In either case electricity comes to the front. In many cases, the topographical surroundings and the location of fuel and water, limit the location of a steam plant, which may have to be so far away as to be very inefficient, where the steam is to be used at the mines; with electricity we generate it at these same boilers, and placing them where they will suit the economic conditions of best service, convey the power to its work with but slight loss. These conditions very often obtain in the Western mining States, the location of a steam plant perhaps being a matter of great mechanical difficulty in transportation and erection in the first place, and where the site of water for the boilers and the haulage of costly fuel prescribe the limits. With this agent, though, we erect our steam plant and dynamos at the most advantageous site and take the electric cable to the mines, elevation and distance no longer almost insuperable obstacles. An instance of this kind is the plant at the Virginius mine in Colorado, at an elevation of 12,000 feet. The cost of fuel there, which had to be packed up the mountain on "burros," was stated to be $18.00 per ton, amounting in a year to some $80,000.00. The present source of power is Red Canyon Creek, four miles distant from the openings, where 300 H. P. are generated and carried to the mines at a pressure of 800 volts; the saving of fuel in one year alone paid for the electric plant.

Difficulties occur in mining in proportion to distance, and except for short distances, say up to two miles, neither steam nor compressed air can be considered dangerous rivals of electricity, on account of its high efficiency for long distance transmissions, the comparison growing the more favorable to the latter as the distance increases. We may use steam at the pit mouth for hoisting or running a fan and take it underground for a short distance for pumps, drills and rope-hauling engines, but when we wish to take it several miles away for drilling, coal cutting, etc., its use is entirely out of the question, unless another plant be erected, either underground, which is often objectionable, or at the expense of another surface plant and a shaft or bore-hole to take the steam underground. The efficiency of steam is low because dependent upon its retention of heat which is continually lost by radiation and condensation, no matter how well protected the pipes by covering, and it loses quickly also by friction and leakage. In the use of compressed air, there is a large initial loss of the heat of compression and as in the case of steam further large losses in friction and leakage. In the case of both steam and compressed air, the loss increases much more rapidly than the pro portional increment in distance. Here is one of the strongest points of electricity, and it is the only power so far which meets what we may call the "distance emergency" in mining, from an economical standpoint. Here we have no losses analagous to the losses mentioned in the case of steam and eompressed air to the extent that there prevail in their transmissions. When not at work, no power is consumed in electrical apparatus, the prime generator producing just what is consumed, automatically. At a Michigan mine, 175 H. P. are transmitted three miles by compressed air, with an efficiency at the mines of only 35 per cent—thus showing a 65 per cent loss in transmission. With electricity, these figures would, beyond doubt, be reversed. One electric company guarantees an efficiency of 73 per cent, based upon an initial efficiency of 100 and successive losses of 10 per cent in dynamo conversion, 10 per cent in line transmission, and 10 per cent in reconversion at the motor. An ordinary efficiency of compressed air is from 20 to 40 per cent, rarely 50. The cost of conductors for carrying an equal amount of power at average pressures has been stated by Prof. M. C. Ihlseng to be in the case of electricity, steam and compressed air to be as 1 to 27 to 19. Mr. Pocock, in a paper before the A. I. M. E. gives the following table of Mr. Wm. Geipel, of Edinburgh, showing the relative first costs of plants per H. P. transmitted in England :

Total Power Transmitted.	System of Transmission.	Distance transmitted in yards. 100	1100	11000	22000
5 H. P.	Electric.	75.	31.	142.	210.
"	Hydraulic.	41.	97.	610.	1,880.
"	Pheumatic.	73.	210.	1,090.	2,060.
"	Wire Rope.	6½	61.	760.	1,220.
100 H. P.	Electric.	32.	35.	59.	87.
"	Hydraulic.	14.	28.	164.	310.
"	Pneumatic.	26.	34.	109.	192.
"	Wire Rope.	1 1-10	8 4-10	81.	162.

As to the relative costs of electrical plants for general mining purposes, the "Colliery Engineer" has published the following table :

Distance transmitted in feet.	Volts E. M. force at terminals of motor.	Commercial efficiency.	H. P. required at generator.	Cost of generator, etc., per H. P.	Cost of motor, etc., per H. P.	Total cost electrical equipment, including wire, per H. P.
5,000	400	65	1.53	$61.20	$45.00	$123.42
10,000	400	54	1.85	74.00	45.00	155.08
15,000	400	47	2.13	85.20	45.00	182.00
5,000	800	71	1.41	59.93	47.50	117.35
10,000	800	65	1.53	65.03	47.50	130.46
15,000	800	59	1.69	71.83	47.50	147.06
20,000	800	54	1.85	78.63	47.50	163.71
10,000	1200	69	1.45	65 25	50.00	128.21
15,000	1200	65	1.54	68.85	50.00	137.50
20,000	1200	61	1.64	73.80	50.00	149.12

The study of these tables reveals the increasing economy of electricity with distance, and also, the fact that the cost of increasing the capacity of an electric plant is comparatively small.

Both direct acting and alternating currents are used for mining work. The cost of a wire conductor (copper), other things being equal, varies inversely as the square of the voltage or pressure and hence it is economical to use as high a voltage as is permissible in each particular case. This is limited in the case of direct-acting currents to 1500 volts and alternating currents rarely exceed 5000 volts for mine work. This is considering the transmission of the power, in the working machinery the voltage is much less. The question arises as to the safe voltage in the workings; 220 to 250 volts has been ordinarily adopted although 500 volts (the usual current for street railways) and 1000 volts have been used at certain mines. Direct acting current motors have found most favor and the alternating current can be used in these by means of a "rotary transformer," which transforms the alternating into a direct current. The current is carried to the workings at as high a voltage as possible and then transformed into low-voltage currents for use in the apparatus.

An invaluable feature of an electrical mining plant is its great flexibility and the great ease with which changes in the distribution of energy can be made. It is but a few hours job to branch and take a wire to any part of the mine to a motor, compared with an equal number of days to lay a heavy, cumbersome and and expensive pipe line for the same purpose. with greatest ease we lead the wire round a corner, take it up or down a shaft or slope, in and through places where it would be dangerous and difficult to lay a pipe line. Simplicity and completeness commend themselves at all times to the miner and nothing can be more complete than the different ways in which we can harness electricity to our various uses in this direction. We may use it for lighting our tipple or breaker, hoisting the mineral, ventilating apparatus, inside and outside hauling, cutting, drilling, underground lighting, signaling by bell or telephone and for explosive firing. It is also adapted to outside operations and is applied to them in such lines as crushing, stamping, jigging, concentrating, etc., and further along in metallurgical operations upon the mineral such as the production of aluminium by the Cowles process.

The impediments in the way of the adoption of this agent in mining have been several. Mr. Pocock before quoted says: "Electrical engineers are not familiar with the routine of practical colliery workings and are, therefore, placed at a disadvantage by not knowing the actual requirements of mining engineers and the many little difficulties to be met with in underground workings; and until mining engineers have acquired the necessary knowledge and a confidence in electricity, it is only natural that they will continue to follow the beaten path. Experiments in mining are costly, necessarily, and until a method or appliance can hope to compete with the older way, it has to be brought to a "hard-pan" basis, before it will receive the consideration due to its merits, however pronounced or enticing. While an electric mining plant as a whole is comparatively simple, yet the details of the mechanisms of the different machines, locomotives, etc., remain to be considerably simplified to withstand the inevitable hard usage to which they will be subjected.

Having dwelt to some extent upon the claims that are set forth for electricity, let us examine the several ways in which we propose to utilize it in our operations. The first point that claims our attention is its generation. Where a water supply exists within a reasonable distance and there is hardly any limit to this reasonable distance, of sufficient volume and head to employ as the prime generator, the solution is easy. Several types of water wheels are used for this purpose each preferable for certain conditions of volume and head—turbines and impact wheels. Among the first class the "Leffel" is largely used and Prof. Ihlseng states "that the globe casing with a horizontal axis is the preferable one for mining purposes:" of impact wheels, the "Pelton" seems to be the favorite in this country and is found to be cheap, reliable and efficient. If the generator is to be steam, the best results are to be had by the adoption of the most improved type of engine for this particular use and ample boiler capacity, the often overlooked point.

At the outset we meet an electric diamond drill for prospecting; this is the old and familiar form of the diamond drill, equipped with a special motor and electric pump. A drill of this sort manufactured by the General Electric Company, in an experimental test, bored 12 inches of blue granite in three minutes under 120 pounds water pressure, furnished by the attached electric pump; under 75 pounds pressure, it bored 12 inches in six minutes, and with 35 pounds in sixteen minutes, showing the great regularity and evenness of action. This machine should prove invaluable in metal mining, where it could be taken great distances underground to test the country rock, persistence of veins, etc., and in coal mining where it could be used in approaching abandoned workings, bodies of water, etc. One of these drills in Colorado averages 15 feet per shift in hard silicious limestone; the cost (average of 4400 feet) has been 68 cents a foot, including all expenses. Another drill in Aspen, Colorado, 30-50 feet per 8 hour shift, satisfactorily. For prospecting purposes, it will prove especially valuable, as it can be placed at the most desirable points for testing, where now we must take into account the proximity of water and fuel to some extent.

After deciding upon the mine location, we may make use of electrical machinery in opening up. If the opening be a shaft, we again use the diamond drill perhaps, in sinking by the "long hole" method, or in any event we may use the electric rock drill in the same way that we now use the steam or compressed air percussion drill. In shaft sinking, the electric light has been used to advantage in Scotland. It was placed at the top and used in connection with a lens and a large mirror, encased in a sheet-iron case, enabling the rays to be diffused throughout the shaft or concentrated at the bottom at will. The advantages of so brilliant an illumination in that work are self-evident. The electric sinking pump may be suspended from a windlass and lowered as the work proceeds, without any vexatious pipe connections to make every few feet. A sinking pump should be light, eompact, efficient and strong to withstand hard handling. The General Electric Co. make a pump fulfilling these conditions; they are duplex double acting, with a capacity of 100 to 300 gallons per minute. These pumps being enclosed in water-tight cases, the motor works as well under water as out of it—perhaps better, where care is taken to have the conducting wire water-proof. This of course is an invaluable feature where there is any liability to a sudden flood of water, which would, of course soon render the ordinary sinking pump useless. Triplex single and double acting pumps are also made for this purpose and obtain an efficiency of 70 per cent.

The electric hoist next claims our attention. These are successful because nothing new in principle is involved in their construction. They are made in all sizes and varieties, single and double drum, geared or with friction clutches, or direct acting. The General Electric Co., the Jeffrey Co., and the Sprague Co., make a great variety of these, from the small 4 H. P. hoist for winzes, to the 5000 H. P. shaft engines to wind 3000 feet of rope. Their construction is very compact, and they are provided with complete speed-controlling devices, reversing apparatus, indicators, etc., in the same manner as the most approved modern types of steam engines for the same purpose. An advantage of these over the steam engine may be mentioned, viz: that the electric hoist, having no "dead centre," can start at once with full power, at the beginning of the lift if desired; and it may be here said that no power will respond so quickly to an overdraft made upon it in an emergency, as will electricity, be it in winding or otherwise. The first mining hoist in this country was made for the Aspen Mining Company by the Sprague Company, in 1888, of 7½ H. P., and it proved such a success from the start, that another one was ordered. designed to raise 250 tons 250 feet up a 60 degree incline every 24 hours. This Company, later on, installed its own generating plant of two 50 H. P. dynamos run from two double Pelton water-wheels, 42 inches diameter, each wheel being supplied with two nozzles; the water pressure is 35 pounds and volume 1000 cubic feet per minute; variations in power is obtained by deflections of the nozzles, which work on ball-and-socket joints, by means of Woodward governors. The generating station is 6000 feet from the mine. A recent French installation (the first in that country of its kind) has a central station with two dynamos, the power being transmitted three miles to the mines, to operate five winding gears, 6 to 14 H. P. each. In addition to these, five pumps, requiring 5 H. P. each, several locomotives of 12 H. P. each, speed 8 miles an hour over a gangway a mile long, 26 arc and 200 incandescent lamps, make the installation quite complete.

It is in underground hauling, however, that electricity has made its greatest development and met with its greatest success in mining. The principle of its application for this use is the same as that employed in electric street railways; the locomotives are supplied with trolleys, which take the current from an overhead wire, the rails acting as the return circuit. The storage battery has been employed in several instances, but at present the great weight and bulk of a storage battery locomotive greatly militates against its use. There are several standard types of locomotives by the different electric firms. The first cost of an electric haulage will probably be greater, as a general thing, than a rope haulage plant; but its greater ease of extension, small depreciation and light cost of maintenance, should overbalance that fact. The electric locomotive is especially adapted to low entries, and a great saving on dead work may be accomplished where it is in general use, where the coal is low, the locomotive occupying no more space than the cars which it pulls. The total height of the "Terrapin-back" locomotive of the General Electric Company is from 21 inches to 40 inches, 15 to 150 H. P., 6 to 10 miles an hour speed, 750 to 4500 pounds draw-bar pull and weight 3,500 to 22,500 pounds. This locomotive has a solid iron armor for protection against accidents, and roof-falls, etc. The motor is placed between the axles, and a train of gears reduces to the necessary speed. Another type of machine is especially designed for very narrow entries, as in some metal mines. At the plant of the Hecla Mining Company, at Earlington, Ky., installed by the Sperry Company, a locomotive hauls from 25 to 40 cars, holding a ton each, 4500 feet, part 4 to 5 per cent against the load. It can make the trip in 13 minutes. The locomotive is 4 feet high, 3 feet 6 inches outside width, and weighs 13 tons; it has eight wheels in two pairs, each pair turning on pivots and having separate motors. The current is 220 volts from a 123 H. P. generator. A London company made a novel form of locomotive for the Greenside Mining Company, of Cumberland, it having the armature shaft at right angles to the driving axles, instead of the usual parallel construction; three speed reduction gears are used, one being a bevel gear. The motor is of the Immisch type, the current 200 volts, taken 1200 yards through a bare wire. Power is taken from a large "vortex" turbine wheel, fed by 15 inch pipes, the dynamo being four-pole Immisch machine, running 600 R. P. M. generating a 500 volt current. Electricity is also used there for pumping, lighting the works, and winding. Mr. Karl Eilers, of the A. I. M. E., gives the relative costs of four different electric mine haulages in Germany, as compared to animal haulage as 75, 75, 67, and 23 per cents, respectively. Mr. Pocock gives the relative first costs and running expenses per ton of mule haulage, tail rope and electricity, as follows:

	Mules.	Tail-rape.	Electric.
First cost,	$3120.00	$7375.00	$11000.00
Running exp. pr. ton,	2.63 cents.	1.27 cents.	1.15 c.

In connection with a locomotive we may use stationary motors to haul up an auxiliary slope, winze, etc., where the use of a locomotive would not be permissible. The first electric locomotive used for mining in this country was at Liken's Valley, Pa., of 35 H. P., hauling over 6000 feet. The Loyal Hanna Coal Company, of Pennsylvania, have an electric locomotive delivering 360 tons an hour, necessitating hauling 30 cars a distance of 4000 feet every 15 minutes, the line having several sharp curves and grades up to five per cent. The speed is 7½ miles an hour, and has been as high as twelve. The conducting wire is taken down tbe shaft a distance of 200 feet, and then along the entry, and is there covered with an inverted V trough, as the mine roof is very damp. The generating dynamos are two compound-wound, run by 150 H. P. engine. In Utah, an electric locomotive hauls 800 tons a day, 2600 feet replacing 7 mules and 6 drivers. At Hillside coal Campany's colliery, near Scranton, Pa., a locomotive displaces 7 mules and 3 drivers, and can deliver 700 cars in ten hours, running a total distance of 22 miles in that time. At Rock Springs, Wyoming, an 80 H. P. electric locamotive runs 8 miles an hour, pulling 30 3000 pound cars 6000 feet in 20 minutes. running on a 35 pound rail. The power station is a mile from the mouth of the mine, and has an 80 H. P. dynamo, generating an 550 volt current.

The question arises as to the immunity from fire or explosion, generated either from the wires or from sparking at the motors; especially is this to be considered in fiery mines. By the adoption of a proper wiring system, good insulation, and proper safety devices, such as fusible plugs at the dynamo, safety commutators, etc., there should be no apprehension felt on this point, as it is chiefly a matter of dollars and cents as to the amount of security.

Among electrical stone-cutting machines, the Jeffrey machine has met with considerable success. This consists of a rotary bar 3 to 4 feet long, in which are fixed a number of cutter bits, which, when revolvod, cover the whole face of the bar; the bar is fixed at the end of a sliding frame, and is rotated by sprocket wheels and chain from the motor which is attached to the frame work. It is fed into the face of the coal as it cuts, and is found to feed very evenly, using from 7 to 15 H. P., at a pressure of 220 volts, It is supplied with a separate truck on which it is moved from room to room. It is stated that from 125 to 300 lineal feet may be undercut in ten hours to a depth of 6 feet, depending on the nature and thickness of the coal and the skill in handling the machine. After making a cut, the bar is withdrawn by throwing a lever, and the machine is moved along the face of the coal the length of another cut. There are at present over one hundred of these machines in active use. Where the bottom is soft, the undercut may be made in it. The objection to this machine, which applies to all others as well, is its weight, making it small to handle in small coal; and, furthermore, mining machines require a fair top, as the machine will take up a space of ten feet at the face for its operation. This company also makes a machine of the chain type, having a chain belt carrying the cutter bits running in a horizontal plane. The advantages claimed for this machine over the other style are (1) that it will make a merchantable pea coal of the undercutting, while the other one practically wastes all the mateaial that it cuts away, and (2) that as shown from practical tests, it requires 40 per cent less power for its operation to do the same amount of work. The Hercules Mining Machine Company, of Pittsburgh, make a machine consisting of a number of parallel rotating drills, which are fed at right angles to the face, and which are actuated by a Tesla alternating motor. The "Ednie" machine of the General Electric Company, is also on this boring principle, although considerably different in details. This type of machine is said to be preferred by many practical miners. The General Electric Company also make an "Arc" coal cutter, which has an arm carrying an endless sprocket chain to which are affixed cutter-bits, which scrape the face of the coal; this is said to be suitable for large rooms or for long-wall work. Several cutturs, called pick or "punching" machines, are on the percussive order, using either the solenoid principle or springs in their construction; these would be preferable in very hard or pyritic coal. The power required in a solenoid machine is considerable, being up to 25 per cent more than required for a cutting machine doing three times as much work, hence is only one-fourth as efficient. In the other class the rotary motion is transformed into reciprocating motion, the mechanism rapidly drawing back and compressing, then releasing a spring, which thrusts the pick againt the coal. The transforming apparatus, however, is complicated and expensive. At Earlington, Ky., at the Hecla Mines, there are half-a-dozen pick machines, furnished by the Sperry Company, in daily use; a great trouble with these has been the breaking of the springs. They weigh 1000 pounds each and can cut 100 lineal feet, 4 feet under in a day. The coal is hard and five feet high.

Coal drills are of several styles according to the height and nature of the coal. Direct rotary motion is obtained from the motor, which is attached to the drill frame, by reduction gears. These develope 4 to 6 H. P. and weigh up to 200 pounds. In one case a Jeffrey drill showed 3.2 H. P. with a 2 inch auger, feeding 6 feet a minute; their drills use no starting rheostat or fuse and the machine will start with a full load directly on end.

Electric rock drills are percussive and use the solenoid principle, as in the Marvin-Edison and the T-V-Depoele drills, the former having two and the latter three solenoids. The drills resemble the ordinary air or steam drills in general appearance and are as easily handled and run; they are likewise mounted either on tripod, column or shaft-bar. The T-V-Depoele drill was used at Rock Island, Ill., on U. S. Government Work, in hard limestone, the contract price being 12 cents a foot for 1 3-4 inch hole, and was found to work very satisfactorily. Where an air-compressing plant is already in operation, the compressor may be placed at the most advantageous point in proximity to its working drills and moved forward from time to time, as the work proceeds, by using electricity to run it; in this way the heat of compression is not lost, there is no leakage from a long pipe line and no freezing in the exhaust ports of the drills, their efficiency being increased as much as 35 per cent. Investigations are now being pursued with regard to reheating compressed air at the drills before using, by electricity, which promise to be successful. Other drills are on the order of the boring coal drills already mentioned.

In pumping, a motor may be applied to almost any form of pump on the market, direct-acting or centrifugal, by use of the proper reduction gears. Trouble has been experienced in regulating the speed of electric pumps in any simple manner, at will. The Gould Manufacturing Company, of New York, make a special pump to use with electricity, from 50 to 500 gallons capacity and the Jeffrey Manufacturing Company make a rotary pump which is fixed to a truck for easy handling. In an English colliery electric pumps have been in use for over three years, and the manager says: "It may be stated that they have given very little trouble and have cost next to nothing for repairs. At Normanton, St. Johns Colliery, two coupled engines 22 1-2 inches by 4 feet, 50 R. P. M. connected to three series-wound Immisch dynamos, each 50 H. P. and capable of giving a current of 60 amperes at 600 volts and one compound-wound dynamo giving a current of 155 volts, furnish power which is taken underground in a lead-covered cable and runs two 50 H. P. pumps 500 yards from the shaft and one at the surface, also a pump 1600 yards from the shaft and three pumps, each three-throw, at 1300, 1400 and 2200 yards. In deep shaft mines electric pumps have the great advantage of not requiring difficult pipe-lines; the Calumet and Hecla Co., have installed some large electric pumps in their copper mines, the most interesting feature being the high potential used—1000 volts. It is stated that this high voltage was more in the light of an experiment, but that as great care was taken in the installation and insulation of the plant, the high voltage has given no trouble whatsoever.

In the line of lighting, it is claimed for electricity that it makes a great improvement in the eye-sight of miners, amongst whom diseases of the eye are very common. It gives a strong steady, bright light, free from obnoxious fumes and smoke, capable of instant lighting or extinguishment; the light is of several candle power. The portable electric lamp, with storage battery, has not made much progress as yet; and English design weighs six pounds. A late number of the Colliery Engineer describes a later design weighing much less. With an incandescent lamp if the globe be broken, the current will undoubtedly ignite gas, but, with wire-protected globes, there should be no more danger from this source than from the dangers attending the use of a safety-lamp. Lupton mentions the use of arc lamps in a lead mine which gave great satisfaction. In Lanarkshire, Scotland a dynamo runs 300 lamps distributed throughout the mines and buildings, also an electric pump of 100 gallons per minute.

For signaling, the telephone in French mines and the electric bell in Yorkshire and South Wales as well as largely in this country are used either for signaling from the outside to the mine workings or along rope haulages, etc.

By the use of electricity in explosive firing we gain time and reduce the proportion of missed shots, therefore, the cost. This is done either from a small portable electro-magnetic machine or from the working mine current.

As examples of the diversity of uses to which electricity has been applied in the lines mentioned, we may cite the installations at Telluride, Colorado. At one plant a dynamo of 30 kilo-watts capacity is driven by a 28 inch Pelton wheel in summer and two engines 120 and 135 H. P. in winter. The current is taken to the mines, lighting the snow-shedded inclines, the ore-house, boarding-house, tunnel and shaft, crushers and hoists. It is led 8000 feet up the mountain and then 3300 feet in the tunnel and 1000 feet in the mine workings. There are 300 lights in the circuit. At another plant, the power is generated 3000 feet below the mine by two 30 kilo-watt dynamos, driven by 36 inch Pelton wheel with 670 feet head, and is used to run two electric motors, two Dodge crushers, one set of duplex Cornish crushing rolls, three 5 feet Huntington mills, three Frue-Vanners and six bumper-stables: The loss in transmission is only 3 per cent. At a third plant near Telluride, a 100 H. P. alternating current is carried three miles, the power being taken from a Pelton wheel driven by water through a 2 foot steel pipe, 320 feet head and a Westinghouse alternating dynamo, giving a pressure of 2000 volts at the mill motor. This is the first application of the alternating current for general mining purposes in this country. In In 9½ months the plant was stopped but 48 hour for repairs which were trifling matters.

As already suggested by one of the members of this society, a colliery at which there are coke-ovens, could erect a boiler plant in connection with them and dynamos, and obtain their electric power very cheaply in that way, for utilization in the manner mentioned in this article.

In conclusion the writer desires to say that he claims no originality for the facts herein presented, but has merely attempted a very brief and imperfect summary of the claims and applications of electricity to mining. For this he has drawn upon the transactions of the A. I. M. E. the Engineering and Mining Journal and the Colliery Engineer unstintedly, even to adopting at times the phraseology and he hereby makes a general acknowledgement.

ON THE PHOSPHATE ROCK OF TENNESSEE.

BY WILLIAM B. PHILLIPS.

The discovery of phosphate rock in Hickman County, Tennessee, which was announced last winter, has rendered possible the transfer of at least a part of the fertilizer trade from the coast to the interior. Uutil the utilization of cotton seed meal as an ammoniate the chief sources of nitrogen in commercial manures was bones, dried blood, tankage, fish scrap and sulphate of ammonia. While the consumption of this latter salt is no inconsiderable factor in the saving of by-products at gas works, and while a comparatively large amount finds its way to the fertilizer factories, it is nevertheless true that most of the so-called guanos are ammoniated with organic material. Fish scrap of course will always be derived from the sea coast, where the appliances for catching immense numbers of fish, extracting the oil and curing the residue are all that can now be desired. When it comes, however, to dried blood, tankage, etc., the chief sources of supply are the great slaughter houses of the interior cities, Chicago, St. Louis, Kansas Ciŋy, Cincinnati, etc. Nearly all the commercial manures now sold in this country are manufactured in the sea-port towns, or such as are within eacy reach of the great deposits of phosphate rock in South Carolina and Florida. It is only within recent years that fertilizer factories have been erected in the interior, the rock being obtained to a very limited extent from Canada, but by far the greater part coming from the above named states. If we consider such cities as Chicago, St. Louis, Kansas City, Louisville and Nashville, the growth of the manufacture of fertilizers has depended on the freight rates on raw rock. Charleston rock of 61 per cent bone phosphate, can be had f. o. b. Charleston, for $4.75 per ton, and the rate to any point within 200 miles of Cairo, Illinois, cannot be less than

$3.00 per ton, so that the cost of a ton of Charleston rock at Nashville, let us say, will be at least $7.75. Considering the fact that acid phosphate of 13 per cent available phosphoric acid, can now be had f. o. b. Charleston, for $7.00 to $7.50, and that the freight to interior points is not very much more than on raw rock, the inducements to enter upon the manufacture of commercial manures in the interior is not of the most attractive sort. It is true that the proximity to sources of ammonia to some extent counter-balances the difference in the cost of roek, and as such material is worth from $25.00 to $30.00 per ton, this advantage may at times be worth consideration. But the ratio between rock and ammoniate is too great to allow of the small saving in freight upon the ammoniate to influence the result ordinarily. Not only has the distance the rock has to be hauled operated against the building of fertilizer factories in the interior, but the question of a supply of sulphuric acid has also been of great importance. With the opening of the great pyrite mines of the Arminius Company in Virginia, and later the beds in Gaston Co., N. C., and the invention of an eflective and simple pyrite burner,such as the N. P. Pratt burner, and the building of special tank cars for shipping acid, the business of manufacturing fertilizers in the Mississippi Valley and contiguous territory has begun to show signs of a vigorous life. Several large plants have been erected and are now in successful operation.

It needed one thing more to attract the attention of capital to this inviting field for investment, and this was the discovery of phosphate rock in the interior. Some months have passed since the discovery was announced by Prof. Wharton, of Nashville, and a great deal of prospecting has been carried on in Tennessee, in the Counties of Hickman, Lewis and Wayne. Up to this time the result sare certainly encouraging, for seams of excellent rock, varying in thickness from 8 to 40 inches have been located and exploited. They underlie the Black Shale of the Devonian, formerly termed Marcellus, but now known as Chattanooga, and overlie limestone. The seams lie almost flat, and for the most part are above the drainage level, thus affording easy and cheap mining and loading.

They cannot be stripped, or worked in open cut, except under very rare circumstances, for the superincumbent strata, Chattanooga and Harpeth shale, are generally more than 100 feat thick, but will have to be mined as a coal seam is mined, i. e., by drift and rooms.

The thinness of the seams is the greatest obstacle to be overcome and it is not likely that less than 30 to 36 inches can be mined, even allowing the rock to yield 65 per cent. of Bone Phosphate. But with 36 inches and a favorable locality there does not seem to be any good reason why this rock should not be mined and loaded for $1.00 to $1.25 per ton. There are places in Hickman Co., Tennessee, as for instance, Totty's Bend, Duck river, the basin of Swan Creek, including Fall Branch, etc., where the seams will average 30 inches, and perhaps 36 inches of good rock, and where the best of facilities for cheap mining and loading are to be found. There are other places where the rock is of a quality quite as good, but where the seams are too thin to admit of profitable mining.

As to the chemical composition of the rock, it must be said that in some places the alumina runs above 6 per cent., but I have sampled some workable seams from top to bottom and found this usually deleterious ingredient to be about 3.5 per cent. The insoluble matter in the best rock is about 6 per cent, but the average is nearer 10 per cent. The phosphoric acid is close upon 30 per cent, and the lime about 40 per cent, the oxide of iron averaging about 5 per cent, the carbonic acid 2 per cent, and sulphur 2 to 3 per cent. Taken as a whole, some of the thickest seams, 36 to 40 inches, will yield a rock of excellent quality, second only to the highest grade Florida rock, with which, however, it would not come in competition as this extraordinarily rich rock is exported to Hamburg, Liverpool, etc.

Above the Chattanooga shale, and lying between this and the Harpeth shale, there is most persistent seam of phosphoric nodules, imbedded in a greenish yellow matrix of varying hardness. This upper seam is rarely more than 6 inches thick, and is separated from the lower or granular seam by the varying thickness of the Chattanooga shale, which in places is 10 feet and more thick, for the most part, however, less than 4 feet thick. These nodules are of the most curious shapes, rounded, oblong, flattened discs, rib-shaped, bone-shaped, all packed in together so tightly as to require, at timea, considerable force to dislodge them. They are very rich in bone phosphate, occasionally to 80 per cent, but are not of economic importance.

They are of a dark gray appearance on the fresh fracture, and when rubbed smartly together emit a decided and unpleasant order, meriting the name by which they are known "stinkstones."

The color of the lower seam varies from a velvetly bluish black to a yellowish brown, ledges of a grayish white being also not uncommon. Some specimens of the yellowish brown are beautifully stratified in shades of brown around the bluish black core, making a characteristic and easily identified rock. The outer streaks of yellowish brown are probably oxidation products from the black core, which contains iron in the ferrous condition.

The black rock is often observed to be filled with small rounded pebbles of phosphate, not unlike those from the Peace River, Florida. The origin of the lower seam would appear to be due to the action of phosporus-bearing solution derived from the organic remains of the Chattanooga shale, upon the underlying limestone, whereby the carbonic acid was driven off and its place occupied by phosphoric acid.

There is as yet no railroad into the best part of the field, as this lies between the Nashville & Tuskaloosa Railway on the west, and the Louisville & Nashville from Columbia to Florence and above Columbia on the east, being about ten miles from the former and from 13 to 20 miles from the latter. The

Duck river is a semi-navigable stream and cannot be depended upon for regular shipments.

Taking everything into consideration and with due regard to proper caution, it may be said that in all probability the Tennessee phosphates will enter the market before 12 months have passed. They will not seriously interfere with South Carolina and Florida rock, but will be the means of building up factories where now there are none and of creating trade in manufactured manures where now it is difficult to sell even a few tons of acid phosphate or guano.

REPORT OF THE SECRETARY.

UNIVERSITY OF ALABAMA, May 29th, 1894.

In going over the book of the Secretary with care, I find that we have on our list 111 names. Of these, 20 do not seem to have become members at all, and have paid none of the assessments; 2 have died; 13 have resigned definitely, after longer or shorter connection with the society; 35 have paid the first assessment only, and of these 3 have attended the meetings from time to time and will no doubt wish to keep up their relations with the society; the rest, 32 in number, having never been in attendance wish probably to discontinue their membership, and I recommend that the circulars and proceedings be not sent them hereafter; 41 members have paid up two or more assessments or have recently joined and are to be considered along with the three just named, as active members, making 44 in all, I suggest that hereafter the documents and notices be sent only to these and to members who may hereafter be elected, or who may signify their wish to renew their connection with us.

During the past year circulars have been sent out announcing the times of the meetings and proposing names for the offices to be filled at the annual meeting. Five hundred copies of the proceedings have been printed at a cent of $1.25 a page, 62 pages making a total of $77.50. I have also had 12 copies of each paper printed as extras for the use of the authors and have sent them out. The cost of the extras bas been $4.00.

I have placed before the council the proposition of Mr, E. Prochaska concerning the printing and publishing of the proceedings in future, and their action will be brought before the society at this meeting.

The suggestion has been made that in making exchanges with certain societies, we send out and receive in exchange 100 copies of proceedings, which may then be distributed amongst the active members. This plan is worthy of consideration.

The proceedings of the Society have been sent to about 175 addresses in addition to the members of the Society. These include individuals, libraries, newspapers and other journals and societies.

In exchange we have received the following, which have been placed in the library of the society:

Trautwine's Engineers' Pocket Book, from the author.

Transactions of the Technical Society of the Pacific Coast.

The Technic, Annual of the Engineering Society of the University of Michigan.

Technology Quarterly, from the Massachusetts Institute of Technolog.

The Age of Steel, St. Louis, Mo.

The Colliery Engineer, Scranton, Pa.

Respectfully submitted,

EUGENE A. SMITH, Secretary.

ANNUAL REPORT OF TREASURER FOR 1891.

RECEIPTS.

From Annual Dues,	$378.00
" Extra Papers,	12.15
Total Receipts	$390.15

EXPENDITURES.

For Stationery and Postage,	$ 45.37
" Printing,	204.35
" Hall Rents,	15.10
" Lithographic Work,	67.75
" Reporting Proceedings,	15.00
Total Expenditures,	$349.57
Balance in Bank,	$ 40.58

HENRY McCALLEY, Treasurer.

University, Ala., Jan. 12, 1892.

ANNUAL REPORT OF TREASURER FOR 1893.

RECEIPTS.

From Cash in Treasury, as per report of Jan. 12, 1893.	$ 40.58
From Annual Dues for 1892.	148.00
Total receipts,	$188.58

EXPENDITURES.

For Printing,	$113.75
" Lithographic Work	25.00
" Stationery and Postage,	21.70
" Reporting Proceedings,	15.00
" Hall Rents,	10.80
Total Expenditures,	$186.25
Balance in Treasury,	$2.33

HENRY McCALLEY, Treasurer.

University of Alabama, May 17, 1893.

ANNUAL REPORT OF TREASURER FOR 1893.

RECIPTS.

From Cash in Treasury, as per report of May 17, 1893, - - - -	$ 2.33
" From Annual Dues, - - - -	191.00
Total Receipts - - - -	$193.33

EXPENDITURES.

For Printing and Stationery, - - -	$87.75
-- Advertising Meetings, - - -	12.95
" Postage, - - - - - - -	8.40.
" Reporting Proceedings, - - -	5.00
" Express Charges on Engraved Blocks, -	0.55.
Total Expenditures - - -	$114.65
Balance in Treasury, - - - - -	$78.68

HENRY McCALLEY, Treasurer.

University, Ala., May 29, 1894.

PROCEEDINGS

OF THE

Alabama Industrial and Scientific Society.

VOLUME IV. NO. 2.

1894.

PROCEEDINGS

OF THE

ALABAMA

INDUSTRIAL AND SCIENTIFIC SOCIETY.

VOLUME IV. NO. 2.

1894.

PUBLISHED BY THE SOCIETY.

SECRETARY'S OFFICE,
UNIVERSITY P. O.,
ALABAMA.

BURTON & WEATHERFORD, TUSKALOOSA, ALA.

OFFICERS.

1894.

PRESIDENT.

Wm. B. Phillips, - - Birmingham, Ala.

VICE PRESIDENTS.

T. H. Aldrich, - - - Birmingham, Ala.

*

L. C. Harrison, - - - Warrior, Ala.

F. M. Jackson, - - - Brookwood, Ala.

Geo. B. McCormack, - - Pratt City, Ala.

Ernst Prochaska, - Birmingham, Ala.

TREASURER.

Henry McCalley, - - - University, Ala.

SECRETARY.

Eugene A. Smith, - - University, Ala.

---

*Vacant by resignation of J. M. McKleroy, Anniston, Ala.

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REPORT OF PROCEEDINGS

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY,

Held in the Office of the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., December 14, 1895.

The meeting was called to order at 7:45 P. M., with President Phillips in the chair. The following were present: C. Cadle, H. F. Wilson, Jr., C. D. Harris, R. F. Manly, J. H. McCune, Prof. M. C. Wilson, J. D. Hillhouse, C. A. Meissner, E. Ramsay, J. W. Minor, E. A. Uhling, J. A. Montgomery, Dr. Wm. B. Phillips, Dr. E. A. Smith.

Reading minutes of last meeting was dispensed with, as the same had been printed in pamphlet form and distributed to the members.

Under the head of "Presentation and Reading of Papers," Prof. M. C. Wilson, of Florence, Ala., read a paper on Spathite Iron, which was greatly enjoyed and generally discussed.

Dr. Phillips read a paper next on the "Composition of Flue Dust," after which a general discussion ensued.

Mr. C. A. Meissner then read some "Collected Notes on Cyanides." These notes were discussed by those present.

Dr. Phillips next brought up the question of "Utilization of Coke Braize," which elicited a great deal of discussion.

Mr. Erskine Ramsay, at the request of the President, explained his new coal screen, now erected at Pratt Mines, to the meeting.

Dr. Phillips then addressed the meeting, and stated that Dr.

E. A. Smith, State Geologist, had at last finished the Geological Map of Alabama, and he would like to have the gentleman explain same to those present, which the doctor did.

In closing, Dr. Phillips said he thought that the Society should devote the next six months to the matter of "Saving of By-products of Coke Ovens," and the meeting agreed with the doctor in this matter, so it was resolved to have some papers read at the next meeting on the above subject.

Adjourned.

EUGENE A. SMITH,
Secretary.

SPATHITE IRON.

BY M. C. WILSON.

The production, within the last few years, of a grade of iron known as Spathite Iron, which has uniformly commanded a price of fifty cents to one dollar a ton more than the pig iron ordinarily produced in this district, has led me to believe that a paper on this product might be of interest to this Society.

So far as known, this Spathite Iron is made only at Florence, Alabama, and the ore from which it is obtained comes only from Iron City, Lawrence county, Tennessee, though I am strongly inclined to believe that it occurs also in contiguous portions of North Alabama. The ore is found at Iron City in a stratum about six feet thick with lime-stone both above and underlying it. This stratum dips to the Southward.

The ore, of which I have several specimens here, looks, at first glance like an ordinary red ore. It was first described as a spathic ore but on closer examination by Dr. J. M. Safford, was found to be a very different mineral, and by him was given the name Spathite. It differs widely both in chemical composition and physical character from the typical spathic ore. The carbonic acid is almost entirely combined with the lime, and the iron is almost entirely found as ferric oxide.

From numerous analyses I am led to believe that this so called spathite iron ore is a more or less intimate and uniform mixture of red hematite and carbonate of lime. There is a variation in the percentages of the two; that part lying next to the lime-stone layer, having a somewhat larger amount of carbonate of lime and a correspondingly small amount of ferric oxide.

I give here a couple of analyses taken from a list of five or more. The iron is given as metallic iron. This being *nearly* all in the form of ferric oxide. In only one sample examined did I find the ferrous oxide exceed one per cent.

SPECIMEN NO. I.

Iron,	22.19%
Silica,	14.79
Lime (CaO),	24.04
Carbonic Acid,	21.63
Alumina,	2.45
Magnesia (MgO),	1.68
Manganese,	Trace
Phosphorus,	.534
Sulphur,	Trace

SPECIMEN NO. 2.

Iron,	21.62%
Silica,	15.13
Lime(CaO),	21.97
Carbonic Acid,	18.75
Alumina,	2.79
Manganese,	Trace
Phosphorus,	.49
Sulphur,	Trace

The specific gravity of this ore is 2.78. It is more or less porous and soft in texture and disintegrated somewhat when put into water.

In making up the burden of the furnance, the usual practice is to use one part of spathite ore to two parts of the ordinary brown ore assaying about 50% of metallic iron; very little, if any, carbonate of lime is required for fluxing.

Just what are the physical characters of the iron produced from this mixture, I cannot say with any authority. Nor can I say how far its peculiarities are due to furnace practice, and how far to the chemical composition of the ore. I have here three analyses of the iron, which may throw some light on the question.

Of these specimens. the first is what is ordinarily called a Gray-Forge iron; the second a distinctly silver white, and unusually hard iron, and the third a number two foundry iron.

SPECIMEN NO. I.

Graphitic Carbon,	3.11
Combined Carbon,	0.27
Silicon,	1.82
Phosphorus,	1.73
Manganese,	.26
Sulphur,	Trace

SPECIMEN NO. 2.

Graphitic Carbon,	2.77
Combined Carbon,	0.53
Silicon,	2.75
Phosphorus,	1.68
Manganese,	0.12
Sulphur,	Tiace

SPECIMEN NO. 3.

Graphitic Carbon,	2.61
Combined Carbon,	0.34
Silicon,	3.09
Phosphorus,	1.60
Sulphur,	Trace

The precentages of phosphorus are somewhat higher than in the ordinary pig, but very nearly the same in all, while the variation in the amounts of silicon is much wider. One surprising fact is the smallness of the amount of Manganese in the iron, and this small amount is, I believe, derived from the brown ore mixed with the Spathite in the reduction, numerous analyses of the Spathite having failed to give anything more than a trace of manganese.

Some remarkable properties are claimed for the working of this iron in the Cupola furnace; such as giving increased fluidity, and making decreased shrinkage in the castings. But I am sure there are several persons here who know much more about this than I do.

DUST-CATCHER REFUSE.

BY WM. B. PHILLIPS.

While conducting some experiments in the magnetizing and concentrating of soft red ores, I was led to investigate the nature of dust-catcher refuse, in order to ascertain if it could be economically treated for the iron it contains.

Samples were taken at intervals extending over several days, and well mixed so as to give a fair average of the material. Five hundred grams were taken for examination and analysis, and screened over seives from 10 meshes to 100 meshes per square inch, without pulverization. The material remaining on each screen was separated into two portions, magnetic and non-magnetic, by a current from 3 1-quart "Samson" battery cells actuating a magnet. Thus the material left on the 10 mesh screen was divided into two portions; that through the 10 but left on a 20 mesh, into two portions, and so on with each succeeding seive.

An analysis was made of each portion, the magnetic and the non-magnetic. Below are given the results, the first table showing the composition of the magnetic portions, and the second that of the non-magnetic portions:

MAGNETIC PORTIONS.

Residue on	Per cent of total by wt.	Iron, pr.ct.	Phos. pr.ct.	Alumina, pr.ct.	Lime. pr.ct.	Insol. pr.ct.
10-mesh seive	0.06	51.93	0.39	3.00	2.75	15.00
20 " "	0.53	38.42	0.26	3.90	3.20	19.95
30 " "	5.34	43.38	0.28	3.25	4.40	17.30
40 " "	6.62	39.46	0.30	4.14	6.90	21.70
50 " "	10.30	41.54	—	4.18	7.20	18.96
60 " "	9.00	40.38	—	4.00	7.80	17.96
70 " "	10.00	41.67	0.32	3.50	6.80	14.68
80 " "	35.00	44.00	—	4.50	6.00	14.00
100 " "	10.00	45.00	—	4.00	5.50	13.50
Thro' 100-m.seive	13.15	44.50	—	3.75	7.00	14.00

The first thing that attracts attention is the fineness of the material, more than one-third of it passing a 70-mesh seive, and more than one-fifth passing an 80-mesh seive. The per centage of iron varies from 40.38 in the material passing a 50 and remaining on a 60-mesh seive, to 51.93 in the material remaining on a 10-mesh seive. The average per centage of iron is 43.03, and of insoluble matter 16.70.

It would be impracticable to pass the refuse through such fine screens and then concentrate it over a magnetic separator in order to obtain a product no better than is indicated by these analyses. If one should use a 70-mesh screen, he would lose 58% of his material, and 23% if he used an 80-mesh screen.

So far as concerns the screening of the refuse, it is not to be recommended. If the entire material as it comes from the dust catcher should be treated magnetically, we could not hope to secure, on the average, more than 43% of iron, nor less than 16% of insoluble matter, in the concentrates, while we would throw away a large amount of available fuel represented by the non-magnetic portions.

The composition of these non-magnetic portions is given in the following table :

NON-NAGNETIC PORTIONS.

Residue on	Per ct. of total by wt.	Vol. matter pr.ct,	Fixed carbon pr.ct,	Ash pr,ct.	Ox. of iron pr.ct.	Alum'a pr.ct.	Lime pr.ct.	Silica pr.ct.	Phos. pr.ct.
10-mesh scive	0.73	3.30	70.95	25.75	6.58	4.72	2.60	7.40	0.10
20 " "	3.42	2 20	76.30	21.50	4.12	2.68	1.50	6.40	—
30 " "	8.66	3.80	71.40	24.80	3.70	2.50	1.60	9.35	—
40 " "	4.49	2.80	61.80	35.40	2.68	4.14	5.50	15.15	—
50 " "	4.40	6.10	52.70	41.20	4.44	4.06	8.40	20.20	—
60 " "	3.30	6.15	53.95	39.90	3.75	4.00	9.00	17.20	—
70 " "	3.00	6.70	47.85	45 45	12.26	3.00	8.50	17.30	—
80 " "	5.00	7.00	45.50	47.50	11.50	3.75	10.00	18.50	—
100 " "	4.00	6.00	42.00	52.00	13.00	4.00	9.00	20.00	—
Thro' 100-mesh	2.00	5.00	41.00	54.00	12.00	5.00	8.00	22.00	—

The average per centage of Fixed Carbon is 56.34, and of Ash 38.75, the ash containing a notable amount of lime, especially as the fineness increases. The presence of metallic iron in the refuse may be due to particles mechanically removed from the bell and hepper during charging, or to reduced iron held in a very finely divided condition, or to both these causes. When it is treated with hydrochloric acid, there is an evolution of evil-smelling hydrocarbon gas, such as comes from cast iron when treated with acid. But the amount of metallic iron is small, as is shown by the low content of total iron, which is but little above the metallic iron of the burden. If this material were handled over a dry magnetic concentrator, there would be a great quantity of dust, with its consequent troublesome effects. A wet concentrator of the Finney-Lovett type would handle it to better advantage, especially as the difference between the specific gravity of the concentrates and the tailings is so great. It has been recommended by a Past President of this Society, Mr. C. A. Meissner, to mix this material with tar, or other suitable binding stuff, and compress the mixture into bricks for use as a part of the burden, and the suggestion is worthy of attention.

The flue dust from two furnaces in this district will amount to ten tons per day of 24 hours, which will contain 43% of iron, or 4.3 tons. This is now going to waste, and it does seem that some means could be devised for saving it.

When the magnetic concentrator now building at Bessemer is completed, it is our purpose to mix a certain quantity of dust-catcher dust with the ore as it goes to the separator, to ascertain whether or no its economical treatment can be effected in this way. No great amount can be thus used, because the metallic iron in the concentrates from the dust cannot be increased above 44 to 45%, which is from 12 to 14% below the per centage of iron which we hope to obtain from ore concentrates.

If some method could be devised for mixing this dust with coke braize and moulding into bricks, it would prove a not unwelcome addition to our burden. But the saving of by-products in this district seems to await a greater competition, or a larger population, or both.

NOTES ON THE FORMATION OF CYANIDES IN THE BLAST FURNACE.

BY C. A. MEISSNER.

Very little has been written on the subject of cyanides in the Blast Furnace, and as Mr. Means, Supt. of the Sloss Iron & Steel Co's., furnaces at North Birmingham, mentioned to the writer his trouble experienced at his tuyeres with cyanide formation, an effort was made to get some information on the subject. Mr. Means stated that he had heavy accumulations of what has every appearance of cyanide of potassium and sodium in his tuyeres and blow pipes, that he frequently had to take them down to clean them, and that he thought the cyanides cut his tuyeres. This led to the collection of the following notes by the writer. G. Hilgenstock, an eminent German authority, found that the greater the coke consumption the greater the amount of ammonia formed, and hence the more cyanides formed in the furnace. It is generally considered that the ammonia found in the waste gases is derived from the blast, which passing over white hot coke, produces a mixture of carbonic oxide and nitrogen, and this mixture passing over carbonate of potassium and sodium in presence of carbon forms cyanide of potassium and sodium, which latter by decomposition with steam produces ammonia.

An experiment made by Hilgenstock threw some light on this theory. After tapping, and before the slag had risen again, the gases escaping from the cinder notch were led through an iron pipe into water and this became alkaline at once, and contained mainly cyanide and carbonate of potassium, and on evaporating, large amounts of ammonia were found. The slag contained 0.53 per cent of potash. In another case H. Von

Juptner publishes analyses of cyanides which flowed from a slag tuyere. It is described as thick fluid, which during solidification evolved dense suffocating fumes; analysis is here given:

SOLUBLE IN WATER.

Sulphide of Potassium,	2.99%
Carbonate of "	39.52
Cyanide of "	49.58
Cyanate of "	1.15
Metasilicate of "	1.75
Sulphocyanide of Potassium,	Trace.

INSOLUBLE IN WATER.

Carbon,	1.37%
Slag,	6.39

A great deal of ammonia is supposed to come from the nitrogen in coke, which when red hot, will evolve ammonia when water is thrown on it. Water gas from coke contains as much as .0489%. Coke analysis showed nitrogen 0.087%, 0.287%, and some coke taken from the tuyere region was found to contain no nitrogen at all, all having been taken away in the descent in the furnace. Some brown ores may contain considerable ammonia according to their exposure to atmospheric influences. Following are analyses:

Brown Ore, Ammonia—0.24%, 0.08%.

Bog Ore, Ammonia—0.025%, 0.435%, 0.140%.

Only about one third of the ammonia in a charge goes off into the gases: it is probable that the very hot working of a furnace assists the formation of cyanides in the fusion zone where it is carried forward by the draft and decomposed by water vapor in the upper part of the furnace. Von Juptner found that when working in different mixtures he obtained different results. It would also appear from his results that soft coke contained more ammonia than hard coke, hence led to greater cyanide formations. Ledebour finds that cyanides have a strong reducing action on the red hot ore, and carbonize the iron so that in this respect their action is beneficial.

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AND

SCIENTIFIC SOCIETY.

VOLUME V

1895.

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SECRETARY'S OFFICE,
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ALABAMA.

BURTON & WEATHERFORD, TUSCALOOSA.

OFFICERS.
1895.

PRESIDENT.

Thomas Seddon, - - - Birmingham, Ala.

VICE PRESIDENTS.

*

F. M. Jackson, - - - Brookwood, Ala.
Geo. B. McCormack, - - Pratt City, Ala.
Ernst Prochaska, - - New Castle, Pa.
James Bowron, - - - Birmingham, Ala.
E. A. Uehling, - - - Newark, N. J.

TREASURER.

Henry McCalley, - - University, Ala.

SECRETARY.

Eugene A. Smith, - - - University, Ala.

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*Vacant by resignation of L. C. Harrison, of Warrior, Ala.

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REPORT OF PROCEEDINGS

OF

ANNUAL MEETING

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

Held in the Office of the Tennessee Coal, Iron, and Railroad Company, Birmingham, Ala., June 8, 1895.

The meeting was called to order at 8:30 P. M., with President Phillips in the chair, Those present were E. Ramsay, Dr. Wm. B. Phillips, Dr. E. A. Smith, J. A. Montgomery, G. W. Chase, Chemist of the Pioneer Mining and M'fg Co., J. R. Harris, Chemist of the Tennessee Coal, Iron and R. R. Co., James M. Lock, of Cincinnati, R F. Manly, representatives of the Age-Herald, and Evening News, and others.

Dr. W. B. Phillips, President of the Society, read his Address, which will be found in the body of the proceedings.

The minutes of the last meeting were then read and adopted without comment.

There were no applications for membership in the Society.

The Secretary read his report, which will be found elsewhere in the proceedings.

The Treasurer's report was examined by a committee appointed for that purpose, and being found correct was accepted.

The next thing in the order of business was the reading of papers. Col. J. A. Montgomery read a very interesting and exhaustive one on the subject of "Recovery Ovens."

The question of the Society making arrangements for the delivery of a series of lectures on scientific subjects, from time to time, was discussed, but no definite conclusion reached.

The Secretary was instructed to request J. W. Minor to furnish a paper to be read at next meeting, on the subject of Fire Brick; Mr. G. D. Fitzhugh one on the subject of Phosphates; Mr. Thomas Seddon one on the Coal and Iron Future of the State; and Mr. A. E. Barton one on the Increased Production of Pig Iron in the past three years as against Previous Records.

After the ballots, which had previously been cast, were counted, it was announced that the following officers had been elected: Thomas Seddon, President; E. A. Uehling and C.E. Bowron, Vice Presidents, E. A. Smith and Henry McCalley were unanimously re-elected Secretary and Treasurer, respectively.

The meeting then adjourned.

EUGENE A. SMITH, Secretary.

REPORT OF PROCEEDINGS OF AUTUMN MEETING.

BIRMINGHAM, ALA., NOVEMBER 23, 1895.

The meeting was called to order by President Seddon, at 3 P. M., in the rooms of the Commercial Club. There were present Messrs. Seddon, Aldrich, McCalley, Phillips, Brewer, er, Manly, Smith, Gibson, representatives of the press, and others.

The minutes of the last meeting were read and adopted. There were no committees to be heard from. The council recommended the following for membership: Wm. M. Brewer, of Heflin; J. R. Harris, of Birmingham; and Gordon Robinson, of Birmingham; who were duly proposed and elected.

Some discussion was then had upon the prospects of the Society, from which it appeared that there was a general desire among the members that it be continued, for the present at least, under its present name and with its original objects in view. But it was thought advisable for the members to interest themselves more decidedly in trying to keep the Society before the attention of those who should be members, and thus do what could be done towards increasing the membership. To this end, it was directed that the Secretary enter into correspondence with Mr. John Fulton, of the Cambria Iron Works, for the purpose of getting that gentleman to prepare an address and deliver it before the next meeting of the Society, upon Recovery Coke Ovens, and their adaptability to the Birmingham District.

The reading of papers being next in order, the following were read:

(1) *Mobile Point, the Deep Water Harbor of the Gulf Coast*, by G. D. FITZHUGH, of Birmingham. In the absence of the author, this was read by Dr. Phillips. Some discussion followed, in which Dr. Phillips, Mr. Aldrich, and Dr Smith took part.

(2) *Alabama Barite or Heavy Spar*, by HENRY McCALLEY—read by the author, discussed by Messrs. Aldrich, Phillips, and Seddon.

(3) *On Alabama's Resources for the Manufacture of Portland Cement*, by EUGENE A. SMITH. read by the author. and discussed by Messrs. Seddon, Aldrich, and McCalley.

(5) *On the Value of the Raw Materials in Iron Making*, by Dr. WM. B. PHILLIPS, read by the author, and discussed by Mr. Seddon and Dr. Phillips.

(6) *On the Pig Iron Market; Its Extent and how to Improve it*, by JAMES BOWRON, read by Mr. Aldrich, in the absence of the author.

There being no other papers, Mr. Seddon moved that Dr. Phillips be requested to prepare for the next meeting, a paper upon the relative values of dolomite and calcite as furnace flux, especially as to their values for high sulphur cokes, and also as to their effects upon the silicon in the iron.

Mr. Aldrich next gave an account of his recent experience in prospecting for gold in the Arbacoochee district. In the course of his remarks, Mr. Aldrich stated as the result of his observations, that he was satisfied that there was, at several points in the gold region, a great abundance of low grade gold ores, carrying from $4 or $5 up, that could be worked with profit; and he expressed his opinion that we should, in the near future, witness the establishment of plants using modern processes in that section.

In continuation of the discussion of the affairs of the Society, Dr. Phillips brought up the subject of the collection of statistics of the mineral industries of the State by this Society, and the publication of these statistics monthly. It was thought that this would be a good thing for the Society, and also for those who are interested in keeping up with the progress of our industries; and, on the motion of Mr. Aldrich, Dr. Phillips, Mr. Seddon, and the Secretary were appointed a committee to examine into the feasibility of this proposition, and to report thereon at the next meeting. The idea being, that the statistics be collected by the Society, and printed each month for distribution among technical and other journals, and to all interested, and thus in time to make this Society the headquarters for accurate information on all these points. This was not considered to be any encroachment upon the territory of the State Inspector of Mines.

Dr. Phillips then gave some notes of his progress in the magnetic concentration of Red Mountain Ores, after which a vote of thanks was tendered to Mr. N. F. Thompson, the efficient Secretary of the Commercial Club, for his courtesy in placing the rooms of the Club at the disposal of the Society for the present meeting.

The meeting then adjourned.

EUGENE A. SMITH, Secretary.

UTILIZATION OF BY-PRODUCTS FROM COKE OVENS.

BY J. A. MONTGOMERY.

At the last meeting of this Society, three or four of its members—myself among the number—were appointed to prepare articles on the merits of the different By-Product or Retort ovens, now most prominent in this and foreign countries, and to me was assigned the discussion of the plan of oven invented by M. Carves and afterwards modified by M. Simon, and known as the Simon-Carves oven. The reason for this being that, several years since, whilst in England examining a coal washer, I had the opportunity of examining a battery of this kind of ovens in operation, and such description as I can now give is based upon memory and the meagre notes taken at the time as to this oven, and published information as to other kinds. No detailed description can be attempted, as I have been unable to get anything but the most general information from agents in this country, and have not had time to correspond with the patentees who live in England or in France.

All of the Retort or By-Product Ovens are the invention of foreigners; and I will state here that the Simon-Carves patents are claimed as the original ones, and that all others are deviations from these, and are not as successful. The truth of this assertion I am not in a position either to affirm or to deny; but that they are the most largely used in England, Scotland, France, and Spain, there is no question. If one judges success by the number of ovens used, however, the Otto-Hoffman oven leads, as there are in operation in Germany and Austria about twice as many of this oven as of all other retort ovens, and they have been very successful in treating coals that were not considered good coking coals prior to the adoption of retort ovens. It is to be hoped that the present agitation of the subject of By-Products from coke will put our American inventors to work to improve on the economy of working, simplifying of methods, and, last but most important, the reduction of cost of plant, as this high first cost is the most serious drawback to the introduction of these systems in this country, where, having such a wealth of material, obtained at a small cost, we are apt to think we can waste half our product and still compete with our neighbors. We have been doing this with some measure of success, but now it is beginning to be realized that we had best change our methods, and either find some way to utilize the waste gas from our Bee-Hive oven, or adopt one of the Retort ovens found to be best suited to our coals. Briefly, a By-Product Coke oven is a retort differing from ordinary gas retorts in the fact that care is taken to preserve and improve the coke instead of destroying it—the object being, first, to make good coke, and then to take care of and utilize the gas which otherwise would be wasted.

Very briefly, I will attempt to describe the general form of these ovens, and the method of recovery of By-Products. They are made in banks or batteries of from 25 to 35 each—two batteries, forming a plant, are rectangular in shape, built of stone or brick, lined with fire brick, and vary in length from 24 to 34 feet, in width from 18 to 26 inches, and in height from 4½ to 6½ feet, depending on the coal to be treated, and varying in charging capacity from 4½ to 6½ tons of crushed coal. Combustion and distillation are accomplished by burning the waste gas under the bottom and sides in horizontal flues or chambers, and carrying this heated product by means of flues in the sides of the oven around the coking chamber described above. Some of the patents have these flues arranged horizontally, others vertically, the idea being to give a uniform high heat to the bottom and sides as well as the top of the oven. The products of combustion of gas, after serving their purpose in making coke, are passed through flues running parallel to the air inlet in the Simon-Carves and Semel-Solvay patents, and into regenerators in the Otto-Hoffman oven,to heat the air coming in. As the combustion is caused by the cold gas by being ignited by the hot air, the amount of both gas and air is regulated various devices, giving accuracy as to quantity,and allowing of control as to the amount of heat evolved. The coal is charged in the top of the oven through two or three openings, according to length of oven—exactly as a Bee-Hive oven is charged by larries running on two or more tracks on top of the ovens. The coke is taken by a ram which runs on tracks in the rear of the batteries; this ram thrusting the whole contents at one time upon the yard, allowing of reclosing of doors and immediate re-charging. The coke is watered outside by a hose whilst in mass. This is an objection, as it causes a very high per centage of moisture in the coke, but I think some other method of watering would materially lessen, and probably a spray under complete control of the operator might reduce to a minimum the per centage of moisture. Watering outside also causes the coke to be dark in color, against which there is great prejudice on the part of furnace men; but it is claimed that the color of retort coke has nothing to do with its strength or density, and where used that the coke has given even better results than Bee-Hive coke. The gases are taken from the top of the oven, by a main of either brick or iron, to the exhaust house, where the tar and ammonia liquor are condensed by a cooling process, usually by running the pipes through water tanks, then passes through several scrubbers, the first ones taking any remaining ammoniacal liquor, and the next, by a washing process in oil, recovers the benzol and naptha. The gas is lastly treated with sulphuric acid, to take out any remaining ammonia, then is taken to the boilers for heating purposes, and to the oven by pipes, to be burned by the addition of hot air as mentioned before under the oven. The tar and ammonia liquor are first separated into different tanks—the tar being barrelled and sent to market, or is distilled on the place into the various products of the tarry oils, and into pitch. The ammonia liquor is treated with sulphuric acid and made into sulphate of ammonia. The oils from the scrubbers are pumped into tanks, and flow into stills where by steam they are made into benzol. There are other things that could be recovered, but as these three can be readily obtained without the use of a large chemical outfit, and are the main products of marketable value, they will be the only ones discussed in this paper.

It is claimed that a 60-oven plant will turn out from 300 to 325 tons of coke per day, at a cost of from 45 to 60 cents per ton of coke produced ; this includes the recovery of the three main products—tar, benzol, and sulphate of ammonia, but does not include interest on plant or office expenses. Such a plant is estimated to cost $150,000.

The commercial value of these by-products will next be considered. Some have a recognized demand now, and I will try and show how others can be used. Coal tar is first on the list and first in importance as to the various products derived from it. In itself, it is largely used for paving and road making, and by cheapening its production no doubt a much larger demand will be occasioned. Gravel roofing is another growing use—especially in the West and Northwest and a large trade could undoubtedly be worked up in this direction. A large proportion of the present output is used in paint, and should be more largely used as a preservative for metal exposed to the action of the atmosphere and underground ; the demand in this direction is increasing all the time. Also, I think that when the coal operator who has to waste his slack coal finds out that by mixing 7 to 15 per cent of pitch with this slack, and making the product into a briquette, he will have as good a steam producer as ordinary run of mines coal, a large, very large use will be made of it. These, with the other uses I will mention further on, will probably increase by 25 per cent, the price at which I estimate it can be disposed of. When retort ovens were first used in England, they found that the tarry oils in the form of benzol, aniline dyes, carbolic acid, and scores of other products successfully disposed of, there still remained from one-half to two-thirds of what they started with, with a very limited market for it. Coking the pitch was tried, by moulding and putting it into an oven in the form of a brick. This made a very pure refractory coke, but was very expensive. Then it was run hot into large ovens and coked; but all these and other methods of disposing of it were abandoned when it was found to be the best agglomerating agent available for mixing with fine coal in the formation of briquette or patent fuel. This trade wherever started seems to grow rapidly and has caused a constantly increasing demand for all the pitch that can be obtained, and at very reasonable prices. In the manufacture of briquettes, one plan successfully followed is as follows: The fine coal is first disintegrated and then fed into a tank heated by steam, with from 3 to 10 per cent of ground pitch, thoroughly mixed in a machine with adjustable knives working in a vertical shaft, then fed into a mould plate in measured quantity, subjected to pressure of about 4000 pounds to the square inch, and turned out in the shape of a brick with rounded edges, or any other convenient shape that the operator desires by changing the mould plate. In this way, a large amount of otherwise worthless slack coal could be made merchantable, as a most excellent fuel has been made from slack coal containing 25 to 35 per cent of ash by mixing with from 7 to 10 per cent of pitch. If our run-of-mine coal after disintregrating was mixed with a very small percentage of pitch, say from 2½ to 4 per cent, a very fine fuel for locomotive use or any other use where a quick constant fire is needed, would be obtained. One of the chief advantages of this kind of fuel is its adaptability to carriage and exposure without deterioration or loss in weight. Briquettes would revolutionize the export trade in Alabama coals if once inaugurated, there being no appreciable loss in weight, nor in the gases, even after exposure for long periods neither heat, moisture, nor cold seem to affect it seriously. These facts would be appreciated if you have ever watched the transformation that sometimes takes place in the soft coals of this district when exported; leaving the mines practically all lump, fresh looking, shining, veritable black diamonds. When loaded into vessels at the seaboard a considerable amount of slack is produced. When unloaded there is still more slack, and you are somewhat surprised at the loss in weight; but after being handled again into cars, and reaching its destination, you are not willing to acknowledge it as your coal—little or no lump, volatile matter gone, and coal of dull appearance—a loss in weight of from 7 to 10 per cent. The loss is not so great in harder coals, but we should export our best steam coals, which are soft.

Briquette fuel for retail has been very successfully tried, there being no appreciable loss in handling and on account of cleanliness and ease of firing are very popular when sold for domestic use.

Benzol is a large product, and it is feared that it could not be used to any great extent is the United States, as there are no aniline dye manufacturers in this country, and as a fuel it would be too expensive. I suppose if large quantities of benzol were made, that some one would start manufactories, as our cotton manufacturers import large quantities of these dyes for their prints; but there is a way to utilize this product, which would take all that can be made. A very small per centage of the whole in our ordinary gas contributes to its illuminating power, and all gas companies use what they call an "enricher"—cannel coal and petroleum oils are ordinarily used, but as from 70 to 75 per cent of the illuminating power of gas is ascribed to benzol, it seems to me that this is the most natural enricher our gas men could have. Benzol also takes out the napthaline in gas—something to its credit to start with. It has been stated by a very prominent gas engineer, that 1 per cent of benzol will increase 14-candle power gas to 22-candle power, and he recommends its use at even 60 cents per gallon. If gas contains other gases besides hydro carbons, its absorbing power for benzol is enlarged. Possibly our gas companies would use cheaper coal, decreasing the cost of their gas, and use larger quantities of benzol, give better light, and still manufacture their gas for less money.

Carbolic and cresylic acids are growing in popularity and use as disinfectants, and if cheapened in production, their use would be largely augmented.

Melinite, a powerful explosive, is also being largely manufactured, and will be more largely used in the future. It is a smokeless powder that is getting to be popular.

Creosote is growing in use every day, and if it were not so expensive no doubt every cross-tie and bridge timber on our railroads would be treated with it before use, as it is well recognized as a preservative of timber both in the ground and in water. Whenever a method of manufacture is found to cheapen this article so that it can be generally used, all that can be manufactured will find a ready sale. Also, creosote is one of the most economical fuels we have for steamships, and would be extensively used by them if they could rely on finding it at all ports of entry, a one pound of creosote will evaporate 13 pounds of water, at 100 pounds pressure; its compactness in carriage and requiring no firemen to burn it, will at once show its economy.

There are many other things that could be mentioned as of use in medicines, arts, and sciences, but I would weary you, and will now speak of the product that we have a certain market for, at our very door. Sulphate of ammonia is the most valuable at present of all the by-products. It is the most adaptable of all fertilizers, and the nitrogen contained in sulphate of ammonia is considered now much more valuable than nitrogen in nitrate of soda. The use of this product will grow each year, as our agricultural lands are worn out, and there is a steady demand for all that is made at 3 to 3½ cents per pound, or $60 to $75 per ton. A prominent engineer, vice president of one of the largest phosphate works in Georgia, tells me if we can reduce the cost of snlphate of ammonia to $55 per ton, that at least 25,000 tons per annum would be used in the State of Georgia alone in phosphate manufactories. As all the coal used in the making of coke in Alabama in 1892, the largest output we ever had—would only turn out 22,300 tons of sulphate, one can readily see that a constant market could be had at all times. In fact, there is room for all of this product that will ever be made, as the demand will increase largely every year.

About one-half of the gas made by these ovens is waste gas, and can be used for fuel, under boilers, in furnaces, and for domestic purposes; and by eliminating the sulphuretted hydrogen, and using a "carburetter," say benzol as above mentioned, a first class illuminating gas can be made, of light specific gravity. As a fuel gas, however, no preparation is required, and on account of its lightness, and its not being easily affected by change in temperature, it can be piped long distances. Natural gas is very irregular in pressure, and serious accidents have resulted therefrom. This would not be the case with coke oven gas, as the pressure would be uniform and the supply cauld be made constant, thereby promoting economy. As compared in heat value with natural gas, it is about 70 or 73 to 100. It could be economically used around blast furnaces, as it has 6 to 7 times the heating capacity of furnace waste gas; and is from three to five times higher in heating value than average producer gas. There are other points in its favor, but these are sufficient to show that its extended use is only a question of availability as to a market.

As a matter of curiosity, and to give an idea of the amount of material wasted in Alabama by the use of the bee-hive oven, I submit the following calculations, taking the year when almost all the coke ovens in the State were running. From the actual experience of the Birmingham Gas Company, we can safely count on 8000 cubic feet of gas, about 8 gallons of tar, 20 to 24 pounds of sulphate of ammonia, and two gallons ofbenz ol per ton of coal carbonized.

In the year 1892, the product of the coke ovens of Alabama was about 1,500,000 tons, sold at $2.30—$3,450,000; consuming about 2,500,000 tons of coal. If this coal had been coked in retort ovens , the product would have been something like the following:

2,000,000 tons of coke, - -	@2.30,	$4,600,000
500,000 barrels coal tar, - -	1.50,	750,000
20,000 tons sulphate ammonia, -	50,00,	1,200,000
4,000,000 gallons benzol, - -	15cts,	600.000
Total product,		$7,150,000

wth an additional 8,000,000,000 cubic feet of gas to be utilized. To do this, however, would require an expenditure of something like $4,500,000 for new ovens, and the abandonment of the present ovens, which have cost us about $1,600,000, or a total investment of about $6,100,000. As you will see, in this State alone, about $3,700,000 went up in smoke.

If a good retort oven could be made, utilizing our present bee hive oven, at a cost of $300 to $350 per per oven, or an expenditure in the district of $1,600,000 or $2,000,000, and I think this can de done, it might be something within reach of our operators. I commend this to our inventive associates,who have done well in other lines. The use of the waste gas for fuel under boilers is a step in the right direction; but why not save at least the eoal tar and sulphate of ammonia.

If all the coal used for making coke in the United States for the year 1892 had been coked in retort ovens, the comparison would stand about as follows:

Bee hive ovens in 1892, with 18,800,000 tons of coal produced 12,010,000 tons of coke, sold at an average of $2 per ton, or $24,020,000.

Estimates of cost of retort ovens to produce same amount of coke now produced by bee hive ovens in Alabama and the United States include cost of by-product plants

If the same amount of coal had been coked in retort ovens, the result would have been about as follows:

15,000,000 tons of coke, @$2.00, - -	$30,000,000
3,340,000 barrels coal tar, @$1.50, - -	5,010,000
175,000 tons sulphate of ammonia, @$50.00,	8,750,000
28,200,000 gallons benzol, @15c, - -	4,230,000
	$47,990,000

plus about fifty-seven thousand million cubic feet of waste gas for fuel or waste. The cost of our present ovens in the United States is about $14,000,000; to replace these with retort ovens would cost something like $45,000,000, or a total of $59,000,000. As you will see, about $24,000,000 was wasted in the United States in 1892, not considering the value of the waste gas. If this gas could be used for illuminating and fuel purposes, a further saving could be made. Since in the United States and Canada there are now used about forty-seven thous and million cubic feet of gas yearly, this waste gas amounts to 21 per cent more than is now used. The waste gas can be yiped for long distances, under steady and constant pressure, and no doubt would be remunerative.

My principal object in submitting this paper is to interest others in the determination of some plan of utilizing the bee hive oven (something we now have, and which has cost a great deal of money) for recovery of these by-products. It is absolutely necesfary to have the coke pulled quickly, and to stop our present plan of watering inside the oven. With this eliminated, I think a good retort oven could be made out of this class of oven, and I hope this will be taken up vigorously and some conclusion arrived at. If our competitors use the new style of oven, we wil be compelled to do something to keep up with them, and the most economical way would be to improve what we have.

MOBILE POINT, ALABAMA,

WILL BE THE DEEP WATER HARBOR OF THE GULF OF MEXICO.

BY G. D. FITZHUGH.

The traffic on the Gulf of Mexico is something enormous from all parts of the world, and was foreseen by Commodore Maury, of the United States Navy, when he stated in his book entitled "The Physical Geography of the Sea," that the "Gulf of Mexico would be the great thoroughfare for navigation from all parts of the world and the center of commerce."

To facilitate this commerce, it will be necessary to open up to the world some safe and cheap deep water harbor near the central coast of the Gulf States.

Nature has already laid out this Deep Water Harbor of Safety and Cheapness immediately east of the main entrance to Mobile Bay, and in a "stone's throw" of Mobile Point, behind which the beautiful harbor of Navy Cove is situated.

Any one can readily see the great advantage this harbor will be to the great steamers and ships of the commercial world plying the waters of the Gulf of Mexico. The numerous railroads already built and being constructed, besides the many being projected, will come to this terminal point on the Gulf of Mexico when properly brought to the attention of the millions of people now bartering with each other. Besides, it will be the true terminal point for all railroads coming south through the United States to export coal, lumber, iron and merchandise of every description, as well as the seaport for all incoming steamers with their immense cargoes of goods, fruits, and materials of import. The enormous tonnage of coal for all incoming and outgoing steamers will be taken as fuel from this cheap deep water harbor; besides the export coal for all seaports in the West Indies, Mexico, Central and South America, will be loaded at this harbor.

Mobile Point, at Fort Morgan, is situated at the entrance of Mobile Bay, immediately to the east of the great ship canal leading into the Bay. It is thirty-five miles south of the City of Mobile.

The length of the peninsula lying east and west from Fort Morgan to Bay John, an inlet from Mobile Bay, is eighteen miles; about four miles of the eastern part from Fort Morgan to Navy Cove will average three-fourths of a mile wide at high tide.

This part of the peninsula is made up of two parallel ridges capped with white sand of variable depths, while the bottoms are formed of dark bluish clay. The distance between the ridges is about five hundred feet. The northern ridge, or Bay Front as it is termed, is nearly fifteen feet above sea level; whilst the southern ridge, next to the Gulf beach, is nearly thirty feet above sea level. The northern ridge is quite of an even elevation, and without unevenness in alignment extending to high tide in Mobile Bay, presenting most beautiful sites for buildings of any description.

The southern ridge maintains its height very uniformly above sea level. It overlooks Bay Ridge, and most generally is of an even line with the Gulf beach, which is near one mile in width from the foot of the ridge to high tide.

No part of the ridges forming this neck of land has ever been known to be inundated by the Gulf storms that devastate the Gulf coast from Pensacola to New Orleans, as was proven during October, 1893—the date of one of the most terrible storms visiting the Gulf coast.

Between the two parallel ridges are sloughs or ponds of water, not exceeding twelve inches in depth. The ponds are what are known as "wet weather ponds," and can be easily drained and filled in by material from the adjoining ridges.

The bottom of the ponds are dark bluish clay, hard and firm "to the tread," and not miry.

It is noticeable these ponds drain into Mobile Bay, never into the Gulf.

At the Station Navy Cove, about four miles from Fort Morgan, is quite a neat little village of eight or more cottages built not more than one hundred feet from the bay shore. This village is marked on the map as "Pilot Town," as the cottages are owned and occupied mostly by pilots for ships and steamers entering and leaving Mobile Bay.

That part of the peninsula extending east from Navy Cove for four miles has an average width of three and a half miles. It is made up of a series of parallel ridges not unlike the ridges west of Navy Cove, excepting, however, that no ponds of water or low wet places exist between the ridges save the inlets from St. Andrews' Bay just at Navy Cove and along the bay shore to Three Rivers Inlet. The make-up of this part of the peninsula can be termed a gentle undulating ridge capped with the sea sands.

The Bay beach varies in the direction from the line of beach west of Navy Cove, it that a prominent point is formed northwest into the bay, known as Little Clear Point—a commanding and desirable eminence.

The Gulf Beach is in line with the beach west of Navy Cove. Extending eastward ten and a half miles, the topography of the region shows a more level field of land, with an average width of one and a half miles. The Bay Front presents an uneven line, cut into by three inlets from Bon Secour Bay—the local name for this part of Mobile Bay. The elevated front to the Bay is from ten to twenty feet above high tide. Along Seymour's Bluff on the Bay Front, numerous orange groves and truck farms are located for three or more miles.

There is no necessity for engineers, however skilled and distinguished, to suggest plans for a harbor from Fort Morgan to Navy Cove in Mobile Bay. Nature has already planned and laid out this, the only safe deep water harbor along the

Gulf coast. The peninsula itself is a natural sea wall and protection against the Gulf storms.

No dredging will be necessary to bring deep water to the wharves, nor will it be necessary to build expensive break-waters and other defenses against the storm wave. The main ship channel here shows from thirty-three feet to fifty-six feet of water, as given on the maps of the United States Engineers, and passes immediately under Fort Morgan. The timber fleet rest easy at anchor immediately above Fort Morgan in water from twenty-one to thirty-six feet deep.

The outer bar showa a depth of twenty-three feet of water, while on either side of the bar the depth of water is more than forty feet. As this, the outer bar, just below Sand Island, is so very narrow, it has been suggested that it was a coral reef, or some ledge against which the sands drift and lodge, and could be removed by blasting, thereby never requiring any cost in the future.

Just east of Fort Morgan, coal chutes can be built to forty feet of water at a very short distance from shore. The railroad cars can be brought to the water's edge along the river front and connected, with but little cost, to the elevated coal chutes and wharves so as to offer every facility for unloading.

The marine commerce of the world looks for a great coaling station to be established at the entrance of Mobile Bay, as steamers passing could take coal with little delay and at small cost; and for these reasons no harbor on the Gulf coast of the United States is better adapted for a coaling station than the harbor from Fort Morgan to Navy Cove. It will be a harbor to be recognized as of national importance, as the largest steamers of the United States Navy could come to safety and take coal and other supplies at the least cost.

As to the plans for building, wharves and coal-chutes are so varied that this should be left as detail work after the location of railroads to Mobile Point. Suffice it to say, the cost of building coal-chutes and wharves will not be the expensive construction of such work as has been laid out at other points along the Gulf coast for similar purposes.

Several railroads have been projected on maps and otherwise, to connect this deep water harbor with the railroads coming south towards Mobile and the Gulf of Mexico. The suggestion to build a belt line of railroad to connect all the railroads coming to Mobile with the deep water harbor, is a most excellent idea, but the cost to operate this belt road, and the additional freight charges to be added to the charges by the railroad companies, would be but a little less, if any, than the charges now being made for tonnage, pilotage and towage from Mobile to the Gulf. That to be considered most in constructing a railroad will be to secure cheap transportation. The most feasible plan, and least expensive, would be to invite the attention of all railroad companies operating trunk lines already built and to be built towards Mobile to form a combination to build and operate such lines of railroad to Mobile Point as would be adequate to the traffic, as in this the railroad companies would make but little difference, if any, in rates of through freight to Mobile and to the Deep Water Harbor.

ALABAMA BARITE, OR HEAVY-SPAR.

BY HENRY MCCALLEY.

Barite, or Heavy-Spar, the native Sulphate of Barium, is easily recognized by its heavy weight, its specific gravity being about 4.5, and by its insolubility in acids. It varies in color from white to black, though it is most commonly a white, grayish, or bluish mineral. It is soft enough to be scratched with a knife, though it is brittle. It is most commonly a dense compact massive mineral, that is sometimes granular like a white marble and sometimes earthy. It is a common mineral, or is widely distributed over the earth's surface, though it may not occur in many places in workable quantities, It has been mined in this country only in Missouri, Virginia, North Carolina, New Jersey, and Illinois. It is most often found in nodules and boulders imbedded in a clay overlying limestones and dolomites, and as loose "*float*" over the surface. Its lumps are often much colored on the outside, but on a fresh surface they show the characteristic colors of the mineral. It occurs also in regular beds or in pockets or veins. It is commonly associated with other mineral substances, especially galena, as a gangue, etc.

This mineral is found in Alabama, in a number of places in Calhoun, Etowah, St. Clair, and Bibb counties. It doubtless occurs in many other places in these counties and in other counties of the State. Some of the known deposits of Calhoun, St. Clair, and Bibb counties appear to be in workable quantities, as the deposit on Mr. A. L. Tullis' land near Tampa, on the East and West Railroad, Calhoun county; a deposit just west of Greensport, St. Clair county; and deposits in Bibb county, near the Macguire Shoals, on the Little Cahaba River, and the "Sinks" on Six Mile Creek. The first named of these deposits is the only one that has ever been tested. Its ore is in loose nodules and small boulders in a deep red loam that overlies limestones and dolomites. It shows for a distance of some 200 yards, and down to the bedded rocks, a depth of some 20 feet. It appears to be for the most part of good quality. It is of the characteristic white, grayish, and bluish colors, though some little of it is stained a dark color. It has some spots of galena.

The deposit near Greensport, St. Clair county, shows as ledges in an east and west belt 8 to 10 feet broad. Those of Bibb county are said to be in veins. Most of the other known deposits of the State show up as "*float*," or as loose nodules and boulders scattered over the surface, principally along with loose chert. Many of them are associated with more or less limonite. The Tampa deposit has in it a bed of good kaolin about 10 feet thick.

The Alabama deposits, so far as known, are confined to the Lower Silurian formation. The principal ones are along the dividing line between the Siliceous (Knox) Dolomite and Cherts and the Pelham or Trenton Limestones, though many of the lesser deposits are far within the boundary of the former group, and it may be that there are pockets ond veins well within the latter of these groups. Pockets and veins, in the underlying bedded strata, have doubtless furnished the loose nodules and boulders now imbedded in the overlying residual clays, etc. These loose nodules and boulders would, of course, have to be mined by open pits, while the ore in pockets and veins in the bedded rocks would doubtless have to be gotten, for the most part, by underground mining.

This mineral is put upon the market only as a fine ground powder. It is sometimes prepared for the market by simply crushing and grinding the carefully washed and assorted fragments. More commonly, however, the crushed ore is boiled with dilute sulphuric acid and then, to get rid of the acid, with pure water. It is next ground, and then sorted by "floating" in water, as it is called. The coarser powder settles quickly, while the very finest, the most valuable, remains longest in suspension. It is finally dried by steam, barreled and shipped. The most common and objectionable impurities are siliceous matter and iron stains. The former gives a gritty feeling to the powder and the latter injures its white color.

Pure barite has 65.7% of barium and 34.3% of sulphuric anhydride. In the native state, however, the barium is commonly replaced by more or less strontium and calcium, and the mineral has usually some impurities of silica, clay, and bituminous matter. Of the mineral that has been mined in this country, that of Missouri and Virginia is said to be not only in much the largest quantities, but also much the purest; that of Missouri being the best. The Missouri ores have the following analyses, as given in the Geological Survey Report of that State, Vol. VII :—

Locality.	Bar. Sulph	Strontium Sulph	Calcium Sulph	Am'n Sulph	Silica.	Ferric Oxide	Water	Total.
(1) Jefferson Co.	98.194	0.500	Trace.		0.898	0.190	0.454	100.222
(2) Jefferson Co.	96.791	1.436	0.325		1.200	0.191	0.148	100.091
(3) Pettis Co.	87.200	10.900	0.200	0.2		2.400		100.900

We have no analyses of the Alabama ores, though, as a whole, they appear to be quite pure. The German ores are said to best, or the softest and most easily worked of the foreign ores.

The production in this country is very variable. This is because the principal mines are in Missouri where the principal miners are farmers who dig the ore only at odd times and as extra jobs. The production in the United States between the years 1890 and 1894 inclusive, varied from (the following statistics of production and imports are from The Mineral Industry, Vol. III.) 21,911 short tons in 1890, valued at $86,505 at $3.95 per ton, to 28,476 short tons in 1892, valued at $142,-

380, at $5.00 per ton. The production for last year was only 23,958 short tons, valued at $95,032, at $4.00 per ton.

The imports between the years 1890 and 1894, inclusive, varied from 6,362 short tons in 1890, valued at $29,586, at $4.65 per ton, to only 2,720 short tons in 1894, valued at $15,-826, at $5.80 per ton.

The decrease for last year, in both the production in this country and in the imports, is said to be due to the general depression in business. The production reached its maximum figures during the civil and Franco-Prussian wars, because of the demand for and high price of lead.

The principal markets in this country are St. Louis, Mo., and Lynchburg, Va., for our ores, and New Haven. Conn., for the imported ores. The price fluctuates about as much as the production. It varies very much with the different makers and with the various grades of the same maker. The lowest grade is usually sold at about one-half the price of the best grade of any maker. The best grade is now worth from $18 to $20 per short ton, and the crude material about $6 per short ton. It does not take much of a pile to make a ton, as it weighs more than one-half as much as metallic iron.

It ranks next to white lead as a white pigment. Its principal use is, therefore, as a paint, as an admixture with white lead, which it resembles in color and weight. This is a tempting use for it, as it greatly lessens the cost of the paint, being worth not over one cent per pound, while white lead is worth from six to seven cents per pound, and adds but little to the weight. In Europe, it is held as a valuable addition to white lead as a paint, though in this country the mixture is still looked upon with disfavor. The highest authorities say that an addition of 35% to 50% barite to white lead for paint is to be desired, as it detracts nothing from the quality and body or covering properties, while it adds to the permanency of the paint, in that it is not effected by agencies that discolor and destroy pure white lead. The only tenable objection to this use of it, therefore, is that the purchaser pays for one thing and gets another, though some still hold that it injures the body and flowing properties of the white lead. It is used as an adulteration to give weight in other things in which there is no disputing its non-beneficial effects. It also has some other legitimate and good uses, as in the manufacture of paper and of canvas for the covering of the products of the pork packer. In the former case, it serves as a makeweight, and in the latter to stop the meshes of the canvas to keep out insects.

THE PIG-IRON MARKET.

ITS EXTENT AND HOW TO IMPROVE IT.

BY JAMES BOWRON.

I have been requested to prepare a paper for the next meeting of this Society on the subject of "the pig-iron market; its extent, and how to improve it."

The extent of the market for Southern Pig Iron is very remarkable. According to the statistics published by Mr. Swank, of the American Iron and Steel Association, there were produced in 1894 6,657,388 gross tons of pig iron, of which 120,180 tons were spiegeleisen and ferro maganese, leaving 6,537,208 tons to represent all the iron produced in the United States for melting or puddling. There were also produced in the same year 4,412,032 gross tons of steel of various kinds. The production of this steel would require more than a corresponding number of tons of iron, so as to allow for the waste incident to any method of conversion; but, as this is a commercial and not a scientific paper, I am content to offset the above mentioned tonnage of spiegeleisen and ferro against the waste incurred in conversion, and simply to deduct the 4,412,032 tons of steel from the available tonnage of iron, which leaves 2,125,176 tons available for foundry and forge purposes. This may be considered to represent the American market during the restricted and unusual year of 1894, for the importations of foreign pig iron were only 15,582 tons, consisting mainly of Seotch, but including some Swedish pig iron.

The production in Alabama in 1894 was 592,392 tons, and in Tennessee 212,773 tons, being 805,165 altogether. This production represents for Alabama 27.8% of the entire consumption of the United States of pig iron apart from that used in the manufacture of steel; and for Tennessee a similar production of 10% ; being for the two States an aggregate of 37.8%.

Without entering into any labored comparisons with other States or districts, this per centage is quite sufficient to show the commanding position taken by these districts in the general foundry and rolling mill trade. This is emphasised by the wide area over which the iron is distributed. I give at this point the two following tables, showing the distribution of iron by the Tennessee Coal, Iron and Railroad Company, for the calendar year 1888, and for the twelve months ending July 1, 1895:

1888.		1895.	
Ohio,	65,561	Ohio,	136,487
Missouri,	23,733	Alabama,	89,054
New York,	22,495	Kentucky,	48,376
Kentucky,	19,808	New York,	44,690
Michigan,	16,582	Illinois,	38,736
Illinois,	16,193	New Jersey,	31,965
Alabama,	15,790	Tennessee,	30,368
Tennessee,	13,184	Missouri,	29,851
Indiana,	9,599	Michigan,	28,170
Pennsylvania,	6,777	Indiana,	28,047
Massachusetts,	3,929	Pennsylvania,	27,215
Iowa,	2,300	Wisconsin,	9,038
New Jersey,	1,820	Maryland,	4,748
Connecticut,	1,505	Massachusetts,	4,456
Colorado,	1,200	Iowa,	2,251
Rhode Island,	818	Connecticut,	1,950
Wisconsin,	818	Maine,	1,925
Louisiana,	588	Georgia,	1,910
West Virginia,	387	Texas,	1,605
Kansas,	383	North Carolina,	1,102
Maryland,	268	Kansas,	1,034
Nebraska,	234	California,	842

Texas,	221
Mississippi,	155
California,	150
Arkansas,	122
Minnesota,	70
Delaware,	36
Georgia,	18
North Carolina,	15
Total,	224,634

Vermont,	800
Oregon,	685
Rhode Island,	645
Louisiana,	635
Minnesota,	612
Virginia,	580
Mississippi,	560
Delaware,	360
Arkansas,	308
New Hampshire,	295
District of Columbia,	293
Nebraska,	276
Colorado,	158
Florida,	60
South Carolina,	57
Washington,	50
West Virginia,	18
FOREIGN.	
Canada,	2,034
Mexico,	357
England,	250
Nova Scotia,	40
Italy,	17
Total,	572,910

An examination of these tables shows the following interesting points :

1st. That the number ot States consuming these brands of Southern iron increased in six years from 30 to 39, besides the addition in the last mentioned table of five foreign countries.

2nd. That the home consumption had so far increased that Alabama moved up from 7th in progressive importance to 2nd, and Tennessee from 8th to 7th. This is a point of supreme importance, for notwithstanding the fact that Birmingham iron ranges from Mexico to Canada and from San Francisco to

Liverpool, it is obvious that distant markets can only be controlled by the sacrifice of profits, and that it is the development of the home market, that can be reached without the payment of intervening freight charges, that we must look to for our profitable business.

Obviously, therefore, everything that producers of pig-iron in this district can do, should be done to advance the interests of the rolling mills, pipe works, machine foundries, etc., which are located beside us. We should advertise their products, give them our own patronage, become personally familiar with the character of their business, quality of the iron they use, their methods of treatment, the stocks that they carry, and study to deliver to them the quantity and quality of iron that will best subserve their necessities.

There are three ways in which the market for Alabama iron may be enlarged; namely, the development of (a) the home market; (b) the domestic; (c) the foreign.

a. For the enlargement of the home market, it is necessary for us to bring continually under the notice of manufacturers in other parts of the country the advantages which our cheap iron and coal, our mild climate, and reliable labor afford. This is doubtless done at present, with perfect loyalty to the district, by the gentlemen who are interested in it, but necessarily in a manner which is more or less desultory; and if we had a well organised iron trade association the work might be done continuously and systematically. Many of the largest consumers of our product have never been in the South, and their attention has not been personally directed to the consideration of the removal of their existing plants or the establishment of new ones. A thoroughly intelligent and competent representative of the district might be sent to call upon and make a presentation of our case to such consumers at a distance as might be selected by the trade association. Facts and figures in the same direction should be submitted in every case where a northern consumer of our iron is burned out and compelled to rebuild. It is needless to say that the chief direction in which our efforts should be united, is to impress upon the producers of basic open hearth steel the advantage to accrue to them from the consumption of our metal at the point of production, where, if desired, it ean be furnished hot. With the establishment of such a plant, works for the production of boiler plates, sheets for tinning, bars, structural and bridge work, wire rods, and railroad material will very readily follow.

b. For the enlargement of the domestic market, the most desirable thing to be done, in my judgment, is to secure uniformity in grading and naming iron, and selling it upon terms of uniformity. It is very unsatisfactory to the consumer in Canada or Minnesota to buy a car load of forge iron for foundry purposes, and next month to buy from another producer a car load of 2 soft and find that it contains less silicon and is less fluid. It is scarcely too much to say that the whole question of grading iron is assuming a more complex condition, and that if it is not in a somewhat chaotic state, the minds of some of the graders have attained that undesirable goal! Harassed by the pressure of evil times and the desire of consumers for something cheaper, the effort has been continually made not to split hairs but to split grades in a corresponding degree of fineness. This leads to an absence of physical or chemical lines of demarcation, and makes the question of grading depend more than ever on the individual opinions of the buyer and consumer, who naturally look at it from different standpoints and arrive at different results. This leads to considerable friction, and in the long run Southern iron gets a bad name. With the organization, as before suggested, of a strong local trade association, the names of the grades could be definitely agreed upon, and arrangements made for at least monthly or bi-monthly interchange of visits from one works to another, so that the members might agree on the maintenance of a common standard, and correct discrepancies and divergencies from it.

c. The question of developing a foreign market is one which will at some future day be one of very great interest. When prices of Birmingham iron were at the lowest notch, on April

1, 1895, it was then possible to put iron for export f. o. b. ship at tide water in Pensacola or Mobile harbor, $2.00 per ton below the corresponding value of the cheapest English iron, and it was found practicable to lay down iron in Liverpool grade for grade at less than the price of Middlesbro iron shipped across England to that point. The facts also developed that at those figures we have for Alabama iron an exceedingly good chance for competition in all Mediterranean ports, very large quantities of iron being shipped from England to Barcelona, Genoa, Civita Vecchia, and other Italian ports. This iron may be shipped in conjunction with steam coal or foundry coke. It would be an experiment of somewhat doubtful outcome as to whether the coke might by the rolling of the vessel in an Atlantic voyage be unreasonably broken up in comparison with the shorter voyage sustained by the English coke; but, if not, there is room for the shipment of Alabama coal and coke in competition with English into Mediterranean ports, although it is fair to say that there has not yet been a profit demonstrable in that business. The main difficulty, however, in the development of a European market for our iron is and will be the commanding of marine tonnage; and any other business that could be grouped with pig-iron such as the exportation to Spain or Italy of coal and coke, or either to Genoa, Bremen, or Havre of cotton will materially facilitate the solution of the difficulty. Whenever our prices for iron fall again to bring them below the parity of English figures, we should commence to work upon ship-brokers, and get in touch with both regular established lines of steamers and also "tramp" steamers and sailing ships. The same remarks apply with as great force to the less important markets of Bombay. Calcutta, Melbourne, Yokohama, and others. These markets are dominated, both in pig-iron in iron pipe, in coal and in coke, by the English, because of the present exchange of commodities, which has settled steamers and sailing ships in certain marine lanes of travel, from which it will require patience and perseverance on our part to divert them.

VALUE OF RAW MATERIALS IN IRON MAKING.

BY WM. B. PHILLIPS, BIRMINGHAM, ALA.

The quality of the materials used is the most important consideration affecting the production and sale of pig iron. This is a general truth and does not depend upon any local circumstance. It is as true for one part of the country as for another, for Bessemer metal as for foundry, or mill, iron, or basic open hearth stock. The time has long since gone by when the iron maker could afford to put almost anything into the furnace and trust to Providence to get something saleable out. The entire history of the iron trade for the last thirty years proves that the greatest change that has come over it is the dependence placed on the accurate analysis of the materials to be used in the furnace. So much is this the case, that one may say now that a very large proportion of the raw materials consumed is bought on analysis, and the remaining portion is subjected to very close inspection.

It is the exception now to find a furnace without a chemist whose business it is not only to analyze the products but the materials as well, and to advise as to the best disposition to be made of the various ores, fuels, and fluxes.

It is an inevitable tendency of the trade, and cannot be neutralized by the refusal of some old fogy to adapt himself to the change. The attention paid to the quality of the raw materials for the blast furnace has grown in this district within recent years to very considerable dimensions. We are to-day buying and selling on analysis to an extent which even two years ago would have been considered highly improbable, and there is no indication that the practice will abate. On the contrary, there is good reason to think that the tendency will be more and more towards the unit basis for ores and fuels and fluxes, and the maximum basis for pig iron. Thinking that perhaps some general observations on the principles governing the purchase of raw materials might be of interest to the Society, I have endeavored to present the matter in as simple and at the same time as accurate a manner as possible under the conditions that confront us here.

In order to bring the matter at once to the front, we must assume the truth of some data, to discuss which would consume more time than we have at our disposal. We will start with an ore containing 40 per cent of iron, 35 per cent of silica and alumina (reckoning the small amount of alumina as silica, in actual practice the silica is to the alumina as 1 to 0.87), and 0.50 per cent of lime. We will assume that for each increase of 1 per cent of iron above 40, the silica falls 1.50 per cent, so that for an ore of 45 per cent iron the silica will be 27.50 per cent, and for 50 per cent of iron the silica will be 20 per cent.

The lime remains constant. The following table exhibits the rise of the iron and the fall of the silica plus the alumina.

Iron.	*Silica plus Alumina.*
40	35 00
41	33.50
42	32.00
43	30.50
44	29.00
45	27.50
46	26.00
47	24.50
48	23.00
49	21.50
50	20.00
51	18.50
52	17.00
53	15.50
54	14.00

55	12.50
56	11.00
57	9.50
58	8.00
59	6.50
60	5.00

While this ratio between the iron and the silica plus the alumina is not absolutely correct, it is near enough for the present purpose. In a great number of cases examined, it is a very close approximation and may be used in the calculation of furnace burdens.

It is a general rule for the soft ores of the district, that as the iron gains 1 per cent the silica plus the alumina falls 1.50 per cent so that starting with iron 40 and silica plus alumina 35, we can arrive at the composition of any ore carrying from 40 to 60 per cent of iron merely by remembering the rule and also that it is meant to apply to soft red ore. The more simple we can make the rule for calculating burdens the better for all concerned. Further, and as regards the coke. We will assume that it carries 10 per cent of ash, and that the ash contains 80 per cent of silica plus alumina, and 10 per cent of lime, the remaining 10 per cent being exide of iron and alkalies. We will also assume that of this coke there will be required for a 40 per cent ore 1.50 tons or 3,000 pounds for each ton of iron of 2,240 pounds. This is equivalent to saying that for each pound of iron there will be required 1.34 pounds of coke, and this is just the amount which was used in the production of more than 47,000 tons of iron, the returns from the manufacture of which were especially examined. This does not mean that it always requires 1.34 pounds of coke to make a pound of iron, for, in fact, a pound of iron has often been made here with a trifle over 1.07 pounds of coke; but it is thought that with an ore carrying 40 per cent of iron and 35 per cent of silica plus alumina, the consumption of coke per ton of iron would not be far from 1.50 tons. For our present purpose, we have taken it at this amount, basing our opinion on a long course of observations on different ores and the results of different methods of running a blast furnace.

So much for the ore and the coke. Now for the stone. The amount of limestone required to make a ton of iron varies not only with the nature of the ore and the coke, but also with the quality of the stone itself. For instance, it will require much less stone per ton of iron when the stone carries 2 per cent of silica than when it carries 4 per cent; but, as the stone under consideration for this purpose carries 4 per cent of silica, the calculations are based on this amount.

We have, then, an ore carrying 40 per cent of iron, 35 per cent of silica plus alumina, and 0.50 per cent of lime; the coke carries 10 per cent of ash, and the ash contains 80 per cent of silica plus alumina and 10 per cent of lime; the stone carries 4 per cent of silica and 53 per cent of lime. Are there any other factors that must be considered in calculating the burden? Certainly. We have to fix upon the amount of silica to be carried in the slag. This we will take at 35 per cent, and for this type of slag we will allow that one of silica is saturated by one of lime; or, in othre words, that it will take 1 per cent of lime to flux 1 per cent of silica. This being the case, we have in our stone only 49 per cent of available lime instead of 53 per cent, for the 4 per cent of silica in the stone will require 4 per cent of lime to flux it and 53—4=49.

We are now in position to calculate the amount of ore, coke and stone for a ton of iron. I have done this for each per cent of iron from 40 to 50 per cent, the silica plus alumina falling from 35 per cent to 20 per cent. The results are as follows:

Iron, - - -	40
Silica plus alumina, -	35
2.50 tons of ore at 60 cents, - -	$1.50
1.50 tons (3000 pounds) coke at $1.75,	2.62
1.97 tons of stone at 60 cents, - -	1.18
	$5.30

Iron, - - -	41
Silica plus alumina, -	33.50

2.4 tons of ore at 60 cents, - - -.	$1.46
1.47 tons (2950) pounds) coke at $1.75,	2.57
1.85 tons stone at 60 cents, - - -	1.11
	$5.14

Iron, - - -	42
Silica plus alumina,	32

2.38 tons of ore at 60 cents, - -	$1.42
1.45 tons (2900 pounds) coke at $1.75, -	2.53
1,77 tons stone at 60 cents, - - -	1.06
	$5.01

Iron, - - -	43
Silica plus alumina,	30.50

2.33 tons of ore at 60 cents, - -	$1.39
1.42 tons (2850 pounds) coke at $1.75, -	2.45
1.63 tons stone at 60 cents, - - -	0.97
	$4.84

Iron. - - -	44
Silica plus alumina, -	29

2.28 tons ore at 60 cents, - - -	$1.36
1.40 tons (2800 pounds) coke at $1.75 -	2.45
1.52 tons stone at 60 cents, - - -	0.91
	$4.72

Iron, - - -	45
Silica plus alumina, -	27.50

2.22 tons ore at 60 cents, - - -	$1.33
1.37 tons (2750 pounds) coke at $1.75, -	2.39
1.42 tons stone at 60 cents, - - -	0.85
	$4.57

Iron, - - -	46
Silica plus alumina, -	26

2.17 tons ore at 60 cents, - - -	$1.30
1.35 tons (2700 pounds) coke at $1.75, -	2.37
1.32 tons stone at 60 cents, - - -	0.79
	$4.46

Iron, - - -	47
Silica plus alumina, -	24.50

2.13 tons ore at 60 cents, - - -	$1.27
1.32 tons (2650 pounds) coke at $1.75, -	2.31

1.23 tons stone at 60 cents, - - -		0.73
		$4.31
Iron, - - -	48	
Silica plus alumina, -	23	
2.08 tons ore at 60 cents, - - -		$1.24
1.30 tons (2600 pounds) coke at $1.75, -		2.27
1.18 tons stone at 60 cents, - - -		0.68
		$4.19
Iron, - - -	49	
Silica plus alumina, -	21.50	
2.04 tons ore at 60 cents, - - -		$1.22
1.27 tons (2550 pounds) coke at $1.75, -		2.22
1.06 tons coal at 60 cents, - - -		0.63
		$4.07
Iron, - - -	50	
Silica plus alumina, -	20	
2.00 tons ore at 60 cents, - - -		$1.20
1.25 tons (2500 pounds) coke at $1.75, -		2.18
0.98 tons stone at 60 cents, - - -		0.50
		$3.96

According to the values here taken for the raw materials, a pound of coke is worth $0.00089, a pound of ore $0.00027, and a pound of stone $0.00027. Comparing the cost af making iron, so far as concerns the raw materials, with a 40 per cent ore and a 50 per cent ore, we find a saving in the use of the latter of $1.34 made up as follows:

500 pounds of coke, - - -	43 cents.
1,120 pounds of ore, - - - -	31 cents.
2,240 pounds of stone. - - -	69 cents.
	$1.34

These results indicate that for each per cent of iron above 40 per cent, there is a saving of fifty pounds of coke, worth 4.3 cents, 112 pounds of ore worth 3.1 cents, and 224 pounds of stone worth 6 cents, or a total saving of 13.40 cents. Is this really the case? Is there so great a saving per unit of iron in the ore?

We must all agree that there must be some saving, er else there is no reason at all for securing better ores and we might as well use one ore as another. If there is no economy in demanding that those who provide the ore shall see to it that it is as good as can be expected, why should the furnace men desire better ores? That there is a real economy in using good materials in the furnace is an axiom which admits of no dispute, and the sole question is as to the extent of the economy. Some might be disposed to doubt that the economy is as great as 13.4 cents per unit of iron, but all must acknowledge that the saving is capable of being expressed in this way, and whether the amount is 13 or 10 or 8 or even 5 cents, the saving certainly exists.

A considerable claim for the improvement in iron making here has been made within the last two years, and we are now disposed to insist that the practice is much better than it was in 1893. This is true, and I do not think that any single circumstance has contributed more to this desirable result than the attention that has been paid to the improvement in the raw materials. We have better ore, better coke and better stone, and the methods adopted for the utilization of these things are themselves better than two years ago. But admirable as have been the advances there is room for still further advances. The inspection of the stock is much closer than it was in 1893, but it does not yet go far enough. A considerable amount of material is bought on analysis, bnt there is no reason why all the materials used should not be bought in the same manner. Limestone and dolomite are bought on the unit of silica, coke is sold on the unit of ash, a large amount of brown ore and soft red ore is sold on the unit of iron, and I see no reason why the principle should not be extended to all ores at present bought by the ton. We hear a great deal said about the irregular stock, and doubtless there is reason for the remarks. How is the evil to be corrected? Either by the stocking of large amounts of ore, coke and stone, and the thorough sampling and analyzing such stocks, or by the furnace companies mining their own ore and thus controlling the nature of the output, or by the purchase of materials on the unit system, or by a combination of these plans. It seems to me that the simplest and most satisfactory plan would be to purchase by the unit, as is already done with brown ores, limestone and dolomite.

One can readily see why the miners would object to such a plan, for it costs less to mine soft red ore of 43 per cent iron than the same ore with 48 per cent iron. More of the seam can be taken and the cost per ton of ore is less the greater the output from each laborer. But a ton of ore with 43 per cent iron carries only 963 pounds of iron as against 1,075 pounds with 48 per cent iron. The cost to the furnace per ton of ore is the same no matter whether this ton carries 43 per cent or 48 per cent of iron. It costs the furnace man more to make his iron from a 43 per cent ore, and it appears that he should pay less for it, just as he should pay more for a 48 per cent ore, inasmuch as it costs him less to make a ton of iron from it. If a 48 per cent ore is worth 60 cents at the furnace, a 40 per cent ore cannot be worth 60 cents also. It is a contradiction in terms. The present system would be fairer if a reasonable amount of the ore was of the better grade, but this is not the case. The variations in the ore approach the lower limit, and as a general rule the ore is nearer the 43 per cent than the 48 per cent mark. The subject is most fruitful of discussion, and I trust that these very brief remarks may induce some of those interested to look further into it.

ALABAMA'S RESOURCES FOR THE MANUFACTURE OF PORTLAND CEMENT.

BY EUGENE A. SMITH.

Portland cement has been defined as "a product of hydraulic properties, obtained by submitting to an intense heat approaching vitrification, a mixture containing the proper proportions of carbonate of lime and clay." Dr. Branner, the State Geologist of Arkansas, has given a very clear and condensed statement of the steps in the manufacture of this cement, and I cannot do better than to quote from him. "The changes which take place when a mixture of carbonate of lime and clay is heated to the verge of vitrification, may be briefly described as follows: The first effect of the heat is, of course, to drive off any moisture contained in the mixture; next, the heat being increased, the carbonate of lime loses its carbonic acid, and lime is left; finally, when the heat is intense enough almost to vitrify the mass, the lime unites with the silica and alumina of the clay, forming silicate and aluminate of lime. This product, a silicate and aluminate of lime, is Portland cement. It is to the readiness with which these two compounds, silicate and aluminate of lime, unite chemically with water, forming extremely hard compounds, insoluble in water, that the most valuable properties of Portland cement are due, namely, the properties of quicksetting and durability in the presence of water. Of these two constituents of Portland cement, silicate of lime is conceded to be the most important, and the one to which the hydraulicity of the cement is due."

"The manufacture of Portland cement involves the following principal steps:

I. The selection and estimation of the raw materials—the chalk and the clay.

II. Grinding and mixing the raw materials.

III. Burning the mixture.

IV. Grinding the product or clinker.

V. Testing the cement."

THE RAW MATERIALS OCCURRING IN ALABAMA.

(*A*). *The Limestone.*

The carbonate of lime used in this manufacture may be almost any form of moderately pure limestone. Hard, compact limestones, such as are quarried for fluxing purposes, or for the manufacture of quick lime in this State, might be used, but it has been found more economical to use some form of soft easily crushed stone, of which the English chalk is a leading type.

The most promising of our Alabama materials under this head may be enumerated as follows:

1. *Cretaceous Limestones.*—Passing over the harder limestones of the older formations, our attention is first attracted to a rock of the Cretaceous formation (*Rotten Limestone*, or *Selma Chalk*) widely distributed in Alabama, and forming the basis of the "canebrake" or black belt soils of the central parts of the State. We have recently shown that this rock is in a great measure a true chalk, i.e., it is formed of the calcareous shells of minute, even microscopic animals (foraminifera). This chalky limestone is exposed in the bluffs of the Alabama, Warrior, and Tombigbee rivers at many points, as well as across the country between and beyond the rivers. By proper selection it seems highly probable that a stone of suitable composition may be found. We have not very many analyses of this rock, but I present a few below:

ANALYSES OF CRETACEOUS LIMESTONE.

Soluble in H Cl.	1.	2.	3.
Carbonate of Lime,	75.07	66.37	80.40
Carbonate of Magnesia,	.92	.79	.53
Ferric Oxide,	1.44	2.19	1.24
Alumina,	.79	.75	.98
Phosphate of Lime,	.40	.54	.37
Silica,	.14	.06	.19
Insoluble in H Cl.			
Silica,	11.99	19.58	9.04
Alumina,	3.38	3.97	2.19
Ferric Oxide,	1.84	2.44	1.55
Lime,	1.47	.78	1.01
Potash,	.09	.04	.11
Water,	2.49	3.58	2.22

	4.
Moisture,	2.50
Silica,	19.74
Alumina,	7.74
Ferric Oxide,	3.93
Lime,	30.77
Magnesia,	2.45
Sulphuric Acid,	0.85
Carbonic Acid,	26.39
Alkalies,	2.88
Combined Water,	2.46
	99.74

1. Demopolis, Dr. Mallett, Analyst.
2. Cahaba, Dr. Mallett, Analyst.
3. Jones' Bluff, Dr. Mallett, Analyst.
4. Benton, Dr. Phillips, Analyst.

These rocks, as may be seen, are all soliceous and aluminous limestones, to which in the manufacture it would not be necessary to add the same proportion of clay as would be required for a purer stone. With a rock of somewhat uniform composition, it seems to me that by chemical analysis it would not be a difficult matter to determine the proper proportions of the two constituent raw materials.

2. *Tertiary Limestones.*—At the summit of the older or Eocene Tertiary formations of Alabama, there is a white limestone at least 150 feet in average thickness, extending across the State from Mississippi into Florida. This is our St. Stephens limestone, which represents essentially the Vicksburg limestone of the Mississippi geologists. In its physical and chemical characters this rock seems to be eminently suited to tha manufacture of cement, for it is soft, in places almost pulverulent, easily quarried and easily crushed, and very nearly pure carbonate of lime. In quantity, also, there is nothing to be desired, for it underlies a belt of twenty miles or so in width across the State; it makes bluffs along both the Tombigbee and the Alabama rivers, and could be obtained and loaded upon barges at very little expense. It is also equally convenient to the railroads, especially to the Midland and the L. & N. and the M. & O., which go north and south through the State.

I present a few analyses of this rock from Clarke and Conecuh counties, where it has perhaps the widest distribution and in its greatest variety.

ANALYSES OF TERTIARY LIMESTONE.

	1.	2.	3.
Carbonate of Lime,	94.84	94.85	93.19
Carbonate of Magnesia,	.96	1.57	1.09
Ferric Oxide,	1.81	.21	1.03
Alumina,	.31	——	.20
Insoluble,	1.69	2.44	4.15

	4.	5.
Moisture,	0.65	0.60
Silica,	1.26	2.75
Alumina,	0.51	1.09
Ferric Oxide,	1.21	1.64
Lime,	53.36	52.36
Magnesia,	0.31	0.11
Carbonic Acid,	42.28	41.14
Sulphur,	0.02	0.018
Alkalies,	0.11	0.14
	99.72	99.848

1. Col. Darrington's, close and compact texture, Clarke Co.
2. Chimney rock, soft and easily worked, Clarke Co.
3. Orbitoidal rock, soft and friable, Clarke Co.

Analyzed by Dr. J. W. Mallett.

4. Orbitoidal limestone, Evergreen, Conecuh County, Dr. Phillips, Analyst.

5. Obitoidal limestone, Evergreen, Conecuh County, Dr. Phillips, Analyst.

The possible objection to the second of the above might be the carbonate of magnesia, since a cement containing by analysis more than 1 per cent of magnesia is considered inferior. It would hardly be difficult, however, to find plenty of rock in which the proportion of magnesia would fall within the desirable limit.

For comparison, I add an analysis of the chalk of Medway, England, used in the manufacture of the English Portland cement ;

Carbonate of Lime,	88.58
Carbonate of Magnesia,	——
Silica, - - - -	5.45
Ferric Oxide, -	1.05
Alumina, - -	2.82
Alkalies, - - -	2.61

(*B*) *The Clay.*

The composition of pure Kaolin is as follows:

Silica, - -	47.0
Alumina, - -	39.4
Water, - -	14.6

The quality of the clay used at Medway, England, in the manufacture of Portland cement may be seen from the two analyses following:

	1.	2.
Silica,	64.72	70.56
Alumina,	24.27	14.52
Ferric Oxide,	7.14	3.04
Lime,	1.89	4.43
Potash,	1.10	2.05
Soda,	2.90	1.90

A comparison of these analyses with that of pure kaolin will show that ordinary sedimentary clays, such as are abundant in every section of the State, can be used in the manufacture of the cement.

We have not as yet made any analyses of the clays from the regions where the above described limestones occur, with a view to finding suitable material for mixing with the lime in the immediate vicinity, thus saving the cost of transportation of the raw materials, but since clay of one kind or another is one of the most widely distributed of rocks, and since a pure clay is by no means essential to the purpose, I fancy there will be no trouble in finding in the immediate vicinity of the limestone, an abundance of clay which would answer the purpose.

If the manufactory should not of necessity be located at the limestone quarry, there is certainty that the clay can be furnished either from our Tuscaloosa division of the Cretaceous formation, which extends across the State from the northwestern corner around to Columbus, Ga., or from the Post Tertiary formations of our river terraces, everywhere the source of good brick clays To go further interior, we shall find in many places in our gold region and in the territory of other geological formations older than the Cretaceous, no lack of purer clays and kaolins.

The following four analyses will illustrate the composition of some of the Cretaceous and Post Tertiary clays above alluded to:

	1.	2.	3.	4.
Moisture,		2.70	1.70	3.60
Silica, - - -	47.20	62.75	61.15	60.81
Alumina, -	37.76	21.15	24.81	21.69
Ferric Oxide, -	.91	4.00	2.43	3.43
Lime, - -	trace.	0.72	0.30	0.17
Magnesia, - -	trace.	0.32	0.39	0.57
Sulphuric Acid,		0.13	0.11	0.10
Alkalies, -	trace.	2.28	2.30	2.15
Combined Water,	14.24	6.00	6.45	7.26
	100.11	100.05	99.64	99.78

1. Cretaceous Clay, Chalk Bluff, Marion County (Tuscaloosa Formation) (McCalley, Analyst).

2. Post Tertiary (River Terrace) Clay, Montgomery Brick Yard (Dr. W. B. Phillips, Analyst).

3. Post Tertiary (River Terrace) Clay, near Elmore Station (Dr. W. B. Phillips, Analyst).

4. Post Tertiary (River Terrace) Clay, near Elmore Station (Dr. W. B. Phillips, Analyst).

I have not thought it desirable at this time to go into any details concerning the methods, wet and dry, which are followed in this manufacture. It is, however, generally thought that the dry method yields the best results. Before sending the cement to the market, it is carefully tested, both physically and chemically, and the faulty product rejected.

In chemical composition, a cement should approximate the following:

Lime,	60.05
Magnesia,	1.17
Alumina,	10.84
Silica,	24.31
Alkalies,	1.54

By the rules of the Ecole Nationale, of Paris, a Portland cement containing over 1½ per cent of sulphuric acid or 1½ per cent of carbonic acid, or 1 per cent of magnesia should be rejected by analysis. On the other hand, cements showing good analysis, should be carefully tested mechanically.

It should be understood that the intention of this paper is merely to direct the attention of our citizens to a manufacture which may utilize the resources of the lower portion of the State outside of what is usually known as the Mineral Belt, and it makes no pretension to being an adequate presentation of the subject. Our clays at this time are being investigated both chemically and physically, and I hope in the near future to be able to place before you a much fuller and more satisfactory statement of the case.

PRESIDENT'S ADDRESS.

The President's Address had for its subject, The Magnetic Concentration of the Red Mountain Ores of Alabama, and gave some details of a series of practical tests conducted at Bessemer. This work is still in progress and it has been deemed best to delay the publication until a complete account can be given of the results of these experiments, conducted on a commercial scale.

SECRETARY.

REPORT OF THE SECRETARY

FOR THE YEAR ENDING JUNE 7, 1895.

University, Ala., June 7, 1895.

During the past year the usual circulars announcing time of the meetings and proposing names for officers of the Society have been prepared and sent out.

Five hundred copies of the Proceedings for 1894 have been printed, in two parts, aggregating 69 pages, with an additional 14 pages of a carefully prepared Index of the first four volumes —which we owe to the courtesy of Mr. Chas. E. Bowron. The Proceedings have been distributed among the members of the Society, and to libraries, journals, and other Societies, as heretofore.

By way of exchange, we have received a number of journals, proceedings of societies, etc., which have been placed in the library of the Society.

Respectfully submitted,

Eugene A. Smith,

Secretary.

REPORT OF TREASURER

FOR THE YEAR ENDING JUNE 7, 1895.

University, Ala., June 7, 1895.

RECEIPTS.

From cash in treasury, as per report of May 29, 1894,	$ 78.68
From annual dues, - - - - - -	151.00
Total Receipts. - - -	$229.68

DISBURSEMENTS.

For printing and Stationery, - - -	$128.65
For advertising meetings, - - - -	10.70
For postage, - - - - - -	10.00
For reporting proceedings, - - - -	6.05
Total disbursements, - - -	$155.40
Balance in treasury, - - - -	74.28

Henry McCalley,
Treasurer.

PROCEEDINGS

OF THE

ALABAMA INDUSTRIAL

AND

SCIENTIFIC SOCIETY.

VOLUME VI.---PART 1.

1896.

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SECRETARY'S OFFICE,
UNIVERSITY POST OFFICE,
ALABAMA.

BURTON & WEATHERFORD, TUSCALOOSA.

OFFICERS.

1896.

PRESIDENT.

F. M. Jackson, - - - - - Brookwood, Ala.

VICE PRESIDENTS.

George B. McCormack, - - - Pratt City, Ala.

Ernst Prochaska, - - - - New Castle, Pa.

James Bowron, - - - - - Birmingham, Ala.

E. A. Uehling, - - - - Newark, N. J.

Joseph Squire, - - - - - Helena, Ala.

J. H. Fitts, - - - - - Tuscaloosa, Ala.

TREASURER.

Henry McCalley, - - - - University, Ala.

SECRETARY.

Eugene A. Smith, - - - - University, Ala.

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REPORT OF PROCEEDINGS

OF THE

ANNUAL MEETING

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY,

Held in the Rooms of the Commercial Club, Birmingham, Alabama, May 13, 1896.

The Society met pursuant to notices sent out to the members and inserted in the Birmingham papers. There were present F. M. Jackson, James Bowron, G. B. McCormack, Erskine Ramsay, W. B. Phillips, R. F. Manly, W. M. Brewer, J. A. Montgomery, E. A. Smith, J. R. Harris, J. D. Hillhouse, Wm. Bromwell, Joshua Franklin, P. G. Shook, L.A.O. Gabany, C. J. Gohegan, W. J. Boles, J. M. Martin, representatives of the press, and others.

After the meeting was called to order, the Secretary stated that the death of Col. Thomas Seddon, President of the Society, made it necessary to call one of the Vice Presidents to the chair; and Mr. F. M. Jackson, as First Vice President, was requested to preside.

The reading of the minutes of the last meeting was dispensed ed with, since the proceedidgs of that meeting have already been published.

A Committee was appointed at the last meeting to consider the matter of the collection and monthly publication by the Society of the statistics of coal and iron production. Dr. Phillips, on behalf of this committee, reported what had been done, saying that the prospect was very good for obtaining these statistics. He requested that the committee be given more time, and that Mr. Hillhouse be added to it in place of Mr. Seddon, deceased. This was done, and the committee was authorized to take such action with regard to the collection and publication of the statistics as they might deem advisable, and without waiting till the next meeting. The committee consists of Dr. Phillips, Mr. Hillhouse, and Dr. Smith.

The report of the council was next in order, and they recommended the acceptance of the five papers named below, and also recommended for membership the following: John H. Hawkins, of Rock Run; J. M. Garvin, of Rock Run; H. B. Christiansen, of Rock Run; Joshua Franklin, of Idaho; W. H. Brannon, of Bessemer; L. A. O. Gabany, of Brookwood; Charles J. Gohegan, of Brookwood; Paschal G. Shook, of Birmingham; William Bromwell, of Birmingham; and S.L. Graham, of Birmingham. In addition to those recommended for regular membership, they recommended Mr. James D. Hillhouse, Jr., State Mine Inspector, and W. J. Boles, Secretary of the Commercial Club of Birmingham, for honorary membership.

The names of the gentlemen recommended were placed before the Society, and they were elected by *viva voce* vote.

The Secretary then read his report to be found printed at another place, and a committee was appointed by the President, consisting of Dr. Phillips and Col. Montgomery, to audit the books of the Treasurer. The report of the Treasurer was afterwards read and approved, as well as that of the Secretary.

No changes were suggested as regards the delinquencies of members, to which attention was called in the report of the Secretary, and the provisions of the Laws and By-Laws are therefore to be carried out by the Secretary, so far as he is able to do it.

The Secretary called attention to propositions of the Chattanooga "Tradesman" and of "Dixie," relative to the printing of the proceedings of the Society; and it was ordered that the

Secretary be requested to consider the propositions, and to take such action in the matter as he might deem advisable for the good of the Society.

On motion of Dr. Phillips, a committee was appointed to draft resolutions of respect to the memory of Mr. Thomas Seddon, which resolutions are to be spread upon the minutes of the meeting and communicated to the family of the deceased, and to be published in the Birmingham papers. On this committee were appointed Dr. Phillips, Mr. Ramsay and Dr. Smith.

Mr. J. D. Hillhouse then extended to the members of the Society and to their families, on behalf of the Association of Mine Foremen, an invitation to attend and participate in a pic-nic of the mine foremen, to be given at North Birmingham Park, on the 6th of June next—the object of the meeting being to organize an Institute of Mines for the State.

On motion of Dr. Phillips, this invitation was accepted with thanks by this Society.

The reading of papers being next in order, Mr. Paschal G. Shook read one on the manufacture of Steel in the Birmingham District. This paper will be found in full in the proceedings below.

In the absence of the author, Dr. Phillips then read to the Society a paper on the Grading of Southern Coke Irons, with special reference to the Birmingham district, by Mr. W. H. Brannon, of Bessemer.

Mr. W. M. Brewer then read a paper on Gold Mining in Alabama, in which he shows that there are several occurrences of low grade gold ore in Alabama, in which the quality and accessibility of the gold are such as to render easily possible the profitable mining of this metal.

Mr. F. M. Jackson then read some notes descriptive of the Coal Washer in Brookwood, together with analyses showing the character of the improvement effected by the washing of the coal prior to the coking. Also, he spoke of the use of feldspar as a bed for the washers, and detailed his experience with the rounded pebbles so abundant about Brookwood as a substitute for feldspar, which has shown that they will answer quite as well as the feldspar, if not better, besides being far cheaper. This paper elicited a good deal of discussion, in which Dr. Phillips, Col. Montgomery, Mr. Ramsay, Col. Shook, Mr. Gabany, and the author of the paper took part.

A paper by Mr. John S. Kennedy, of Chambersburg, Pa., was then read by title by the Secretary, in the absence of the author, which paper the author promises to have ready by the time of the printing of the proceedings.

A paper by Dr. Phillips on the Grading of Coke Iron was also read by title only, inasmuch as the Doctor described it as technical in nature, and hardly suitable for public reading. This, as well as the other papers above named, will be found printed in full in another part of this report.

The election of a President and of two Vice Presidents was next in order, Mr. Aldrich and Mr. Jackson being named for the first place, and James H. Fitts, Joseph Squire, Walter Crafts, and J. W. Minor for Vice Presidents. On counting the ballots sent in to the Secretary before the meeting and cast at the meeting, it was found that Mr. F. M. Jackson, of Brookwood, was chosen President for the current year, and Messrs. James H. Fitts, of Tuscaloosa, and Joseph Squire, of Helena, were chosen Vice Presidents to serve for a term of three years.

On motion of Dr. Phillips, a vote of thanks was passed to the Secretary and officials of the Commercial Club for the use of the room so obligingly placed by them at the disposal of the Society for this meeting.

There being no further business before the meeting, the Society adjourned to meet again in November, at the time and place to be selected later by the council, and communicated to the members by the Secretary.

EUGENE A. SMITH, Secretary.

BIRMINGHAM, ALA., May 13, 1896.

TO THE PRESIDENT AND MEMBERS OF THE ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY:—

Your Committee appointed to draft suitable resolutions on the death of Mr. Thomas Seddon, our President, which occurred on the 10th inst., beg leave to report as follows:—

Mr. Seddon was one of the original members of this Society, having signed the call for the first meeting, held December 11th, 1890.

From that time until his death he was deeply interested in its success, attending nearly every meeting and evincing by his presence and active co-operation his hearty sympathy with the purposes of the Society. No one in the State or district was more concerned in the success of the Society, and he was at all times ready to assist in making the Society the gathering place for all who were engaged in industrial enterprises in Alabama. He was elected President of the Society June 8th, 1895, and passed away during his term of office.

We recommend the following Resolutions :—

1st. That we deeply deplore the death of our President, occurring as it did when he was fully equipped for the management of the large business entrusted to his care as President of the Sloss Iron and Steel Company.

2nd. That a page of our records be set apart for his memory, upon which shall be inscribed this tribute to his worth as one of the most efficient members of this Society.

3rd. That copies of this paper be sent to the daily papers of Birmingham, to the Sloss Iron and Steel Company, and to the surviving members of his family.

Respectfully submitted,

WM. B. PHILLIPS,
ERSKINE RAMSAY,
EUGENE A. SMITH.

ADDRESS OF THE PRESIDENT.

Owing to the death of Mr. Seddon, there was no Presidential Address.

THE GRADING OF SOUTHERN COKE IRON WITH SPECIAL REFERENCE TO THE BIRMINGHAM DISTRICT.

BY W. H. BRANNON, BESSEMER, ALA.

Eight years ago there were in the Birmingham District 15 grades of iron, viz:—1 Foundry; 2 Foundry; 2½ Foundry; 3 Foundry; Extra No. 1 Mill; No. 1 Mill; No. 2 Mill; Mottled; White; No. 1 Bright; Medium Bright; Close Bright; No. 1 Silvery; No. 2 Silvery; and Silvery Mill.

This list was revised in 1888, and today we recognize 11 grades, viz:—No. 2 Silvery; No. 1 Silvery; No. 2 Soft; No. 1 Soft; No. 1 Foundry; No. 2 Foundry; No. 3 Foundry; No. 4 Foundry; Gray Forge; Mottled; and White.

In 1888 very little attention was paid to chemical analysis, the irons being graded almost entirely by color and granulation. In addition to having a fair knowledge of the principal chemical ingredients of pig iron the grader now must be thoroughly familiar with the four points in uniform grading, viz:—color, granulation, fracture and face.

No. 2 Silvery contains from 5 to 5.50 per cent. of silicon, has very little or no granulation, and is almost smooth, with a galvanized appearance. No. 1 Silvery has some granulation, and a smooth face, and contains from 4.50 to 5 per cent. of silicon. Both these irons are weak in fracture, and show a fine, silvery lustre on a fresh face, and are flaky. They should exhibit no dark spots, and the crystallization is obscure. They are what they purport to be Silvery irons, and the difference between them, on the yard, is mainly, one of granulation. They are hottest irons, and contain much more silicon and much less combined carbon than any of the other grades. Their carbon is almost wholly in the shape of graphite, but the large excess of silicon prevents this ingredient from conferring a dark color on the iron.

No. 2 Soft contains from 3.50 to 4.0 per cent. of silicon. No. 1 Soft from 3.0 to 3.5 per cent. They are both of a light color, smooth face and weak fracture. A distinct granulation begins to be apparent in No. 2 Soft, which is more pronounced in No. 1 Soft, but in neither of these grades is the granulation so marked as in the Foundry irons.

The Soft irons are darker than the Silvery irons, but lighter in color than the Foundry irons, and the granulation is not so jagged as in these latter grades. In particular they do not show a silvery appearance, and are not flaky. The increasing ratio of graphite to silicon begins to manifest itself in the Soft irons in the darkening of the color as compared with the Silvery irons.

No. 1 Foundry contains from 2.50 to 3.0 per cent. of silicon, has a very open and regular granulation extending through the entire face, and a dark gray color. The crystallization is marked, and the face is rough to the feel. The difference between this and No. 2 Foundry, which contains from 2.25 to 2.50 per cent. of silicon, is the same in kind as exists between the two Silvery, and the two Soft irons, and is chiefly one of granulation. In No. 2 Foundry the grain is not so open as in No. 1 Foundry, nor is the crystallization so coarse. The color may be as dark in one as in the other, but in No. 1 Foundry there is a deep blackish gray color which is absent in No. 2 Foundry.

No. 3 Foundry contains from 2.0 to 2.25 per cent. of silicon, and resembles No. 1 and No. 2 Foundry in structure, but the granulation is much less marked. The crystallization is finer than in No. 2 Foundry, and the color, while still dark gray is not so pronounced.

No. 4 Foundry, recently called Foundry Forge, shows the dark gray color of the other foundry irons, but the granulation is closer and the crystallization finer. It carries from 1.75 to 2.0 per cent. of silicon. Taken together the foundry irons are distinguished by dark gray color, open grain, and well marked crystallization, three points which are seen to the best advantoge in No. 1 Foundry.

Gray Forge is the old No. 2 Mill. It has 1.50 to 1.75 per cent. of silicon, and shows a pebbled granulation in the center, with mottled edges about one-quarter of an inch deep all around. It has a blistered and pitted face, and is frequently honey-combed on the fractured end, some of the holes being an eighth to a half an inch deep.

Mottled iron has from 1.25 to 1.50 per cent. of silicon, shows no granulation, and has a pepper-and-salt appearance on a fresh face. It begins to show an increasing amount of combined carbon about one half of the total carbon being in this condition.

White iron has from 1.0 to 1.25 per cent. of silicon, shows no granulation, and is often as white as bleached linen. It carries very little graphite, and is usually high in sulphur. It is very hard, often resisting the drill, and on this account is difficult to sample properly.

In sampling pig iron one of two methods may be used, the choice depending on the extent of the subsequent analysis. When silicon, sulphur, phosphorus, manganese and total carbon are to be determined the iron is best sampled from the runner, from 4 to 6 small ladlesfull being taken during the cast and shotted in a bucket of cold water. When graphite, and combined carbon are also to be determined boring must be resorted to. In this case two methods may be used. In the first, the face of the pig is bored in three places to the depth of ½ to 1 inch along a line drawn diagonally across the face, the borings being mixed. In the second, the pig is bored diagonally almost entirely through in one place.

In boring pig iron care must be taken to prevent the intermixture of sand from the pig with the borings, and it is well to put a careful man in charge of the drill. In boring chilled pig, and in sampling from the runner, there is, of course, much less danger of adhering sand getting into the borings. A neglect of this matter may often mislead the grader, as sand in the borings shows up as silicon in the pig, and a No. 3 Foundry may be classed as a No. 1 Soft. It is a difficult and tiresome matter to separate sand from borings by means of a magnet, and at the best entails a good deal of extra and unnecessary labor upon the chemist.

The tendency of the trade is now strongly towards a closer chemical inspection of the irons offered for sale, and the grader who intends to keep up with his profession must take this fact into consideration. He must, therefore, acquaint himself with the effect of the chief constituents upon the various irons in respect of color, granulation, fracture and face. He is called upon every day to decide questions involving a great deal of money, and as it sometimes happens that he can not wait for an analysis he must be prepared to grade without it. But he should by all means cultivate the closest intimacy with the laboratory, and have the grades analysed as often as possible, and not neglect to inform himself as to the influence of the burden, heat and pressure upon the product under his care.

OBSERVATIONS ON GRADING COKE IRON.

BY W. B. PHILLIPS.

The grading of coke iron calls for a considerable amount of skill, which can be attained only by experience and the closest attention to details. Even then it not infrequently happens that the best graders will be at fault and the question can be settled only by the chemist. Reference has been made by Mr. Barton, (Proc. Vol. III, 1893, page 35-39) to a case where an iron which was afterwards found to contain 1.12 per cent. silicon was graded by these different men as No. 1 Soft. Other instances might be adduced in support of the proposition that, after all, the proper place for grading iron is the laboratory. It is not meant by this that iron should be graded only in the laboratory, for this would entail considerable expense, which might not be warranted by the situation. But that the closest affinity should exist between the grader and the chemist, no one who has observed the course of the Southern coke irons during the past eight or nine years can reasonably deny.

When Mr. Robertson prepared his paper on rhe grading of Southern coke irons (Trans. Amer. Inst. Min. Engrs. Vol. XVII, 1888-89) the foundry irons carried more than 3 per cent. of silicon, and there was constant complaint by consumers that there was too much variation in the grades. This was to a great extent alloyed by the practice that began with the circular issued by the Southern iron men in 1888, which has been quoted in full in my Report on Iron Making in Alabama.

But it was found in 1893 that another grade was needed, intermediate between 3 Foundry and Gray Forge, and it was established by some companies under the term Foundry Forge. To this the objection was made that the term was self-contradictory, an iron could not be at once Foundry, and Forge. In

1895 the grade was abolished, and what was formerly Forge is now termed No. 4 Foundry.

Now and then it happened that a close, fine grained silvery looking iron would show on analysis not more than 2 per cent. of silicon, while again, without greatly altering in appearance, it would show from 2.90 to 3.10 per cent. silicon. If the silicon was about 2 per cent. the iron was termed Foundry Forge, as it is now termed No. 4 Foundry; if the silicon was about 3 per cent. it was, and is yet, termed No. 1 Soft.

Ordinarily and when grading for the same furnace running on about the same burden, the competent grader comes very near the proper grade, and can be trusted to ship on his own judgment. But when complaints arise, as they do sometimes, and especially on a depressed market, the only way in which the ire of the consumer can be placated is to show him that the iron he objected to as not being No. 3 Foundry, for instance, does really contain from 1.75 to 2 per cent. of silicon, and falls well within the limits for this particular grade. This much as to silicon. But how is it in respect to graphitic, and combined carbon? Is the iron to be graded solely by its silicon content? It is granted that for the most part iron can be fairly well graded on its content of silicon, and that the variation of this element confers upon the iron peculiarities of color, granulation, fracture, and face that are more strongly marked than peculiarities due to other elements. It is this fact that has rendered possible the present system of visual and tactual grading. It was quietly assumed that if the silicon was all right, the iron was all right, and this was supplemented by the further assumption that if the iron was all right the silicon was all right. In this way it was possible even for a conscientious grader to fortify himself behind a pretty high wall of silicon, and fire silicon bombs *ad libitum*.

The easiest way of grading iron is by its silicon content, but it by no means follows that it is the best way, or the only way. Leaving out the content of sulphur, as not seriously affecting any of the grades above Gray Forge, there should be certain ratios established between silicon and combined carbon for the Soft and Foundry irons. The variation in the amount of silicon does, of course, influence the quality of the iron, and one might go even farther and allow that it influences the iron more than any other single element. But combined carbon is by no means to be neglected.

In 29 complete analyses of No. 3 Foundry iron it was found that the silicon varied from 1.45 to 3.83 per cent., the average being 2.37 per cent. Five of the samples should have been graded as No. 1 Soft, as the silicon was between 3.04 and 3.17 per cent., and one should have been No. 2 Soft with silicon 3.83 per cent. These irons were all graded on the yard by a careful and competent man yet in 6 cases out of 29, or 20.7 per cent., the iron graded as No. 3 Foundry was really Soft. Excluding these six the average silicon in the other 23 was 2.16 per cent., a result not far wrong, if at all, as No. 3 Foundry may vary from 1.90 to 2.20 per cent. of silicon. In the six cases in which the silicon was over 3 per cent. the combined carbon was 1.04 per cent., and the 23 others it was 0.82 per cent., the average of the 29 being 0.87 per cent.

The combined carbon in No. 3 Foundry does not usually run as high as 0.82 per cent., the average being about 0.40 per cent. In the Soft irons it should not be above 0.40 per cent., but in some cases especially when the iron resembles No. 3 Foundry it may go to 1.00 per cent.

We have then to discriminate between Soft irons with over 3 per cent. of silicon, and the normal amount of combined carbon, and irons which contain over 3 per cent. of silicon and upwards of 1 per cent. of combined carbon. Grading on fracture and appearance some of these latter irons would be put in No. 3 Foundry; grading on silicon content they would go in the Soft irons, with the understanding that the combined carbon was abnormally high.

The same principle holds good in respect of the other Foundry irons, although in a less degree. It is this tendency of the lower grades of Foundry iron to show higher percentages of combined carbon than is usually the case that renders grading by fracture and appearance somewhat uncertain. In case of doubt a silicon estimation will enable one to decide whether or no the iron should be put in the Soft grades, and an estimation of combined carbon will show whether or no it should be stated that this element is above the average.

In a paper read before the Alabama Industrial and Scientific Society in 1895, which we have quoted in full, Mr. James Bowron said. "For the enlargement of the domestic market, the most desirable thing to be done, in my judgment is to secure uniformity in grading and naming iron, and selling it upon terms of uniformity. * * * It is scarcely too much to say that the whole question of grading iron is assuming a more complex condition, and that if it is not in a somewhat chaotic state the minds of some of the graders have attained, that undesirable goal. Harassed by the pressure of evil times and the desire of consumers for something cheaper, the effort has been continually made not to split hairs, but to split grades in a corresponding degree of fineness. This leads to absence of physical or chemical lines of demarcation, and makes the question of grading depend more than ever on the individual opinions of the maker and comsumer, who naturally look at it from different standpoints, and arrive at different results. This leads to considerable friction, and, in the long run, Southern iron gets a bad name."

Mr. Bowron's long and intimate acquaintance with the commercial aspects of grading qualifies him to speak *ex cathedra*, and if he can deliberately take the position that uniformity in grading and naming iron is the most desirable thing that can be done towards enlarging the domestic market for pig iron, surely it is time to discuss the matter from every point of view, with the hope of arriving at some more reasonable system than is at present used.

The multiplication of grades may go on indefinitely according as the fancied needs of consumers increase in number. If a manufacturer asks for an iron carrying not more than 3.50 per cent. and not less than 3 per cent. of silicon with combined carbon not over 0.50 per cent., he should be able to get it. If, under the present system he does get it once he may thank his good fortune, for it is not likely that he can get it twice.

There has recently been completed and agreement between the chief producers of Alabama coke iron whereby certain uniform prices for standard grades are to be observed. It is a very good thing as far as it goes, but it does not go far enough, nor strike very heartily at the root of the trouble.

The main point is to secure uniform grading, and this can certainly not be gained merely by establishing uniform prices. Mr. Bowron was unquestionably right in saying that uniformity in price *and uniformity in grading*, (the italics are ours) must be maintained if the domestic market is to be enlarged.

The local trade association of which he speaks could take the matter in hand, but a simpler and it seems to us a more satisfactory plan would be for the companies that made the agreement as to prices to make a similar agreement as to grading, and put a competent man in charge of it. The price depends upon the grading. It is not enough for the iron-masters to meet and say what the names of the grades shall be, nor to fix the price at which the grades thus named shall be sold. Unless there is at the same time an agreement as to what kind of iron shall be deemed No. 1 Soft, or No. 3 Foundry, the protocol as to uniform prices is to a large extent abrogated. It is sure to happen that permission to ask a special price for a special iron will be solicited, and unless it is known what this iron is, what relation it bears to the grades whose prices are already fixed and agreed upon, how can there be any thing but confusion? One may say: "I am making an iron, or I have it and it is now piled, which to all ordinary grading would be put in No. 2 Foundry. But it carries less than 1.50 per cent. of silicon and is therefore not a typical No. 2 Foundry and I wish to ask a special price for it." He has called in his chemist and knows that the iron is not No. 2 Foundry, although it closely resembles it in granulation, color, fracture and face. He wishes to sell it on analysis, for this is really the gist of the whole matter.

By all means let there be uniform prices, but if the grading is not uniform what do the uniform prices amount to, after all? They are simply grade-splitters, and will inevitably lead to more confusion than at present exists, if they are not based on the chemical analysis of the irons.

Some people are inclined to regard the chemical grading of pig iron as a sort of Panjandrum, or mysterious Monster, lying in wait for the unwary, and they begin to tell their beads as soon as a chemist heaves in sight. But no chemist who understands the situation in Alabama can declare out and out for laboratory grading, as no chemist can doubt that the present system is out-of-date, illogical, and cumbersome.

The purposes to which pig iron is put depend absolutely upon its composition; the color, fracture, granulation, and face have nothing to do with it except in so far as they indicate the existence of certain ingredients whose actual percentages can be determined only by the chemist. As regards grading the inferences to be drawn from data obtained on the iron yard are reliable only if confirmed by laboratory tests, and it is particularly ungrateful in graders and furnace managers to decry the further application of the very science upon which they base the practice of their art.

What changes are to be suggested? First the maintenance of a chief grader, whose business it should be to regulate the grading under conditions imposed by the separate companies. Second, the establishment of a central laboratory devoted to pig iron analyses. Third, the diminution of the number of grades and the substitution therefor of not more than six grades, differentiated by the content in silicon, and combined carbon, and possibly sulphur. These six grades might be as follows:

	Silicon.	Combined Carbon.	Sulphur.
Silvery Irons.	5 to 6	0.10 to 0.30	0.01 to 0.04
Soft Irons,	3 to 5	0.20 to 0.60	0.01 to 0.05
Foundry Irons,	2 to 3	0.30 to 0.90	0.01 to 0.07
Gray Forge,	1 to 2	0.40 to 1.25	0.04 to 0.09
Mottled,	0.6 to 1	0.50 to 1.80	0.06 to 0.11
White,	0.1 to 0.6	1.00 to 2.50	0.08 to 0.30

This scheme, or some modification of it in line with its general provisions would retain the present nomenclature, and bring it into closer accord with laboratory results. It would do away with five grades, which are no more than side-grades at best, and would enable the grader to exercise better discretion in the yard. The rapidity and accuracy with which the estimation of silicon, and combined carbon can now be made render it possible to have the results from the cast-house by the time the iron is ready to break and pile. The estimation of silicon now leaves very little to be desired, and while the estimation of combined carbon in pig iron is not so accurate as in steel it is sufficiently so for the purpose in hand. If objection be made to such a radical change much could be done to improve the present system without decreasing the number of grades, or interfering with the nomenclature. If a systematic record of the pigs sampled were kept it would be possible to control the grading within narrower limits than now maintain. An excellent system has been devised by consultation with Mr. W. H. Brannon, chief grader for the Tennessee Coal, Iron & Rail Road Co., Mr. W. J. Sleep, manager of the American Pig Iron Storage Warrant Co, in this district, and two well known pig iron brokers whose names it is not necessary to mention. It was our purpose to have a convenient envelope prepared for holding the borings, and on the front of it we had the following:

Tennessee Coal, Iron & Railroad Co.,

——Tons.
No——Furnace.
Made——189—

Grade——
Division——
Sampled——189—

Color { Light. / Dark.

Fracture { Weak. / Strong.

Granulation. Regular. / Irregular. { Fine. / Medium. / Coarse.

Face. { Smooth. / Pitted. / Blistered.

Chilled edge——

Signed——-

On the back of the envelope was printed the following:

Charges——

Burden.	Pounds.
Hard Ore - - - - - -	———
Soft Ore - - - - - -	———
Brown Ore - - - -	———
Stone { Limestone. / Dolomite.	———
Coke - - - - - - -	———
Total - - -	———

To be taken before each cast.					
	Time.				Average.
Revs. of Engine.					
Heat.					
Pressure.					

The line on the front of the envelope that does not apply to the sample is marked out, thus if the colors is dark the word 'light' is marked out, if the granulation is regular and fine, the words irregular, medium, and coarse are marked out, if there is a chilled edge ⅛ or ¼ inch deep it is so stated, if there is no chilled edge, the words are erased.

By the use of this envelope it is possible to have recorded a complete history of the sample under examination. The results reached are of the highest importance if the system is faithfully adhered to, for at any time, by reference to the laboratory books it can be known what was the exact composition of any grade of iron, its physical peculiarities and the burden on which it was made.

We are convinced that if this, or a similar, system were intelligently and persistently followed the complaints of lack of uniformity in grading our coke irons would gradually disappear.

It is acknowledged on every side that the irons are *not* uniformly graded, and unless some steps are taken to remedy this most serious obstacle to the enlargement of our markets we shall always be met with the assertion that we are not doing what we could do to correct the evil.

THE MANUFACTURE OF STEEL IN THE BIRMINGHAM DISTRICT.

BY P. G. SHOOK.

In the early '50's the father of our distinguished fellow-citizen, Mr. T. T. Hillman, acquired some ore lands on Red mountain, near Birmingham, Ala., at a price of $10 per acre, and later on, the fact having been demonstrated that coke could be made from our coals, many wagon loads having been hauled from slope No. 1 at Pratt mines to Oxmoor, a distance of ten or twelve miles, and there coked in a crude oven erected for the purpose of making the experiment, Mr. Hillman himself moved to Birmingham, and, in conjunction with Mr. H.F. DeBardeleben, projected and built the Alice furnaces. The furnaces at Oxmoor were built previous to this time, and were being operated with remarkable success. It was said at that time, although making but fifty tons of iron per day, the profit on the operations amounted to $1000 per day.

Immediately after the boom of 1879 and 1880 the furnaces of the Sloss Iron and Steel company at Birmingham and the Woodward Iron Company were erected. Following this period little was done in the building of blast furnaces in the South until 1886 and 1887, when began the era of our greatest development. In 1884 and 1885 the Citico furnace at Chattanooga, Tenn., was built, and this was followed by the four great furnaces at Ensley, an additional stack at Woodward's, two additional stacks by the Sloss Iron & Steel Company; Mary Pratt, Williamson, the five furnaces at Bessemer, the two Pioneer furnaces at Thomas, Ala., and the Vanderbilt furnace in North Birmingham.

Thus the South was given a productive capacity of pig iron largely in exces of the demand; then it was that we reached the zenith of our prosperity in the manufacture of crude pig iron, and have ever since been declining. This condition will continue so long as we are dependent upon markets removed from us by great distance as to 80 per cent. of our product. True it is that under pressure of adverse conditions we have demonstrated our ability to produce iron in Birmingham much below the cost of other competing districts. Under this pressure badly located furnaces and those built for town booming purposes only have been abandoned and torn down and sold for scrap iron ; others have passed into the hands of creditors. In contradistinction to the prediction of an overzealous writer in 1880, when pig iron was selling at $40 a ton, that it could be produced at Birmingham at less than $10 a ton, I may say that large quantities have been sold within the last few years at less than $6 per ton at the furnace.

Perhaps the most serious and unpleasant feature of the situation from the standpoint of the crude iron manufacturer is the remarkable rapidity with which steel is displacing iron in many of the articles of daily use. Rails, structural materials for bridges and buildings, cotton ties, merchant steel, boiler plates, rivets, wheels, pinions, and machine castings are now made of steel instead of iron, and it is encouraging to note a fact, which we will later on bring out more forcibly, that in all of the above mentioned articles, or practically so, basic open hearth steel, the product of the process to be employed in the south, and the one so admirably adapted to southern conditions and material, is in all cases preferable and in very many specified over the acid Bessemer or acid open hearth steel.

The production of pig iron in the United States was in

1885,	4,044,526 tons.
1890,	9,202,703 tons.
1895,	9,446,308 tons.

From the official reports of Mr. James M. Swank, of the American Ironand Steel Association, we find that the production of all classes of steel was aa follows (the production of open hearth steel in 1895 being partially estimated):

1885, - - - - - -	1,711,926 tons.
1890, - - - - -	4,277,071 tons.
1895, - - - - -	5,909,180 tons.

We find that after deducting the steel used in each of the three above years from the iron produced, and allowing the amount of spiegeleisen produced to offset the small imports of iron, and assuming that in each case a long ton of pig iron has made a short ton of steel, thus allowing for the natural waste of conversion, it has left available for consumption as iron in the United States the following tonnage:

1885, - - - - -	2,332,606 tons:
1890, - - - - -	4,925,632 tons.
1895, - - - - -	3,537,180 tons.

The growth of the southern iron industry may be said to be confined to the past twenty years, and its phenominal development and expansion has greatly surpassed that of any other section of the country, and reached the point of supplying, in the year 1894, from Alabama and Tennessee alone, 37.18 per cent of the entire consumption, apart from steel in the U. S. In this remarkable expansion, the Tennessee Coal, Iron and Railroad Company has taken the lead. That company produced, in

1885, - - - - - -	57,754 tons.
1890, - - - - -	260,378 tons.
1895, - - - - - -	538,338 tons.

Taking these figures in connection with those showing the consumption of iron as iron in the same years, it appears that that company alone supplied in 1885 2.47 per cent, in 1890 5.28 per cent, and in 1895 15.21 per cent of all the iron consumed as iron in the United States.

Is it not manifest, therefore, that the diversion of at least a part of our product to the manufacture of steel seems absolutely imperative? The shrinkage in the consumption of iron, aside from that converted into steel, was, from 1890 to 1895, 1,400,000 tons, while there was an increase in the same period of 1,700,000 tons in the production of steel.

Much has been said and written on the subject of steel making in the south. Numerous imaginary difficulties are entertained by the skeptical few, while others, in fact I may say all who have investigated and familiarized themselves with the few simple points involved are assured, confident and convinced. Not long since, only eight short years ago, the process made perfect by a combination of the great discovery of Messrs. Gilchrist Thomas and Percy C. Gilchrist, of England, in the year 1877, with that of the regenerative gas furnace of Messrs. Siemens and Martin, in 1856, known as the Siemens-Martin open hearth furnace, the process so admirably suited to our conditions, in dealing with and eliminating the hostile element, phosphorus, contained in our iron, the one which is so rapidly revolutionizing the steel industry and transforming our age into one of steel instead of one of iron, was introduced into the United States, and the first basic open hearth steel made at the Homestead works of the Carnegie Steel Company, near Pittsburg, Pa. The early use of the Siemens-Martin regenerative gas furnace was confined to the acid open hearth process, and the iron used was and is similar to that required for the ordinary acid Bessemer. From the nature of the materials employed in the Bessemer converter, it was frequently found impossible to generate the necessary heat, which is dependent upon the oxidation or combustion of the silicon and carbon contained in the original pig, and that process is necessarily confined to an iron containing a sufficient quantity of these two elements, the burning of which serves to generate the necessary heat.

The Bessemer process was discovered by Sir Henry Bessemer, in the year 1856. The discovery of Mr. Robert F. Mushet, on the 22nd day of September, of the same year, by which, by addition to the metal while in a molten state of a compound of iron, of which carbon and manganese are predominating elements, and of which spiegel-eisen is perhaps the cheapest and most convenient form, the carbon and manganese are restored to the metal, gave great value to the invention of

Mr. Bessemer, which, as originally conceived by him, had no commercial or practical value, in that it contemplated the conversion of pig metal into steel wholly or practically decarbonized as well as desiliconized; in fact, by the nature of the process the product was so completely deprived of its carbon as to render it of no value. We shall see, also, that Mr. Mushat's discovery bears a most important relationship to the basic open hearth process, and that it provides a simple, economical and effectual means of making high carbon steel for rails and other articles where extreme hardness is required.

High phosphorus irons are not available for use by either the acid Bessemer or the acid open-hearth process, silicon and carbon only being the elements with which they deal. In the acid open-hearth, by using a Bessemer iron containing, say .10 phosphorus and 50 per cent scrap iron containing not over .06 or .07 phosphorus, it may be seen that the phosphorous in the mixture may be reduced to some extent, although the process does not in any manner treat with it, and the reduction comes wholly from a mechanical manipulation of the materials. Very important, therefore, was the discovery of Messrs. Thomas and Gilchrist, both of London, England, of the basic process, by which the use of an iron containing a large percentage of phosphorus was rendered possible. This occurred in November of the year 1877, and the application of the process to the Siemens-Martin open-hearth furnace, gives us what is known as the basic open-hearth process. The one difference between the basic and the acid furnace is in the composition of the lining or bottom, it being in the case of the basic open-hearth usually dolomite or magnesite prepared by roasting or calcining, then pulverizing and mixing with tar, crude oil, or other material free from objectionable elements which will serve to render it plastic or adhesive. In the acid, sand is employed as a bottom material. I would call your attention to the interesting fact that in the basic practice, dolomite is rapidly growing in favor, and is used to-day by practically all the large basic steel makers in this country in preference to the magnesite. Its cost is insignificant compared with magnesite, every pound of which must be imported into this country from Russia, Austria, or Greece. The time will soon come, we think, when dolomite or magnesian limestone will be used exclusively.

As before stated, the first basic or open-hearth steel produced in the United States was at the Homestead works, on the 28th day of March, 1888. That day marks the advent into this country of a process, the growth and expansion of which is truly phenomenal. It has rendered possible the manufacture of steel commercially and successfully in the south, which now offers an inviting field for investment and development. Unfortunately, statistics do not give us the production of open-hearth basic steel separate and apart from acid, but include both under the common head of "open hearth" steel; but from the following figures it may be seen that a most remarkable expansion of the industry and increase in production has taken place.

Production of open-hearth steel (production for 1895 partially estimated)—

1890, - - - - -	513,232 tons.
1891, - - - - -	579,753 tons.
1892, - - - - -	669,887 tons.
1893, - - - - - -	737,850 tons.
1894, - - - - -	784,936 tons.
1895, - - -	about 1,000,000 tons.

Undoubtedly the basic open-hearth has shared the greatest portion of this increase, attributable to the superiority and adaptability of its product over that of the acid open-hearth or the Bessemer. It is daily growing in favor, and the demand is constantly increasing. There were in the United States in 1892 but 71 open-hearth plants, consisting of 164 furnaces; in 1894 there were 81 plants, with 189 furnaces; and in January of the present year 88 plants with 225 furnaces complete and

20 in process of erection. The first basic open-hearth furnaces were built in this country at Homestead, in 1890, when eight furnaces, at that time considered to be of large capacity, were completed. Later on, twelve additional furnaces, ranging in capacity from 60,000 to 85,000 pounds per heat, were built, giving the Carnegie company a plant of 20 furnaces, all basic, running to their fullest capacity and yet unable to supply the enormous and rapidly increasing demand for that class of steel. In this connection, I may say that when in Pittsburg recently I heard that the Carnegie company intended to dismantle and move away this Bessemer plant at Homestead, which has a capacity about equal to that of the open-hearth plant, and that it was their intention to build 20 additional open-hearth furnaces of fifty tons capacity each at the Homestead works, it being stated at the time that they had acquired the land adjoining Homestead at great cost with this object in view. It is now officially announced that this will be done, and, if I mistake not, they are at present engaged in dismantling the Bessemer plant.

This development has not by any means been confined to the Carnegie company, but has been participated in by nearly all the large producers in this country, notably the Illinois Steel Company, Jones & McLaughlin, Pennsylvania Steel Co., and others. Thirty-seven basic open-hearth furnaces were built or in process of erection in the United States in the year 1895, only ten acid furnaces were built in the same period, and they specially designed for making steel castings, being of small capacity and having in view the use of scrap from Bessemer plants available for that purpose. Two furnaces only for ordinary acid work were built during the year. Assuming two heats in twenty-four hours, and seeing that the average capacity per furnace per day was seventy tons, we find that there was an increase in the capacity of basic open-hearth steel during the year 1895 of 2590 tons per day.

It is to emphasize and impress upon you the wonderful development of this method for making steel that I call your attention to these facts, and we must bear in mind that it is this process which we will employ in the south, and that, while best suited to our conditions, it is the one least well adapted to the requirements of competing districts. Having recently been detailed by my company to make an investigation of the use of our Alice basic pig iron by northern steel makers, I was afforded a most excellent opportunity to form impressions and make observations as to the views entertained by our northern friends touching the probable future development of the steel industry in the south. With one accord they were amazed at the remarkable success attained by the Tennessee Coal, Iron and Railroad Company in making a pig metal suitable in every particular for basic open-hearth practice. The three elements in the iron around which restrictions are thrown are silicon, sulphur and phosphorus; the specifications being 1 per cent silicon and phosphorus and .05 sulphur. Not only has the company been able to comply with these stipulations with a remarkable degree of regularity, but they have succeeded in producing pig iron running uniformly about one-half of 1 per cent. silicon, .02 to .035 sulphur and .6 to .7 phosphorus. Practically all of the large producers of basic open hearth steel in the country have used, and many are using today the product of the Alice furnace, located in this city. In my rounds on the trip above referred to, I did not meet with an unfavorable criticism of the Southern basic pig. They look upon this as the future field of development and are forced to accept the fact that the basic open hearth process is rapidly pushing its way to the front and displacing all other classes of steel in every conceivable direction. Unknown and unpracticed a few years ago, it is now encroaching upon the Bessemer and driving it back to a narrow channel of trade, where inferior stock will answer. The rail trade is practically all that remains for the Bessemer, and it is freely predicted that when the production of basic open hearth steel reaches a point where it is necessary to extend and enlarge its market, rails will be made by that process. That this can be done is a fact so well recognized as not to admit of discussion, it being, as in the case of the question of the use of scrap iron, purely a commercial proposition. This feature of the subject we shall again allude to later on.

For bridge and structural material, boiler plate, armor plate, and any and all other uses where great strength, durability and ductillity is required, basic steel has no equal; and, realizing this to be true, engineers and builders are now specifying it. Thus we find the causes for the enormous demand, even at a price from $3 to $5 per ton above Bessemer, and which cannot be met by the present productive capacity. Of course the day will come when the supply will fully equal and probably exceed the demand. Then will it fall to the lot of this favorite metal to capture the rail trade, and not a difficult undertaking will it be when we remember that high phosphorus is especially objectionable in superinducing segregation, which is the cause of many broken rails. As you know, it cannot be controlled or regulated by the Bessemer process, but by the basic open hearth may be reduced to any point desired or specified; in fact, may be practically eliminated. High carbon in rails is required in either case, and in both is obtained in a manner identically the same. A fixed hardness being required, and both carbon and phosphorus possessing hardness giving qualities, it will devolve upon the maker of basic open hearth rails to increase his carbon to the same relative extent that the phosphorus is reduced. In other words, he will make up in an advantageous element, carbon, what he loses in a very detrimental element, phosphorus, thereby materially improving the quality of the rail. Instead of containing .10 per cent. phosphorus and .35 to .40 per cent. carbon, it will carry only .02 to .05 per cent. phosphorus and say ¾ of 1 per cent. carbon. Once the trade is provided with a rail of this composition, it is not difficult to imagine the railroads specifying open hearth rails. That this will come seems inevitable. Should not we in the South anticipate this and prepare for it? We have seen that, concurrent, with the introduction of this process into the United States, Birmingham, with her matchless natural advantages and resources, was enjoying her greatest development and progress in furnace building and crude iron manufacture. Had the then existing conditions continued to prevail the necessity for the step now so urgent and important would probably never have arisen, but by the march of progress and civilization those conditions have materially changed; the wants and necessities of the advanced and modern ideas of man have brought it about. To keep pace with the times we must join in this march of progress. It is but the establishment of the "survival of the fittest," both metals being suitable for like purposes and uses that the one of the greatest purity and strength should encroach, excel and finally overthrow is but natural. In this wonderful progress and development our section has not participated, and rather than being benefitted thereby we have been handicapped and embarrassed in undertaking to place our products in a crude and unfinished state on a market gradually becoming restricted and diminished. To such an extent has the consumption of crude iron, as iron, been curtailed that today our markets are practically limited as to large consumers to the cast iron pipe trade and to the stove trade, and the already insignificant foundry and rolling mill trade is slowly but surely slipping from the grasp of the crude iron manufacturers.

The possibilities of Birmingham as a steel-making center are unlimited. It is a conceded fact that pig iron may be manufactured here at a less cost than any other point in the United States; indeed, if not cheaper than anywhere in the world, and the self same conditions which render this possible will enable Birmingham to make the cheapest steel. It would seem that kind providence has smiled upon this particular spot with special favor, and has endowed it with resources and advantages administered by nature's most lavish hand. The Clinton ores, extending in an almost unbroken chain from Clinton County, New York, to a point about thirty miles southwest of Birmingham, growing in thickness and assuming a regular uniform vein as they approach their southern terminal, here come in intimate contact with the coal measures of the Warrior, Cahaba and Coosa fields, and in conjunction with an inexhaustible supply of the purest lime, the bed rock of limpid streams flowing and gushing from the mountain side, form one grand combination and assembly of materials available for the uses and employment and service of man. The supremacy of our great district as a pig iron manufacturing center is attributable to the contiguity of these raw materials, and upon the some conditions may we justly base our hopes and predictions of her possabilities and prospects as a producer of steel, a product removed from pig iron by one short, simple step of further purification and manipulation. At no other point are these Clinton ores found of so great and iniform thickness, nor do they approach in such close proximity to good coking coals.

As unto the product of the blast furnace the cheap raw materials are,
The same relation to the finished steel does our crude pig iron bear,

and when we remember that this marvelous advantage largely more than offsets any possible increase in cost by reason of a greater percentage of impurities to remove, we have the commercial solution of the problem.

In depending upon marketing our pig iron in a crude state our advantage over other sections in lower cost of production is practically met and offset in the freight necessary to be paid to reach consumers' hands, and for many years it has required a great struggle upon the pert of furnace companies in the south to hold their ground, and in meeting the sharp competition of manufacturers not so remote from the centers of consumption they have been compelled to accept prices leaving a very narrow margin of profit. Southern furnaces not so well situated as those of the Birmingham district as regards close proximity of raw materials have been unable to stand this pressure and in many instances have been forced into bankruptcy. This condition is not likely to change so long as we continue to undertake to market our product in the shape of pig iron. It is manifest that the iron interests of the South must go into one of two things. They will have to go into the manufacture of steel or they will have to go into bankruptcy. You may say that we will have the same distance from market to contend with and practically the same freight rates to pay on steel as on pig iron. This is true as regards a very much smaller percentage of the product, but we must not loose sight of the fact that as the product handled rises in the scale of value the item of freight becomes of much less importance. The following comparison showing the original value of the product in Birmingham, the freight rate to Chicago and the proportion which the freight rate bears to the initial value of the article shipped may be of interest to you:

	f. o. b. price.	Frt. to Chicago.	Percentage on initial price.
Grey forge, - - - -	$ 6.30	$3.85	60
Bar iron or steel, - - -	30.00	4.50	15
Sheet iron or steel, - - -	50.00	5.40	10.8

The process to be employed is a simple one, and far less complicated than that of making pig iron. Many are the steps involved in the mining and preparation of the coal, ores and limestone, the coking of the coal and the final conversion in the blast furnace; while in the manufacture of steel only one step further is necessary, that of removing silicon, reducing phosphorus and carbon and regulating and providing manganese, the sulphur being in no wise affected. The work of eliminating and reducing silicon, carbon and phosphorus is effectually accomplished, as you know, by the employment of an oxidizer in conjunction with lime. Oxygen is the agency and oxidation the operation whereby the impurities in the iron are removed or reduced by both the Bessemer and open hearth processes; in the former case by the oxygen in the air being blown through the metal, while in the converter and in the latter case the oxide of iron in the ore put into open hearth with the original metal charge, or by additions after the charge has been melted down of iron oxide into the bath. The basic open hearth, as you are aware, goes one step further than does the Bessemer, in that the oxide of iron in the ore in the presence of lime attacks the phosphorus, converts it into phosphoric acid, which is then taken up and held by the basic slag ; thus depriving the iron of its most objectionable and detrimental element. To this feature of the process alone may be attributed its great commercial and economic value, and in it may we find assurance that grand possibilities are held in store for our district and for the South, to be realized and enjoyed, once it is introduced and developed, on a scale commensurate with the importance and requirements of the case.

An erroneous impression prevails in the minds of many people as to the necessity of a large percentage of scrap iron to the successful working of the basic open hearth process. It is a fact that basic steel of any quality desired might be made from the Alice basic pig and ore without the addition of one pound of scrap iron. This, however, we are free to admit, would be a practice of doubtful economy; and, fortunately, the necessity for adopting such a method (known as the pig and ore method) does not exist. The mills of a plant of the extent and capacity contemplated in the Birmingham district would probably yield 10 or 12 per cent of scrap, and undoubtedly that amount could be secured from other sources. The many industries following in the path of a large steel works in the South would replenish and materially increase the scrap supply. We must not lose sight of the fact that the question involved is purely a commercial one. We can use scrap iron or not, just as our best interest may demand from an economic standpoint. If found desirable to use an amount in excess of what the markets tributary to the district would currently afford, then its equivalent may be had by simply passing molten pig iron through a bath of basic slag, the waste product of the basic open hearth furnace, thereby eliminating the silicon and reducing the carbon. The product of this operation we call "wash metal," and its service in a basic open hearth furnace is such as to warrant, in my opinion, its use under any circumstances. You will doubtless be interested in the following report of a heat of steel made recently by a concern which is consuming monthly large quantities of Birmingham basic iron, and one which occupies an important position among the producers of basic open hearth steel in this country:—

	Lbs.	Lbs.
91 per cent Alabama pig, - - - -		40,000
9 per cent crop ends from blooming mill - -		4,000
Hematic ore, - - - - - -	4,000	
Limestone, - - - - - - -	4,400	
Worked in after melting		
Hematic ore, - - - - - -	2,900	
Burnt lime, - - - - - - -	750	
Final addition. . - - - - -		250
Total, - -		44,250

Weight of ingots, 42,400 pounds; weight of scrap (runners) 925 pounds; weight of product, 43,315 pounds; loss, 1½ pr.ct.

Time from starting to charge to tapping, eleven hours and fifty-five minutes.

Physical tests (average of 3-plate tests)—Thickness of test piece, .290; width of test piece, 1.010; tensile strength, 51.450 pounds per square inch; elastic limit, 35,150 pounds per square inch; reduction of area, 64 per cent; elongation in 8 inches, 31½ per cent; elongation in 2 inches, 51½ per cent.

Chemical tests of finishing steel—Carbon, .11; phosphorus, .016; sulphur, .037; manganese, .30; silicon, .00.

	Alabama Pig.	Scrap.
Silicon,	.52	
Carbon,		10
Phosphorus,	.720	.060
Sulphur,	.020	.060
Manganese,		.35

First test after all was melted—Carbon, 1.40; phosphorus, .24.

After addition of 1000 pounds of ore—Carbon, .86; phosphorus, .09.

Composition of slag before tapping—Silica, 12.98; metalic iron, 12.20; phosphorus acid, 8.13.

I would call your especial attention to the fact that in this heat only 9 per cent of scrap iron was used, that being the product of the mill in the shape of crop ends of billets and blooms; also the extremely low percentage of waste in conversion and the extraordinary quality of the steel.

We have in the Birmingham district everything necessary for the production of steel at a low cost. First and foremost, cheap pig iron ; then an inexhaustible supply of dolomite of a quality perhaps superior for basic lining purposes to that found at any other point in the country, and which may be laid down at the steel furnace at a price not exceeding one-fourth of that paid at present by the Carnegie company at Homestead; in fact, in is being so supplied to the blast furnaces of the Tennessee Coal, Iron and Railroad company in large quantities for fluxing purposes. We have most favorable climatic conditions, cheap labor and cheap fuel. My investigations as to the cost of manufacturing steel billets in the Pittsburg district lead me to believe that in the case of the Bessemer, from the pig metal to the ingot, the cost is about $3 per ton, and from the ingot to the billet $1.50 per ton, in the basic open hearth process, from the pig to the ingot, $4,50 per ton, and from the ingot to the billet, $1.50 per ton. From this it may be seen that the difference in favor of the Bessemer process is only about $1.50 per ton, while the basic open hearth product commands on the market from $2 to $5 per ton more than does the Bessemer, depending upon the quality of the metal furnished.

Permit me at this point to call your attention to the significant fact that by the Bessemer process one price prevails, and one grade, and one only, can be produced, while the basic open hearth, furnishes soft or hard steel, as the case may be, of any analysis or quality desired. Open hearth billets are quoted today at Pittsburg at $5 per ton above Bessemer billets. We are convinced beyond question that steel billets may be manufactured in the Birmingham District, if undertaken under the favorable conditions afforded by a modern plant of large capacity, with ample and improved equipment and facilities for handling materials, at a cost not exceeding $6.50 per ton above the cost of the pig iron. Taking our iron at today's market price, say $7, this would give us billets at a cost of $13.50 per ton at Birmingham. The class of stock that we would produce is now quoted in Pittsburg at $25 per ton, and upon examination of the trade journals you will find the quotation supplemented by the words "in good demand." Based upon a rate of freight of $4.50 per ton, this would leave the Birmingham manufacturer a profit of about $7 per ton in the very heart of our greatest competing district, and in a territory where there is at all times and under any and all conditions an enormous consumption of steel billets. In neutral markets our position would be one of strength and material advantage.

As an evidence that the foregoing figures and estimates are at least conservative, I may say that quite recently a proposition has been made to a large southern furnace company by parties wholly responsible to take their iron at cost and turn over to them steel billets of any size or quality desired at $6 per ton, they proposing to make their profit out of this price paid for conversion. This would indicate that the cost of conversion might be reduced to a figure considerably below our estimate. Assuming that an additional expense of from $1 to $1.50 per ton would be required to make rails, and seeing that the present combination price is $28 per ton at Pittsburg, it becomes apparent that there would be left a very handsome margin of profit in that trade. Indeed, the southern manufacturer must not be satisfied to stop with the billet, but must go on further and furnish to the trade the finished articles of consumption, it being a well known fact that the greatest profit accrues from the manufacture of finished products, and to this may be assigned the wonderful success and achievements of the Carnegie and the Illinois Steel Companies and other large producers in the North and West. Upon this score, however, we scarcely need have anxiety, as once the billets are supplied there will spring up a large and diversified home consumption.

The Commercial club of this city, the Tennessee company, and other firms and individuals are daily in receipt of numerous letters making inquiry as to when steel billets may be had in Birmingham. These communications come from all parts of the country and represent concerns engaged in the manufacture of the greatest variety of products. Agricultural implements, nails, cotton ties, axels, rails, rivets, nuts and bolts, steel castings, etc., etc., will be made here. Who can picture with any degreee of accuracy the full extent of benefits to accrue? Think for one moment of the vast number of people that would necessarily be brought here for direct employment in a large steel works. Once the industry is successfully launched no one can believe that one steel plant only would be the extent of the development. You might just as well imagine that one blast furnace could take care of all the pig iron trade tributary to and controlled by this district. Then think of the multitude that would be brought in and employed by the various smaller industries, the consumers of billets and blooms. It does not stop there. Hundreds upon hundreds of professional men and women in every calling of life are constantly on the lookout for a good town to go to. What do they consider a good town? One where improvement and expansion and development and progress is going on. An increasing population requires accommodation at the hands of men and women of every profession and occupation. The fact of one coming increases the inducement for others to follow, and thus we will go on and on, and some one will do in the Birmingham district what Carnegie has done in Pennsylvania; and Birmingham proper, with her matchless natural resources, mild climate and abundant railroad facilities will become the Pittsburg of the South and the metropolis.

GOLD MINING IN ALABAMA.

WILLIAM M. BREWER.

Before proceeding to a description of some of the occurrences of gold-bearing ores in Alabama, I propose to discuss briefly and also attempt to refute the opinion which to a great extent prevails that gold mining is usually entirely speculative and should not be classed among the legitimate industries. With the knowledge possessed by the present generation of the sciences of geology, metallurgy and mining engineering, it is comparatively easy to determine, not only theoretically, but practically, all the material facts with regard to the gold-bearing ore, and whether such occurrence is of sufficient extent and the ore of sufficient richness to warrant the investment of capital in fully developing and equipping the property for gold mining operations.

Of course the first discovery of gold at any particular location must be followed by an investment, which may be considered purely speculative. But is not such a condition true with regard to every business? For there is a period when the capitalist who proposes to embark in any line of business must make an expenditure on a speculative basis in searching for a location, etc. This is what the gold miner is doing when he goes on a prospecting tour, hoping to make a discovery. If this work is done with proper judgment and system, the greater portion of the speculative character is soon eliminated, and he is able to measure up ore in sight, give the average grade, character of the ore as to its adaptability for the various metallurgical processes, etc.

In my opinion, the reason why so much of the gold mining in Alabama in the past, and, indeed, throughout the entire South, has been attended by failure, is because of the fact, which is clearly demonstrated by examination of nearly any of the occurrences of gold-bearing ore in the section, that the developers of the properties have considered it more essential to sink a large number of shallow pits, scattered here and there and everywhere over the surface, than to concentrate their work at the point of discovery of the precious metal. They seem to forget that one shaft 100 feet deep and a drift 100 feet long below the surface will enable the miner expert to determine the value of a property with more accuracy than a thousand holes two or three feet deep scattered over an area of 75 or 100 acres. The capitalist experienced in the development of mines, never purchases a ton of ore that is not in sight. In other words, he estimates the value of the property entirely on the quantity of ore blocked out in the underground works, and figures from that basis as closely and accurately as the iron master figures the value of the pig iron in his stock yard.

The day has gone by when you could take a man on to a mountain and with smooth talk convince him that he was standing about millions of hidden wealth, which could be extracted by the expenditure of a few thousand.

Taking these arguments into consideration, I am firmly of the opinion that the organization of local development companies, with moderate cash capital at command, and with conservative business men at the helm, for the purpose of investigating and determining, by actual work, the permanency, extent, and value of some of the so-called gold mines in the South, would result in demonstrating to the world at large that there were some properties in the Appalachain mountains, and in Alabama in particular, which would warrant the investment of capital sufficient to operate the same on an extensive scale.

Quantity of ore is one of the most important factors in determining the value of a gold mine. Grade to-day is a secondary consideration, because it has been proven in the black hills of South Dakota, as well as in Alaska, that a large body of low grade ore can be worked more profitably than a small body of high grade.

After having spent nearly five years in visiting the various gold mining districts of Alabama and Georgia, I am convinced that Alabama presents many opportunities for successful operations, because of the occurrences in that State of really a comparatively great number of large bodies of low grade ore; but it is useless to look for bonanzas. These extensive bodies of low grade ore to which I refer are located in Cleburne, Randolph, Clay and Tallapoosa counties, and in several different localities there are exposed ore bodies ranging from 13 to 50 feet in thickness,, and producing ore which will grade from $3 to $6 per ton, if treated by barrel chlorination. No really deep work has been done on any of these locations, but on Crooked creek, in Randolph county, on what is known as the Pine Hill property, an incline shaft 80 feet deep has been sunk during the last spring, and a drift 100 feet long driven on the ore body which occurs in a semi-crystalline slate country rock. In these workings a vein 13 feet thick has been exposed, which shows by panning test pure gold through the entire thickness. A car-load of the ore will be tested within a few weeks at the sampling chlorination works of the Mecklenburg Iron company, at Charlotte, N. C. The prospecting of the property has been under my own superintendence, and the future work will depend entirely on the results obtained from this sampling. The cost of the mining has been about 75 cents a foot, with the openings all six feet high and wide enough for trams.

On an adjoining property in this same district, a syndicate from Indiana is erecting a plant furnished with two Crawford mills to treat the same variety of ore I have found on the Pine Hill property.

The structure of the ore bodies in this district is generally such as I would designate as stratified deposits,* rather than

*I have referred to these ore bodies as stratified bodies, because I desire to provoke discussion. From my observation, I can see no reason for designating such as veins; unless it can be clearly demonstrated that the deposition of auriferous material followed the fracturing of the formation. I desire the opinion of some one more competent than myself to settle the question.

veins, although at Pine Hill we have well defined slate walls enclosing the ore body; yet we find that the body itself is really composed of strata of quartz, decomposed slate, clay, and arsenical pyrites, and that the structure is lenticular, inasmuch as we find in the workings one lens nearly 80 feet long, which perches out at both extremities, and near where it commences to become narrower towards the northeast it is overlapped by another distinct lens. This we have followed in the drift about 50 feet, and have not yet reached its maximum thickness. In the downward trend of one lens, I determined by the incline shaft that it maintained its continuity with great regularity, and the bottom of the shaft to-day exposes 13 feet of vein material which prospects by panning the entire thickness. At other locations in the same district, I do not find the well defined walls we have at Pine Hill, and the structure has all the appearance of stratified deposits.

From my knowledge of the chlorination, I am convinced that if this ore will average $5 per ton, I can work the mine successfully, even if I am compelled to treat the ore by direct chlorination, which means roasting the entire product of the ore body and treating the same, instead of following the Thesis practice of amalgamation of the concentrates.

None of the other properties in this district have been developed to the same extent as Pine Hill; but, from the work that has been done on them, I am of the opinion that there will be but very little difference found between any of them, either as to the extent of the ore bodies or average of grade; and so far as the chemical character of the ores from different locations is concerned, there is comparatively no difference.

In Cleburn county, the Hicks-Wise mine, which was worked for a few months in 1893 by a miner from Colorado, showed the most extensive body of ore known in that county. To-day the workings have all caved in because of the suspension of work, which was caused by the business depression and the inability of the lessee to negotiate a sale.

I visited this property in 1893 and examined the workings, which consisted of an incline shaft 107 feet in depth and about 100 feet of drifting on the 85-foot level. I found that the ore had been stopped out at the 40-foot level for a thickness of 16 feet and milled in a ten-stamp mill. This, I am informed, yielded aboue $2 per ton by amalgamation, while the ore from the bottom of the shaft, which carried quite a large percentage of sulphuret, assayed about $14 per ton. The occurrence of a cave in the workings, soon after operations were suspended, demonstrated the fact that the maximum thickness of the ore body was nearly thirty feet, but what was its grade for that thickness has never been determined, to my knowledge.

In Tallapoosa county, we find the extensive ore bodies are composed of lenses of quartz, interleaved with graphitic slate, and so closely are the slate and quartz associated that mining has to be carried on by the quarry or open cut system, and the entire mass sent to the mill without sorting. By amalgamation something less than $2 a ton is saved, as I am informed by the superintendent of the mine. From pan tests, which I made myself in 1893, from a fair average of the material sent to the mill, I am firmly convinced that the ore carries much greater value, but I could not ascertain the average assay value. There is evidently great loss, though, for the reason that the graphite sickens the quicksilver on the plates, and in consequence the particles of gold fail to amalgamate and are carried off through the sluices with the tailings. When I last saw the mine being worked, the material sent to the mill was from an ore body about 50 feet in thickness, with the heading of the open cut some 30 feet deep. I have been informed several times since my visit in 1893, that this property has been in active operation most of the time; and the superintendent has told me that he has been experimenting with a view to eliminating the graphite from the ore, but up to a few months back his experiments had not been attended with any signal success.

In Clay county, the large deposits of low grade ore are located near the west flank of the Talladega mountains, occurring in mica schist and horn-blendic schist country rock. Two ore bodies have been partially developed, which show a thickness of fifty feet of pay ore. One of these, known as the Idaho mine, on which operations were conducted for several months about seven or eight years ago, yielded, I am informed, satis factory results by amalgamation, when the material was quarried a thickness of fifty feet and sent to the mill without sorting. Litigation, which has recently been decided, caused suspension of the work. The company is now putting in a Huntington mill, because the superintendent is of the opinion that the ore can be more successfully treated in that description of a mill than in any ordinary stamp mill.

This new mill will probably be in operation about the end of June next, and the results from its work will undoubtedly prove very beneficial, not only to the immediate district, but to the entire State; because in this same belt of country rock in which the Idaho mine is situated there are several ore bodies possessing very much the same characteristics, and if ore is successfully treated in the Huntington mill, it will prove an incentive to owners of other properties to commence work, because the Huntington mill is one of the cheapest gold mining plants manufactured.

Some of the reasons for the policy of the superintendent in making a change are, that there is a great deal of clay associated with the ore, which is a very undesirable factor in stamp milling, because it reduces the crushing capacity to a minimum by clogging the screens. There is also associated with the ore large quantities of decomposed mica schist, which, while it is not actually talcose, yet is sufficiently talcoid to cause slimes to form, in which small and light particles of gold are held in suspension, and pass off with the tailing. In feeding quicksilver into the battery, the clay hinders it from becoming properly disseminated through the pulp in the mortar. There is also associated with this ore quite considerable wad, which to some extent interferes with perfectly satisfactory amalgamation.

By introducing the Huntington mill, the superintendent expects to overcome all these objectionable features by treating the soft and claey ores in that mill and the harder quartzite in the old stamp mill. So far as the work has progressed on this mine, no sulphurets have been encountered, but no mining has been carried on yet below water level.

The average yield by amalgamation of this ore when the mine was in operation was about $2 per ton, and the cost of mining and treating the ore did not exceed $1. The crushing capacity of the old plant was about thirty tons per day, and that of the old and new plants will be about seventy-five tons per day. Of course at the present time there is some little extra expense to be considered in reopening, which is properly chargeable to cost of mining, and the capital in the new plant is chargeable to milling expense, or at least the interest on such is. Therefore, when operations are resumed, I doubt if the extremely low cost for mining and milling which I have referred to can be maintained; and it would also appear as though that when deeper mining becomes necessary the cost would be increased; but the superintendent informs me that, taking everything into consideration, he expects to mine and mill this ore for a long time to come at a cost not to exceed $1 per ton.

I could continue this description of occurrences of extensive low grade ore bodies in Alabama, which have come under my own observation for a considerable length of time, but the illustrations I have given are sufficient to convey to your minds an intelligent idea of what results may be expected from operating in these gold fields, provided cool judgment, conservatism, and experience are combined in the management.

I have not referred to the richer, but less extensive, ore bodies of the Arbacoochee district, because operations are being conducted there by a Chattanooga syndicate, which is prospecting a large tract of that district. I am personally unacquainted with the results of these operations, and as I understand the prospecting is far from complete, any reference to the work performed in the past, of which I have personal knowledge, I consider might be prejudicial to the interests of the present operators. Some very rich quartz, as well as valuable nuggets and a large amount of placer gold, have been taken from the Arbacoochee district in years gone by. When the work of the present operators has been carried further, a record of their discoveries will no doubt prove very interesting.

There have been some monumental failures, not only in Alabama but throughout the entire South, in the last decade, but I attribute most of them to the "tender foot" characteristics of the operators, or else to the fact of the lack of capital, rather than to lack of ore of sufficiently high grade, if properly worked, to result to the profit of the investors.

COAL WASHING.

DESCRIPTION OF BROOKWOOD WASHER.

BY F. M. JACKSON.

Several times I have been importuned by members of this Society to prepare an article on Coal Washing, especially describing the washer built and now in successful operation by the Standard Coal Company. Circumstances beyond control have heretofore prevented my complying In submitting this article, I do so with considerable temerity, as so many more competent than myself have given years of study to this question, and have presented to the public mature and exhaustive papers on the subject.

The subject of the improvement of coke has had the consideration of the coke manufacturer, in the United States, but few years. Not until sharp competition in iron production, and the consequent lowering of prices, was economy in the manufacture of coke thought of to any appreciable extent. I believe it was in 1891 that Col. A. M. Shook visited England and came back impressed with the idea that if the pig iron producers of this district expected to keep pace with the balance of the world, they would be compelled to better prepare the coke. Through his influence and efforts coal washing was given the first earnest consideration in this district; at least, my first impression of the great importance of it was obtained from him.

The Standard Coal Company became strongly impressed with the idea of washing coal, on account of the poor quality of coke made from a seam of coal that is generally known as the "University" seam, in the south-western Warrior basin, in Tuscaloosa County. The first efforts to improve the coke was a purchase of a Steadman Disintegrator, for the purpose of grinding the coal before coking. This resulted in making a good looking coke, but those elements, undesirable in all foundry and furnace use, sulphur and ash, still remained to an excessive extent, and, though the coke had a fine appearance, it was not desirable. It was then that Mr. H. L. Einstein, the President of the Standard Coal Company, engaged a party to look into the coal washing plants in Europe. After a careful study of the various ones employed, both in Germany and England, he concluded that the jigging principle was the most reliable and useful. After having the report of this expert, it was decided to erect a coal washer, and to this end Mr. Walter M. Stein was employed to estimate and report on the cost of constructing a plant at Brookwood. His plans and estimates were accepted, and he was ordered to proceed with the work of building.

The system he employed was a very old one, but improved in the course of many years by manufacturers of machinery, engineers and mine managers. The first similar plant on record was built in the Plauen Coal District, in Saxony, as far back as 1830. Who built it, is not recorded. The general introduction of similar plants, in Germany, commenced in the early Sixties. Professor Rittenger's celebrated book of 1867 was a big help to all working in the line of preparing coal, ore, etc. He gave in it the law for falling bodies in water, which clearly defined the theory of washing.

The plans Mr. Stein followed in erecting our washer were the same employed by Schuchterman and Cremer, of Germany. It is similar in many respects to the Luehrig System, there being, however, one main point of difference, as follows: Both systems crush the coal to the required fineness before washing down to free the impurities. The Luehrig people only crush down to 1½ inches before washing, depending on re-crushing the large sizes and re-washing in many cases; while the system Mr. Stein employed required the coal to be crushed to not over ⅜ of an inch in size, and in all cases before washing or jigging.

He also allowed longer jig beds. I am informed that he now makes, in many instances, beds as long as 16 feet, which is claimed to be of great advantage.

Since our washer was erected, Mr. Stein has made improvements in machinery that increases the desirability of this kind of washer. Improvements have also been made on the Brookwood washer, and it is now virtually in perfect shape and working daily, with a capacity of 500 tons of washed coal in ten hours.

In connection with the washer at Brookwood, there is machinery such as shaking-screens, picking bands, and lump-loader, for the more perfect handling of screened coal. The picking-bands and lump-loader are new features in the handling of coal in this district, and the result of the work is eminently satisfactory.

In Mr. John Fulton's book, recently issued, the plan and general description of the washer, by Mr. Rudolph Boericke, who assisted Mr. Stein in erecting it, is ably and correctly given. The description is as full as need be, and those interested I respectfully refer to the same.

The next important question in interest is: Has the washer proven practically successful? To this question I reply, "yes"; and give in a general way the results. It has enabled the Standard Coal Company to produce a coke of uniform quality and of extraordinary structure, the average analysis of which invariably runs below 10 per cent. ash and 1 per cent sulphur. Analyses are made as often as is necessary to keep up with the quality. The total result shows, for the last six months, the average ash to be 8.80 and sulphur .74 of 1 per cent. These analyses were made by our Mining Engineer and Chemist, Mr. L. A. O. Gabany. These results are obtained, whereas coke formerly produced from the same coal contained ash often as high as 18 per cent., and never under 13 to 15 per cent, and sulphur 1.50 to 1.75. The loss by washing averages 6½ to 9 per cent; that is, we account for all the coal put into the washer except this 6½ to 9 per cent, which is washed out and lost in impurities and waste coal. Careful tests of coal in the impurities washed out have never shown over 3½ under ordinary running conditions; it often runs below 2 per cent.

The jigs, eleven in number, are double compartments. The raw coal enters at one end, runs across both compartments and out at the other end as the washed product. The slate pyrites and barites, and all other heavy particles, find their way down through the bottom of the jig and flow out through the slate valve in a constant stream. It has been deemed necessary to use only feldspar as a bed to successfully wash the coal, the first beds in the jigs being made with imported feldspar. The question of cost of this feldspar was so serious that experiments with other material was made. The quartz pebbles, so numerous about Brookwood, were tried and proved equally as satisfactory as the feldspar, and since then are used altogether. There are three sizes of jigs and screens, five ⅝'', three ⅜'', and three ¼'' in diameter; these we term coarse, medium, and fine. A comparison of three days work of these jigs is given below :

March	Slack coal to Washer.	Washed coal from 3 fine jigs.	Washed coal from 3 med. jigs	Washed coal from 5 coarse j.	Washed coal from all jigs.	No. tons coal put through	No. tons refuse dumped	Per ct. lost.	Per ct, coal in refuse.
10th,	11.6 ash. 1.57 sulp.	4.20 ash. .96 suph.	5.25 ash. .979 sulp.	5.15 ash. .87 sulph.	5.50 ash. .91 sulph.	560	38	6.78	1.98
11th,	10.3 ash. 1.30 sulp.	4.70 ash. .80 sulph.	4.50 ash. .98 sulp.	6.75 ash. .95 sulph.	5.40 ash. .89 sulph.	562	40	7.11	2.10
12th,	11.85 ash. 1.43 sulp.	4.50 ash. .82 sulp.	3.20 ash. .90 sulpy;	5.85 ash. .95 sulph.	5.00 ash. .90 sulph.	550	36	6.55	2.00

It will be noticed that the best results are obtained from the fine and medium jigs, thus proving that the fine coal can be treated more advantageously than coarse coal. The analyses and results given are carefully made, though not checked, and any apparent discrepancy can be accounted for in this way.

The washing of coal by the jigging process is, I believe, practiced in Alabama only by the Standard Coal Company. That it has proved successful, any one familiar with the coke produced at Brookwood is well aware. To those interested in the washer I will, therefore, be glad to impart any information not contained in this article.

REPORT OF THE SECRETARY.

Alabama Industrial and Scientific Society,
Secretary's Office,
University, Ala., May 12, 1396.

During the past year the Proceedings of the Society have been published in an edition of 500 copies, for which was paid the sum of $81.50, or $1.25 a page. In addition to this, circulars announcing the times of meeting and blank ballots have been sent out to the members.

Since the last annual meeting, we have had three additions to our number and one resignation, making an increase of two.

At the present time, our list shows the following condition of things: 17 have paid up all dues to date; 6 are behind on the last assessment, i. e., for the current year; 8 are behind for this and last year; 5 are delinquent three years; 3 are delinquent four years; 1 is delinquent for five years.

These, forty in number, are counted among our active members.

Thirty-five have paid their first year's dues, i. e., for the year 1891, which was the first year of the Society, and have made no further payments. According to instructions of the Society, these were dropped from the list a year or two ago. One has never paid for any year, also dropped; and, upon the books, on taking charge of the Secretary's I found 18 names of persons who appear never to have been members—at least, no payments have been made by them.

There are two matters concerning which some discussion might be in order, viz: The propriety of making the first assessment of those who join the Society at the fall meeting (which is usually in November, and thus practically at the close of the year), to begin with the following year. Should this be done, and the action made to apply to those who have heretofore joined at the fall meetings and made their payments for the same year, it would result in the crediting ten members with one year's payment of dues, in all amounting to $90.00.

We have not been very rigid in the enforcement of the rule of the Society, which requires full payment of dues, or no arrearages, as a qualification for giving a vote for the officers of the Society; nor do I think it would be advisable to enforce this too strictly at this time.

I shall be glad to hear the views of the Society with regard to the standing of members several years in arrears, and also to have instructions as to my course in regard to them. I have sent out the notices of dues at regular intervals, and can do no more. We have our by-laws on the subject, but I should like to be sure of my duty on the enforcing of them, especially in view of the leniency recommended in regard to this matter several years ago.

Mr. John Fulton, who agreed to prepare for this meeting a lecture on "Recovery Coke Ovens," and their adaptation to the Birmingham District, writes that he has been unable to prepare this in time for the present meeting, but will furnish it later.

Additions to the Library.—Journal of the Elisha Mitchell Scientific Society, 1895; Technology Quarterly for 1895; Circulars of Johns-Hopkins University; Program of the Royal Mining Academy—Clansthal; Sixteenth Annual Report of the Ohio Society of Surveyors and Civil Engineers.

EUGENE A. SMITH,
Secretary.

REPORT OF THE TREASURER FOR 1895-96.

UNIVERSITY, ALA, MAY 12, 1896.

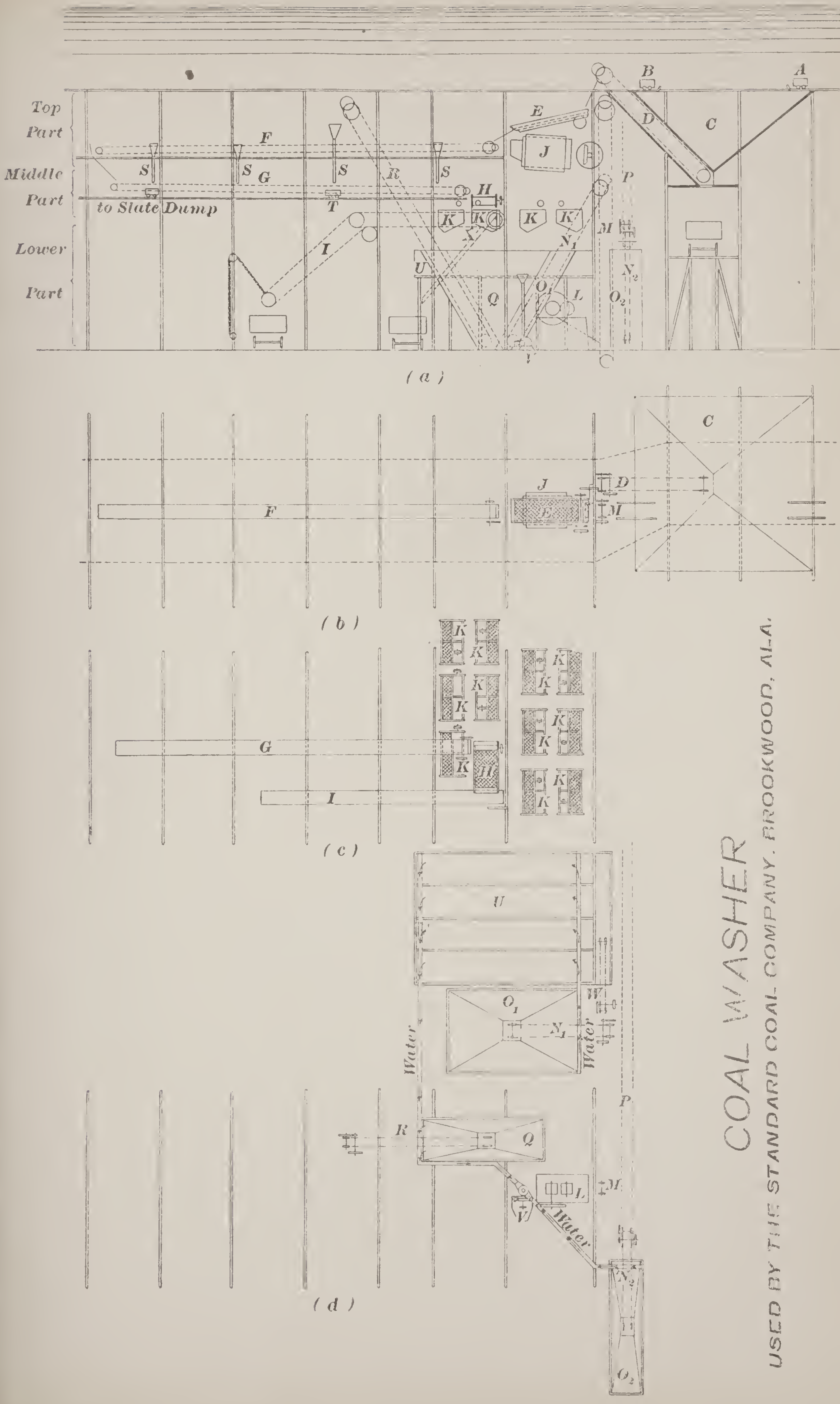
RECEIPTS.

From Cash in Treasury, as per Treasurer's Report of June 8, 1895, - -	$ 74 28	
From Annual Dues, - - - -	138 60	—$212 28

EXPENDITURES.

For Printing and Stationery, - -	$ 81 50	
For Postage, - - - - - -	10 50	
For Advertising Meetings, - - -	7 65	
For Reporting Proceedings, - - -	3 00	—$102 65
Balance in Treasury, - - -		$109 63

HENRY MCCALLEY,
Treasurer.



COAL WASHER

USED BY THE STANDARD COAL COMPANY, BROOKWOOD, ALA.

PROCEEDINGS

OF THE

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

VOLUME VI.---PART II.

1896

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OF THE

ALABAMA INDUSTRIAL
AND
SCIENTIFIC SOCIETY.

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1896

PUBLISHED BY THE SOCIETY.

SECRETARY'S OFFICE.
UNIVERSITY POST OFFICE.
ALABAMA.

BURTON & WEATHERFORD, TUSKALOOSA.

OFFICERS.
1896.

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TREASURER.

Henry McCalley, - - - - University, Ala.

SECRETARY.

Eugene A. Smith, - - - - University, Ala.

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AUTUMN MEETING.

BIRMINGHAM, ALA., DECEMBER 15, 1896.

The regular Fall Meeting of the Society was held in the rooms of the Commercial Club, on Tuesday, December 15th, at 3 P. M.

President Jackson in the Chair. Present: Dr. W. B. Phillips, W. M. Brewer, J. R. Harris, J. A. Montgomery, J. D. Hillhouse, Chas. J. Geohegan, Erskine Ramsay, R. F. Manly, Henry McCalley, Eugene A. Smith, W. J. Boles, H. F. Wilson, Sr., Col. Horace Harding, Dr. Jackson, representatives of the press and other visitors.

Reading of the Minutes was dispensed with, since they had already been printed in the Proceedings and distributed to members.

The Committee on Collection of Statistics of Coal, Iron, etc., reported through Dr. Phillips, that Mr. W. M. Brewer had agreed to undertake the collection of these statistics under the auspices of the Society and of the Geological Survey. The statistics would be collected monthly and furnished to such papers of the State, and journals out of the State, as might wish to publish the same, and the records kept on file by the Secretary of this Society and the State Geologist. This to be done without expense to the Society.

Dr. Phillips proposed for honorary membership, the name of His Excellency Governor Joseph F. Johnston, who was unanimously elected.

Mr. Brewer then read a paper, by Mr. Joshua Franklin, on

Gold Milling in Alabama. This paper will be found in full in the printed Proceedings of the Society.

Mr. Brewer's own paper, on the Manganese Deposits of Georgia, having been delayed in the mail, was read by title only, and will be found in full in the Proceedings.

There being no other papers before the Society, discussion of appropriate topics was declared in order. A long and interesting discussion ensued upon the general subject of Coking of Coal and of Recovery Ovens and By-products, in which Dr. Phillips, Col. Montgomery, Col. Jackson, Mr. Ramsay, and others, took part.

Dr. Phillips called attention to the great differences in the quality of the coke drawn from the same oven, from the middle of the oven and from same horizontal plane, and thinks these differences due to the watering. When under-watered, the coke was very tough and variable in quality, pieces in close proximity showing very different degrees of porosity. He thought that the coke should be drawn as soon as it was cool enough to permit it.

Col. Jackson, Col. Montgomery, and Mr. Ramsay spoke of their own experience in this line. The latter did not feel sure that the coke had not received its porosity before being watered.

Col. Jackson thought the watering caused the coke to break up more effectually, while the porosity he thought due to the quality of the coal and the manner of heating.

Col. Jackson also gave results of some experiments conducted by him at Brookwood with six ovens, on the recovery of by-products. These experiments were not yet successful, from insufficiency of heat; the coke also was inferior. It is his intention to continue the experiments.

Dr. Phillips gave next an account of some coke or carbon deposited upon the surface and in the crevices of some blocks of dolomite placed in the ovens of the Tennessee Company.

This carbon must have been deposited from decomposition of the gases of the oven ; it contained less than 1 per cent of ash, and the structure, as seen under the microscope, was quite different from that of ordinary coke. Mention was next made of the so-called "hair" or whiskers of the coke ovens, which he said were also pure carbon—1 to 1½ per cent of ash. These hairs are hollow, and to produce them a great heat is needed.

Suggestion was made that the various companies might profitably club together and provide a small fund for the purpose of paying the expense of further systematic experimenting on coke, and the suggestion met with the hearty approval of the Society.

Dr. Phillips then spoke of a sample of coke which had been made in a Thomas oven from washed, disintegrated (Stedman disintegrator) slack from the Pratt seam. This coke could not be crushed by his testing machine at three thousand pounds pressure, while ordinary coke gave way at two thousand pounds.

Some remarks were made by Col. Jackson of his attempt recently to introduce the sludge, or fine material from his coal washer, into the market for use as foundry facing, but without success, as the foundry men here prefer the anthracite sludge; though at the North bituminous sludge is much used.

The discussion then turned upon recovery ovens, and it was shown that the by-products were of far greater value than the coke itself. The ammonium sulphate, ammonium chloride, the ammonia, aniline dyes, paraffine, and all other valuable materials now completely wasted by us, are every year purchased abroad and imported into this country. The refuse gas from the recovery ovens also should have a great future in the heating of houses, etc.

In this connection, Mr. Ramsay said that at Pratt City, where, as shown in his paper before this Society some years ago, they utilize the waste gas from the coking ovens in making steam, the gas from every three tons of coal coked was equivalent in heating effect to one ton of coal. It appears further, that there is not a recovery plant in England, though many are in successful operation in Germany.

It was agreed that this Society continue upon all occasions to urge the establishment of recovery plants in this district, whereby to put a stop to the enormous waste which the present style of beehive ovens entails.

It was voted that the thanks of the Society be tendered to Mr. Boles and to the authorities of the Commercial Club for their courtesy in permitting the use of their rooms for this meeting.

Adjournment.

EUGENE A. SMITH,
Secretary.

GOLD MILLING IN CLAY COUNTY, ALABAMA, AT THE IDAHO MINE.

JOSHUA FRANKLIN.

The principal ore body of the Idaho Mine is a hornblende schist decomposed in place, which carries free gold. The ore is low grade, and contains a great deal of clay; besides, the gold ore is very fine flaky colors, by reason of which the value was difficult to save under the old system, with a hand-fed stamp mill, apron plate, and riffled tailing flume; for the large amount of clay called for too much water to wash out the mortars and clear the plates. Besides, it glazed over the sand in the tailing flume with a crust which allowed the little globules of quicksilver to roll away. Too much water hinders amalgamation and sweeps off such fine flaky colors. Clay makes the pulp thick and viscid like oil, and thus retards the precipitation of the finer gold particles. Doubtless it also impedes amalgamation by fouling the bright surfaces of the metals. But it does the most mischief by making the ore bank in the mortar with the least over-feeding, and that is very difficult to avoid, as the ore is not always hard enough to hold the stamps off the dies. Another trouble is, that it fills the interstices of the broken ore in the batteries as mortar fills between the rocks of a stone wall; in consequence of which, when quicksilver is fed in the mortar, instead of sinking through crushed ore, as would happen if it were quartz, it rolls into the hollows like ducks' nests, which form under each stamp when the ore is at all banked, from whence it is quickly thrown out by the falling stamps before it has had time to do its work.

To obviate these evils, a five-foot Huntington Mill and shaking coppers were added to the plant, also a self-feeder to one of the five-stamp batteries. These were supplemented by broad blanket sluices and amalgam traps. The ore that will not pass through the one-inch spaces of a grizzly is fed into a 7 by 9 Dodge Crusher, which prepares it for the stamp mill. The Huntington mill, unlike the stamp mill, saves most of the value in the battery, and instead of crushing the ore on top of the die like a stamp mill, it grinds it between a ring die, which surrounds the inside of the mill, and a series of heavy rollers which press outward against it by centrifugal force as they fly around 70 times per minute. These rollers are suspended one inch above the mill bottom, and when quicksivlver is fed into it or colors of gold are disengaged, they fall to the bottom, where they are agitated but not thrown out by the scrapers which move around with the rollers. Thus the two metals are brought in contact in a most effectual manner. In consequence, three times as much value remains safely within the mill as is found in the mortar of a stamp battery. Hence, the great superiority of the Huntington mill as an amalgamator. It is also a very efficient crusher of soft ore. Its great screening area—three times that of a stamp mill—gives is a fine discharge, hence it does not require so much water to the ton of ore. And I feel confident that the Huntington mill, together with the shaking copper supplemented by broad blanket sluices, will entirely revolutionize gold saving in this class of ores, which Dr. Becker calls "saprolites."

The shaking copper is nothing more than a regular plate of sheet copper electro-plated, which vibrates one inch from side to side 200 times per minute. This is in imitation of the movement given a gold pan or sieve by hand, thereby causing the heavier materials, such as gold or mercury, to sink more quickly in the moving pulp until they come in contact with the amalgamated surface of the plate. This simple invention is, I find, a great boon. Its value is hard to over-estimate in treating our clay ores practically ; neither gold nor amalgam pass it. But it will not stop quicksilver altogether—though in this respect it is greatly superior to the stationary apron plate, which required three times as much water and three times as much fall to keep this clay from clogging the plates. I have a set of stationary plates below the shaking coppers, and, although they are barred with riffles, they catch nothing except when the shaking coppers chance to be out of order. But I have blanket sluices below these plates, which are tested every hour at least, and they catch a good deal of runaway quicksilver. The "blanketings" are returned to the hopper of the self-feeder of the Huntington mill. There are amalgam traps at the end of the tailing flume, which are stirred when the blankets are washed. The object of this is, to break the crust which clay forms over the sand in them, which would enable the little globules of quicksilver to roll away and be lost.

As our ore is low grade, all is planned with a view to milling a large amount of ore at as small a cost as possible. To that end, the ore body is connected with the mill by a small single-track railway 180 yards long. There is a switch and double track at the ore body, and two carts of the scoop pattern are in use, so that while one is being filled the other runs by gravity to the mill, only receiving a push to start. It is pushed back by hand. The time occupied by the round trip is less than five minutes. Each cart contains one-third of a ton of ore, which is dumped on a ten-foot grizzly at a point 24 feet higher than the mills. The grizzly is set at an angle of 40 degrees, and the spaces between the bars is one inch wide. The fine and most decomposed ore falls through the grizzly into a bin capable of holding 70 tons, opposite the chute which supplies the Huntington mill. The bottom of the ore bin is set at an angle of 45 degrees, so that the ore slides down into the hoppers of the self-feeders of the mills. The larger lumps of ore roll off the grizzly on the floor above the bins, and are fed by hand into a 7 by 9 Dodge crusher. This is the only case in which ore is handled a second time during treatment, all else being automatic. I intend to put in movable lines of strong plank by the sides of the ore body in the mine, into which the ore can fall as it is shot down. From thence it can slide as required into the ore carts and thus save further expenses. I can save shoveling on two-thirds of our ore and waste in that way, but not until the mine is opened wider than it is at present. The crushed ore falls into the ore bins at a point opposite the stamp mill, hence it receives hard ore mostly while the Huntington receives the softer parts. The self-feeder of this mill is driven by a belt, and the amount of ore fed is measured in regardless of the capacity of the mill; but the feeder of the stamp mill acts automatically, the amount fed being regulated by the middle stamp, which is so arranged that when the stamp nearly touches the die, a little ore is pushed into the mortal.

At present I am using one-millimeter slot screens on the Huntington mill and two-millimeter round punched screens on the stamp mill, which latter does about ten tons per twenty-four hours, while the Huntington crushes twenty tons in the same time. Yet the latter will require only just the same amount of water as the former, that is, within the mill. It is supplied with water by three pipes—one ¾-inch at each side to clear the outside gutters and one ½ inch pipe in the middle, which delivers into the mill. The stamp battery receives water through the same sized pipe, with the same head. There are eight feet from the supply tank to point of delivery. The pulp from both mills passes directly over shaking coppers, thence over stationary coppers, which are barred with riffles. These are put only as a precaution in case anything should go wrong with the first plates. Next below these are blanket sluices, which are eight feet wide at the Huntington mill and four feet wide at the stamp mill. From those, the tailings drop into a flume, at the outer end of which are placed mercury traps, which save such quicksilver as chances to pass the blanket sluices.

At present I am troubled for water, as the springs in the gulch are very low and are (in the absence of rain) not sufficient to supply our pond from which the water is pumped to supply the mills. This can easily be prevented in future, and

I expect, when I have sufficient water, to add to the plant a hydraulic sizer or concentrator.

I have had as assistants only green hands taken from the cotton fields, and as far as possible everything is planned so, I have to depend as little as possible on their skill and watchfulness. For that reason I arranged the water pipes in the way spoken of. For it is a cardinal principle of amalgamation and gold saving on plates that not one drop of water more than is necessary should be used, as it hinders the union of gold and mercury, and helps the grit of the pulp to scour off the amalgam adhering to the plates, and having found the minimum quantity of water necessary, I can have it by opening the globe valve in full, and the right amount of water is measured exactly without depending on the judgment of the mill man. Quicksilver is fed into the batteries every few hours, in exact measure, giving three times as much by weight as the ore yields in gold. This has to be checked and corrected by the condition of the plates. Thus, if we find the amalgam so hard that it cannot be moved by the finger, more quicksilver is needed; and when it is soft and thin the supply of quicksilver is cut off. In the former case, there is loss by gold passing over unamalgamated; and in the latter case the amalgam is liable to be scoured off. And here is a case requiring perpetual vigilance and skill, which green hands do not usually display. But we are pioneers in the business, and must have patience.

[Note—Mr. Brewer, who had charge of this mill for a month during the past summer, states that the entire cost of mining and milling this ore is a trifle over 50 cents per ton.
—E.A.S.]

THE MANGANESE ORES OF GEORGIA.

AN INDUSTRY THAT HAS BEEN IN OPERATION FOR OVER HALF A CENTURY.

WILLIAM M. BREWER.

The mining and shipping of manganese ores from Georgia dates back nearly fifty years. The United States geological survey, in the statistical volumes published by the division of mineral resources, David T. Day, chief, gives the earliest productions as in 1866, and the quantity for that year 550 long tons. The total productions of the State from that time to January, 1896, is given as 66,318 tons of 2,240 pounds each.

Georgia occupies the proud distinction of being the second largest producer of manganese ore in the United States—Virginia occupying first place, producing between 1880 and 1890, inclusive, 158,312 tons.

The deposits of ore which have been producing this tonnage from Georgia occur principally in the counties of Bartow and Floyd, and are known to the world as the Cartersville and Cave Springs districts, the former being in Bartow county and the latter in Floyd. The ore has also been found in Catoosa county, but although an extensive plant was erected in that county at Tunnel Hill, some years since, for washing and jigging, yet it has never been put in operation.

These deposits are usually found associated with the Knox Dolomite series of the Lower Silurian period, and occupying positions on ridges, one chain of which extends northerly from the vicinity of Cave Spring toward the Etowah river ; another extends northerly from the Etowah river and near the boundary line dividing Bartow and Floyd counties ; another, known as the Tunnel Hill district, on the eastern border of Catoosa county, and the Cartersville district, the deposits belonging to which occupy positions on ridges which are situated on the north side of the Etowah river, northeasterly from Cartersville.

In this last named district the deposits occur in the Cambrian formation, and are really the most important and extensive in the State. It is a noticeable fact that all the bodies of manganese ore which have any commercial value, either past or present, are situated near the southeastern border of Paleozoic formation and usually in that area, although sometimes we find them in the semi-crystalline in close proximity to the line of contact between the slates and shales or slates and dolomite.

Dr. Spencer, in his report on the Paleozoic group of Georgia, refers to the occurrences of manganese as occupying belts and extending for considerable distances longitudinally. Such a statement may be considered as correct if theoretical conditions are considered. But whenever we take up the subject on a commercial basis, to discuss, not the theoretical conditions, but the practical and economic, we find that the belt theory will not hold water, because the ore occurs in pockets in a similar manner as brown iron ore. At least, I formed this opinion from personal observation of the manganese producing sections, and was entirely unable to discover any evidences connecting one deposit with another.

In 1895, while collecting the mineral exhibit for the State of Georgia to be displayed at the Atlanta Exposition, I visited all the bodies of manganese ore in the State, and obtained specimens therefrom. I then formed the opinion that, although near Tunnel Hill such an expensive plant had been erected and a vast amount of work performed, yet that the ore taken should more rightfully be classed as maganiferous iron ore than as manganese.

As all the openings were closed at the time of my visit, and the washing plant had never been put in operation, I could only form my opinion from the ore I found in the dumps near the mouths of the shafts, and from the surface indications, consequently I may have formed an erroneous idea of the property, which an examination into the openings would have corrected.

THE WOODLANDS OR BARNSLEY DISTRICT,

which is very fully described by Dr. Spencer, in his report, and is situated near the border of Bartow and Floyd counties on the north side of the Etowah river, was not in any condition for a critical examination at the time of my visit, and, in fact, I found no evidence except surface indications, from the deep red color of the soil, and finding nodules of manganese ore and bauxite. However, a systematic exploration of the district might result in revealing the occurrence of deposits of ore possessing a commercial value. So far as I could learn, such had never been undertaken by any one, therefore the future prospects of the Woodlands as a producer of manganese is entirely problematical. The districts which have produced by far the greatest quantity of manganese ore in Georgia are the Cartersville and Cave Spring. As I have already stated, Dr. Spencer describes the occurrences in the Cartersville district as belonging to the metamorphic formation, but when I visited this district in 1865, I found that the deposits which had been mined and classed as producers were situated in close proximity to the brown iron ore banks on the north side of the Etowah river, and the Knox Dolomite series of the Lower Silurian. Beds of ochre also occur in association with the manganese ores, which have evidently been formed by the decomposition of the ores, and several of these beds have been producers of ochre on a commercial scale for some years past, the ochre having been manufactured into paint at works located at Cartersville and Emerson.

The Etowah Iron Company, which purchased the property originally owned by Major Cooper in the fifties, and on which was located one of the primitive stone stack iron furnaces, erected in 1890 a very extensive washer plant for preparing manganese ore for market. It is completely equipped with "jigs," revolving screens, picking tables, etc., and has a capacity sufficient to ship about 100 tons washed ore per day. Although this company purchased the Cooper property with the expressed purpose of mining manganese, yet, for some inexplicable reason, a railroad was built from the washer to some deposits of manganese ore held under lease and located six miles from the plant, instead of opening deposits which occurred on the company's own property. This washer plant was operated but a short time, when the company went into the hands of a receiver, and still occupies that unenviable position.

There have been some very fine specimens of crystallized manganese ores taken from time to time on this property—sometimes large boulders weighing from 300 to 1200 pounds have been found on the surface in the vicinity of the deposits of the mineral.

During the years this property was in the hands of the Coopers, there does not appear to have been any attention given to manganese, except as it occurred as manganiferous brown iron ore: and since the war, when Sherman's army destroyed the furnace and the federal government confiscated the property because of its being one of the chief sources of supply of iron to the Confederate government, no attempt has been made to utilize the brown iron ore. Nor, indeed, have active operations of any extent been carried on, except the work of erecting the washer plant and building the railroad to leased manganese mines.

It is impossible for any one to express an opinion as to the value of this property for manganese, because but very little work has been done in either locating or developing the deposits. Farther to the north, though, in the district tributary to the railroad of the Etowah Company, we find the mines which have produced the large proportion of the ore which has been mined. The mining has been on the plan of gophering and taking a few tons from a hole and moving to another. Not always because the first was exhausted, but because further work would necessitate timbering and draining, which the miners, who worked on a royalty, were not disposed to do, for the reason that it would be dead work, and it were easier to open another deposit at the surface and scoop the ore out of it.

In consequence of the popularity of such work, the visitor cannot to-day form any estimate of the value of the properties, unless he has a vast quantity of work done, such as cleaning old pits, unwatering the deeper shafts, and, in fact, opening up the property thoroughly and systematically.

Other deposits of manganese ore in the Cartersville district, from which shipments have been made during the past two or three years, are located to the northeast of the town, about four or five miles distant.

While the shipments from these mines have aggregated several thousands of tons, yet the operations have been on a limited scale.

THE SYSTEM OF WORKING MINES

has been usually by lease and payment of royalty by miners to the owners of the properties. The ore has been prepared for market by screening instead of washing. The openings are usually quite shallow, and work of mining is carried on at as low a cost as possible. In fact, at the time of my visit in 1895 to these mines, I noticed that apparently it was proving more profitable to mine on a limited scale than to keep the extensive plants, which had been erected for preparing the ore, in operation. All the manganese mined is hauled in wagons to Cartersville, and there sold to brokers, who ship it to the eastern market. The bulk of the product is shipped to the carriage works, where it is sold on the unit, after being analysed by that company's chemists.

The average analysis shows a content of about 44 per cent. manganese, and the profit to the shipper after payment of freight must be about two dollars per ton. The royalty charged by the mine owners is generally one dollar per ton, and the price paid by brokers in Cartersville about four dollars per ton for screened ore, regardless of analysis.

It is impossible to form any estimate of the quantity of manganese in this district, because the deposits are all pockets, and as mining is carried on from hand to mouth, without any apparent desire on the part of the miners to perform any more dead work than is absolutely requisite to reach the ore, consequently nothing can be determined regarding the quantity until a pocket has been exhausted, when the miners search for another, treat it in the same way, and leave the openings to cave in or fill up with debris.

In the Cave Springs district, no active operations have been carried on since 1893, when Major Cooper, of Atlanta, had quite a large force of men engaged in mining and washing the manganese, which was hauled about three miles to the railroad and shipped to Pennsylvania. Several years ago, an attempt was made to establish an export trade from this district, and for several months shipments were made to Liverpool, but report says the attempt was abandoned because of lack of capital on the part of the operators. The returns were necessarily slow in reaching the point of shipment, and, of course, lack of sufficient capital to carry on such an enterprise was ample reason for its abandonment.

Although the number of deposits occurring in this district is quite large, yet it is impossible to-day to form any estimate of the quantity of manganese in such, because the same methods of mining which prevail in the Cartersville district were followed in the Cave Spring. Consequently, considerable work of a prospecting nature would have to be done before any material facts relative to the present value of the deposits could be ascertained.

The grade of the ore from Cave Springs has always been reported as equal to that from Cartersville.

Whether the manganese deposits of Georgia are sufficiently extensive so far as quantity of unmined ore is concerned to warrant mining operations on any large scale, is entirely problematical. The industry as carried on at present is profitable to those engaged, because the mine owners receive their royalties, the miners are able to earn living wages for their work, and the shippers, by purchasing as they do, are enabled to ship at a profit. The demand, though, has been limited in the past, but has been sufficiently great to consume all that has been mined in Georgia, whether it would have been equal to the supply, had mining been on a more extensive scale, the shippers only can say.

THE FUTURE OF THE INDUSTRY

should be bright, especially if steel is manufactured in Alabama, and in any event it would appear advisable for the owners of manganese properties to investigate and exploit such more thoroughly and systematically than has been done in order to determine the capacity of the unmined supply. In Alabama, up to the present time, only a few deposits of manganese have been discovered. These are confined chiefly to Cherokee county, and have never been producers on a commercial scale. A few sample cars were shipped from Pleasant Gap station, on the East Tennessee, Virginia and Georgia division of the Southern Railroad. This was mined in the vicinity of Rock Run, in Cherokee county.

There are surface indications of the occurrence of deposits in sections of the same county, in close proximity to the brown iron ore deposits; but little prospecting, though, has been done in recent years, and consequently the supply of manganese ore in the State is an unknown quantity, although in many sections the brown iron ore is manganiferous to a very appreciable extent. Especially so is this the case on the property of the Clifton Iron Company, in Talladega county, where percentage in content of manganese in the brown ore was so large as seriously to interfere with the manufacture of car wheel pig iron in the charcoal furnaces.

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Vol. VII. Part I.

1897.

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TREASURER.

Henry McCalley, ... University, Ala

SECRETARY.

Eugene A. Smith, ... University, Ala.

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ANNUAL MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in the Rooms of the Commercial Club, Birmingham, Alabama, May 18, 1897.

The Industrial and Scientific Society was called to order at 4:30 p.m. by the President, F. M. Jackson, in the halls of the Commercial Club of Birmingham. There were present, Messrs. Aldrich, Geohegan, Manly, Brewer, Smith, DuBose, Gibson, VanKirk, Montgomery, Shook, Ramsay; representatives of the press, and others.

The Secretary stated that he had had the minutes of the previous meeting published in pamphlet form and did not think it necessary to read them.

Mr. Manly and Mr. Geohegan were appointed as a committee to look over the Treasurer's books.

Mr. W. M. Brewer, Chairman of the Committee on Statistics, reported that they could not get any financial assistance from the technical journals in the collection of statistics, but the producers themselves were furnishing the statistics and he was able to report 75 per cent. of the product for January, 90 per cent. for February, 90 per cent. for March, and for April nearly all of the returns were in when he left home to attend this meeting, and he thought about 95 per cent. of the total had been made, and he stated that he had also received some statistics for the other months since the first returns were made and he believed it would amount to a total of 95 per cent. for the four months. The producers were sending in conservative reports. The Alabama producers were not doing like the producers in the other States, sending in estimates to make a good showing. There are seventy-nine producers in the State, including pig iron, iron ore, limestone, building stone, coke, bauxite and gold.

Report of Mr. Brewer was adopted and the committee instructed to keep up their work.

Report of council was called for, but Dr. Smith stated that the council had had no meeting and they would have to pass that.

Mr. J. W. Sibley was proposed for membership and elected.

Mr. Brewer made a motion to amend the Constitution so as to admit members from other States.

Mr. J. A. Montgomery stated that the Society already had that power, whereupon Mr. Brewer withdrew his motion and gave notice that at the next meeting he would present the names of several gentlemen from other States interested, for membership.

Mr. Geohegan was next called on for a talk. He said: In arriving at the figures which I will submit to you I wrote to parties in New York and Chicago for prices on castings and found that it cost $38.35 per ton for castings in the North, while in the South the castings could be made, with favorable appliances and a modern equipped shop, for $18 or $20 per ton. The place where we run up against trouble is in freight rates. From Cincinnati to New Orleans, the freight, by car load, on castings, amounts to 29 cents per hundred, while from Birmingham to New Orleans it is 26 cents, a difference of only three cents. Finished machinery from New York, in car lots, is only 49 cents per hundred. When the railroads come to our help we can certainly get into the market as well as any place in the North or anywhere else.

Mr. Aldrich—For a number of years I was interested in a foundry in this section, and foundry castings are made at a cost of from 85 to 87 cents per hundred pounds, which would be about $17 per ton actual cost, and that was pretty expensive. In the North it costs from $1.46 to $1.96 per hundred. These are cold facts; but in discussing this subject there is considerable misconception—there is something besides first cost. The people cannot be induced to come South and invest in machinery, because age and reputation of the establishment have something to do with it as well as first cost. A foundry, new and not well known, although able to do the work cheaper, cannot get the work to do. I know a concern in Birmingham that built some engines for some home industries and had to leave their names off of them because the people wouldn't have anything built south of the Ohio river. The large producers here would rather go to New York or Cincinnati than have the things made here, though it could be as well done here as elsewhere. Dr. Smith will see some of the engines of which I have spoken in his rounds. I know of some people who think they come from north of the Ohio river.

Mr. Jackson said that was true in a number of other cases, and called attention to the trouble experienced in introducing Alabama coal into the Louisiana market.

Mr. Brewer next read a paper on copper mining in Alabama, which is printed in full—page 13.

Dr. Smith then made a short talk on the desert lands of Texas. He showed some pictures taken of the country and gave an analysis of the sulphur dug up in some places there. This was all west of the Pacas river.

Mr. Paschal Shook was then asked for a statement in regard to the Birmingham Steel Mill. Mr. Shook said: They are building two basic open-hearth, forty ton to a heat, mills, which would be finished in the next two months. They wanted to get started by July, but I hardly think they will get ready by that time. The furnace is stationary, and two heats every twenty-four hours will be made. They will make a soft or mild steel to be used in plates mostly and will be used in the plate mills of the rolling departments. It is thought they will make enough steel to supply all the rolling mills here. The Birmingham Rolling Mill Co. are now buying their billets from Pittsburg.

Treasurer reported $87 in the treasury at present. His report was adopted.

Secretary reported that one member had died since the last meeting, Mr. Walter Crafts, of Columbus, Ohio. Printed proceedings of the minutes had been distributed freely. The library of the Society was growing, and some excellent journals had been added lately. Adopted.

Mr. W. M. Brewer said: There is going to be held in Omaha next year a Trans-Continental Exposition and I wish to introduce the following resolution:

Resolved, That it is the view of this Society that, in consideration of the Trans-Continental Exposition at Omaha, a committee be appointed to confer with the Governor, Commissioner of Agriculture, and State Geologist to provide for a representative mineral display at Omaha.

The above resolution was adopted and Messrs. T. H. Aldrich and W. M. Brewer were appointed as a committee to confer with the Governor, Commissioner of Agriculture and State Geologist.

Mr. Brewer said: It seems to me that Alabama fell down at the Atlanta Exposition, and I have been told that she has put in a very short appearance at Nashville. Alabama can show that she is the peer of any State in the way of mineral, and I think this Society ought to take some action to have an exhibit at Omaha. Alabama had some excellent opportunities at the Atlanta and Nashville expositions, but at neither place is the display what the State is able to make to be seen.

Dr. Smith: The trouble heretofore has been that there has been no money with which to make a display, except a small amount provided by Commissioner of Agriculture.

Mr. Jackson: I think we ought to, in some way, give our Secretary leave to spend more money and let the public know what we are doing. He can employ some one to help him, and at the same time it would be advantageous.

Mr. Smith: I remember some years ago I proposed this idea, that Birmingham was the natural headquarters for this Society, and we would be much better off if the Secretary and Treasurer had their headquarters here in Birmingham. I think it would be an advantage to the Society.

On motion of Mr. Aldrich the Secretary was allowed to spend $75 per year, as a maximum, for the purpose of sending out the proceedings of the meetings and other data of the Society. The above was adopted.

Mr. J. W. Sibley next read a paper on vitrified brick. Printed in full—page 17.

The next was the address of the retiring President; also printed in full—page 11.

Election of officers. Candidates for President were T. H

Aldrich and George B. McCormack. For Vice-Presidents, J. W. Minor, J. A. Montgomery, W. M. Brewer, and J. M. Garvin.

T. H. Aldrich was elected President, and J. W. Minor and J. A. Montgomery, Vice-Presidents.

Mr. Aldrich was then introduced and thanked the Society for the honor conferred upon him, and said that he was in thorough accord with the Society. He said further as follows: It might be of interest to know something of the gold mining district in the eastern part of the State. I represent prospectors working around the Hog Mountain mines, about six miles from Alexander City, and the chances of finding a paying vein are very good. I think Birmingham ought to pay some attention to the gold mining going on in the eastern part of the State, as a great deal of machinery and the necessaries of life are going there and Birmingham makes these things. There is one ore mine in operation with a ten-stamp mill on Hillabee creek, they have a good mill, a large number of veins, and from what I know of their affairs they are getting considerable output. The Talladega belt is being looked into by some capitalists, and there is a great amount of ore in that district that will pay well. We have immense quantities of ore in this district that would pay well. There is also a belt of copper ore running through that district which is being examined into to some extent. Railroad rates are not disturbing the prospectors, as a car load of gold means many millions of dollars. It will not be long before gold mining will be pursued on an extensive scale in Alabama. I met a gentleman the other day in Alexander City who was searching for gems. I know that beryl has been found, and I am pleased to say that in Alabama gems are being searched for. That country is attracting a great deal of attention, and I think Birmingham ought to pay some attention to it. They claim in Georgia, at the Royal Ore Mines, that they can mine their ore at thirty-five cents.

Mr. Jackson: I think we ought to impress ourselves before we go with the importance of getting new members into the Society.

No further business and the meeting adjourned.

Eugene A. Smith, Secretary.

ADDRESS OF RETIRING PRESIDENT FRED. M. JACKSON.

It has been an appreciated honor to have presided over the deliberations of this Society as its President for the past year. The service has been one of pleasure to me, and I could make no better wish for the Society than to say that I hope the ensuing year will be as profitable to the Society as the one now closing has been a pleasure to me. That I have been unable to do more for the advancement of its fortunes and the increase of the usefulness of our organization is to be regretted, but it is from no lack of appreciation of the trust reposed in me or willingness to prove myself worthy.

We have not had the encouragement from the members that is necessary to the success of the institution. Many of them have dropped out from lack of interest and other causes. Several have joined during the year and are making good members. Earnest co-operation by the members with the officers would bring the S ,ciety to that plane of usefulness originally intended. Former presidents have recommended in their annual addresses improvements and plans which, if carried out, would make the Society one of great usefulness to its members and of general good to the State. We have seen many organizations begin with bright prospects only to die while it was yet springtime with them. We have passed through a time of trial when the sole question with nearly all of our people was whether they could stem the tide of general depression; when the personal fortunes of all of them seemed trembling in the balance; when most men were absorbed in the attempt to live, and when few men could keep burning the lamp of public spirit. We ought to congratulate ourselves, therefore, that the Alabama Industrial and Scientific Society has not perished with so much else of good that went down in the wreck. But we have done more than merely come through intact. We have not only preserved our organization, but have succeeded in adding to our archives much that is valuable in the way of information for present and future use, and have succeeded, to some extent, at least, in cheering each other on to the brighter day that is now breaking.

With the consciousness of strength that men feel who have waged a successful battle against odds, our Society should take on new life and draw to itself more and more of interest and secure the active co-operation of a large number of the men who make our manufacturing, timber and mining interests what they are and what they will be. There is no lack of strong and capable men within the area of our operations to make the organization one of the strongest forces in the industrial life of the country, and to compel, if possible, a recognition and standing all over the world.

Cheered by the better outlook for the future, let us insist, individually, that those of our co-workers who ought to join with us in vigorous effort shall not hold aloof. I do not believe in tracing imaginary rainbows across existing clouds. I see no signs of the time coming when good fortune is going to pour into our laps a stream of prosperity. What has been accomplished, especially in North Alabama development, has been done by strenuous and increasing effort, but if we have done so much against adverse circumstances, and often with but poor return in proportion to labor and risk, and have not been discouraged, we can surely go forward now with a better heart and a surer purpose. The progress of our Geological Survey, from point to point, makes good the boast of the people as to our great store of natural resources. It only remains now for the diligent man, with the help of labor and capital, to make our State foremost in the Union in mining and manufacturing. There is in Alabama to-day a spirit of activity not less than in any State in the Union, and there is certainly no section of the country at this time commanding so much attention and inquiry of men of capital as Alabama. The building by the Mobile & Ohio railroad of two hundred miles of new road is evidence enough. This fact is one of many signs that our long night is drawing to a close. Other railroad building is contemplated and projected. The problem of commercial steel making is about solved; the building of large cotton factories, the expansion of our iron market, are further potent facts that Alabama is looking on the dawn of a brighter day. Our Society cannot do better work for itself in the interests of men immediately represented than to reach out and seek ways and means for promoting a greater and greater interest in industrial matters.

COPPER MINING IN ALABAMA.

BY WM. M. BREWER.

Since about 1879, even the most optimistic believers in metal mining in the South have been very silent with regard to the supposed deposits of copper in Alabama, and but for the fact that practical work of re-opening the underground workings at the old Woods Copper Mine within the past year, it would be generally considered that the man who would call public attention to the subject was an impractical enthusiast of the first water. Any one who has visited that section of the mineral belt which is locally known as the Copper Lead, cannot but be impressed with the useless expenditure of money which was indulged in several years since by those enthusiastic prospectors for copper ore. The term "copper lead," is applied by the residents to that geological formation which has been identified as the schist originating from an eruptive rock, the original minerals of which, though, have been so much altered that the experts are unable to detect any but secondary minerals as its constituents. This formation has been designated by Dr. Eugene A. Smith, State Geologist, as Hillabee schist. So far as has been determined up to the present time, it is quite a misnomer to designate that belt of formation as a copper lead, because no copper ore of any quantity has even been discovered along this so-called lead, notwithstanding that there are vast numbers of old openings which were sunk years back by enthusiastic prospectors who believed there were indications of copper bearing ore associated with these Hillabee schists. It is not my purpose in this paper to discuss these abandoned prospect holes or to attempt to take the optimistic view that Alabama contains a paying copper mine in every township.

My purpose is to call attention to the conditions which have been exposed at the old Dick Woods copper mine in the southern edge of Cleburne county, since it has been unwatered and the old workings thoroughly exploited. A brief review of the past history of the property may prove interesting, because it demonstrates the difficulty under which operations were carried on at these mines during their early development. The line dividing Cleburne and Randolph counties passes through the property, leaving the buildings on the mine itself, in the first named and the old furnace and smelter in the last. The discovery was made about 1870 by Dick Woods, who purchased the tract of land on which the gossan outcrop occurred, and commenced mining and hauling the ore to Carrollton, Ga., whence it was shipped to Baltimore for treatment. During 1874–75–76, I am reliably informed that from 200 to 500 names were carried on the pay-rolls, and the string of teams engaged in hauling would sometimes extend for nearly a mile along the wagon road. The mine was usually called the "Woods Copper Mine," and the postoffice established for the convenience of the camp "Stone Hill," while the company operating the property was designated as the "Copper Hill Mining Co." At about the same time copper ore was discovered on another tract of land about a mile northeasterly from Copper Hill, which was operated by ex-Gov. Smith, and was known as the "Smith Copper Mine."

In 1876 the policy of hauling the ore away for shipment was abandoned and the companies operating both these mines erected furnaces for smelting the ore and for refining the matte. The product shipped after this time until operations were abandoned, about 1879, was in the shape of ingots of refined copper. Of course while the black copper or oxide of copper, with occasional sheets of native copper, was being mined in the shallow workings, the business was quite profitable as long as the policy of shipping the ore in its crude state was carried out, even after payment of the excessive freight charges for wagon haul and railroad to Baltimore. But when the smelting was attempted in the primitive method adopted, and with almost inexperienced metallurgists in charge, it was found that instead of being a more economical policy it was really the opposite. Consequently, when the black copper was mined out, and pyrrhotite, iron pyrites and chalco-pyrites or copper pyrites took its place as depth was attained in the mine workings, instead of being able to conduct the operations profitably, as in the earlier days, the companies discovered that losses resulted to such an extent that in 1879 the mines were shut down and the properties abandoned. I am informed that during the years the Copper Hill mine was operated the old books show that $1,300,000, in round figures, were realized from the sale of ore, matte and ingots of copper. It is claimed also that no attempt was made to save any value from the ore except the copper, although by assaying it was shown to carry also gold and silver.

From 1879 until the spring of 1896 these properties remained idle, the buildings were allowed to go to ruin, and what machinery was not moved away fell a prey to rust and weather. But during the spring of 1896 some Western men leased the Woods mine, organized a new company under the title of "The Copper Hill Mining Co.," and commmenced work by unwatering the old mine workings preparatory to resuming work, if the ore body proved, on investigation, to be of sufficient extent, and the ore of high enough grade to warrant such action. Recently I visited this property and found that the new management was doing work of such a character as should command the praise of all who are interested in the development of our mineral resources. The old workings, which extended to a depth of about eighty feet with the dip of the ore body, consisted of an incline shaft, drifting and stoping from that level to the surface, about twenty feet of thickness, and for a distance of eighty feet along the line of strike. These workings had been full of water from 1879, and consequently the mere work of unwatering had been quite an undertaking, especially when it is considered that the present management spent its money merely on tradition, and had no means of ascertaining anything about the property, except from the out-cropping, until the work of pumping out the water had been accomplished.

At the time of my visit their work of continuing to sink the incline shaft to greater depth was being carried on. A shaft house had been erected which was furnished with hoisting and pumping machinery of sufficient capacity to carry on the work of developing the property to at least a depth of 300 feet. The first shaft on the property had been sunk on the ore body with the foot walling of that body for the lower wall of the shaft, the upper wall of the shaft being in ore. When the new work was commenced the ore body was first cross-cut to the hanging wall at the bottom of the shaft on the 80-foot level, and sinking was resumed with the hanging wall of the vein for the upper wall of the shaft. This policy, the management informed me, would be continued until a depth of 200 feet had been reached in the mine, when a cross-cut would be made back to the foot wall, and an up-raise to the old working.

No exact determination has yet been made of the unaltered country rock which forms the walling of the ore-body. From an examination with an ordinary lens it would appear to be an eruptive rock, and may be determined to belong to the same class as the Hillabee schists. If this should prove to be the case then some very interesting geological questions would arise with regard to the occurrence of this rock in this locality which is not only about five miles in a direct line southeast from the main belt of Hillabee schist, but is separated from that main belt by the Turkey Heaven Mountain, which rises to a height of some 400 feet. This mountain belongs to a different geological formation from the schist, as it is composed almost entirely of a graphitic slate which shows every evidence of being of sedimentary origin. A close study of the geological structure in this immediate vicinity is intended by Dr. Smith, the State Geologist, as part of his field work during the coming summer.

The ore-body as cross cut by the present operators is about 24 feet in thickness. The richest ore is found next to the hanging wall and foot wall, while the center of the body of some ten feet in thickness is of a much leaner character. The superintendent informs me that about ten feet of the ore will average more than 7 per cent. in copper, besides an appreciable value in gold and silver, while the entire body would average probably about 3 per cent. Since my visit a quantity of sorted ore has been hauled to the Southern railroad at Heflin, a distance of about twenty miles, and shipped by carload lots to the Bahlbach smelter at Newark, N. J., for treatment.

At the northern extremity of the old underground works I noticed a very interesting sight. This was a well-defined anti-clinal curve showing strata of ore, and country rock alternating, with the center or core of the arch a solid mass of ore. While the thickness of each stratum at the apex of the curve was only a few inches, yet as the strata inclines downwards on each side of the core or center, the thickness increased until at the floor of the drift the solid ore forming the center of the arch had reached a thickness of some feet, and each stratum had also increased until the aggregate thickness of the base of the anti-clinal was several feet.

VITRIFIED BRICK—THEIR MANUFACTURE AND ADVANTAGES AS A PAVING MATERIAL.

BY J. W. SIBLEY.

It would, perhaps, be well to state at the outset, that the term "vitrified" is not used here in its primitive sense—meaning of the nature of glass or glassy, which carries with it the idea of brittleness, a characteristic not permissible in a genuinely vitrified brick. By vitrifaction is meant the perfect blending of the constituents into a homogeneous mass, and thoroughly annealed, so as to obtain the maximum degree of hardness and toughness, together with the minimum tendency to absorption of water.

Vitrified bricks have been made from shales, bastard fire clays and pipe clays. We shall consider only those made of shale, as they have proved the most satisfactory, and our experience has been mainly along that line.

Shale, as its name implies, is a hard clay, or rock, that shells off into layers or cubes when mined or exposed to the action of the elements. It lies in strata from four to seventy-five feet in thickness, and usually found above the coal measures. Its main components are silica, alumina and iron. The alumina fluxes at a lower temperature than the others in burning, and consequently acts as a binder to unite those very hard elements in the brick. The shale is mined after the usual manner of a rock quarry, blasted with dynamite, loaded into tram-cars and conveyed to the stock or grinding shed. It is there fed into heavy crushers, or dry-pans, where it is rapidly reduced to powder of such fineness as the nature of the case demands. The ground clay is then carried to the top story of the factory by means of a cup and chain elevator, and passed over a shaking screen where all the coarser particles are removed and returned to the dry-pan in the form of tailings to be reground. The fine clay then falls into a chute and is delivered to the pug mill, or tempering box, where the proper amount of water is added, and the revolving knives cut the mud up and temper same, passing it automatically to another chute where it is conveyed to the mouth of the brick machine on the ground floor. Here there are more knives to give additional pugging, and then the clay is taken by an auger and pressed through the die, emerging in a stream or column, which is forced out upon the cutting table, where wires, separated at equal distances, cut the column into blocks (or gluts, as better known to clay workers). A traveling belt conveys the gluts to the repress, where they are dropped into moulds and heavy pressure is put upon them, corners are rounded and lettering stamped upon them. Another traveling belt takes them from the repress and they are placed upon wooden pallets upon iron cars and taken to the dry-house, where they are cooked or baked by hot air until the moisture is removed. Then they are set in patented down-draft kilns, and burned and annealed as desired. After having been thoroughly burned, they have to be cooled slowly, so as to be tempered to the maximum degree of hardness. The entire process from the shale pit to the railroad car occupies some sixteen days for a kiln of brick.

For a long time granite or belgian blocks were considered the only successful pavement, and they have had the one characteristic of durability to recommend them. But they soon become polished and slippery, and after five or six years' traffic the corners become rounded off, and the pavement is as rough as cobble stones, as is the case with part of First avenue in this city. The noise on granite pavements is perhaps the greatest objection. The pavement is uneven, consequently the wheels of vehicles passing over same receive constant blows. Some astute mathematician has figured it out that in one year of travel over granite pavements a buggy will have dropped in distance equal to a mile and a quarter. Our brethren of the "wheel" are no doubt prepared to feelingly corroborate this statement. The blocks being irregular in size, the interstices are larger, and consequently become reservoirs for filth and excrement from horses, a serious objection from a sanitary standpoint.

Asphalt has a beautiful appearance to recommend it, but is very slippery and hard upon horses, because of no cushion to give it spring or elasticity; in summer very hot, and dust intolerable; most costly of all pavements, and short-lived.

Macadam is good for country roads, and has cheap first-cost to recommend it to some cities, but requires constant repairs;

is dusty in dry weather and sloppy in wet. It can be said to be good and wear well only when covered by a foot of snow.

In vitrified brick, the civil engineer finds just what he is looking for. The combined silica, alumina and iron give a resultant material that is harder than steel. It is the only substance that will successfully resist the calks and heels of the horse's shoe—that greatest enemy to all pavements. When brick are properly manufactured and thoroughly vitrified, the blacksmith will be kept busy sharpening the chisels on the calks and heels of the horseshoe. And when in the process of time the brick do wear, it will be uniform all over the brick, so that the pavement will present a smooth surface even when the brick are worn half away. Of course if a poor or improper foundation is put under any pavement, it will not stand the traffic on account of unevenness.

Vitrified brick, being non-absorbent and uniform in size, when laid, present an absolutely water-tight pavement, which is easily cleaned by washing or sweeping, thus affording the best sanitary pavement yet discovered.

Brick paving can be easily repaired, when repairs are necessary, on account of uniformity of size. Brick pavements are comparatively noiseless, and less slippery than either granite or asphalt. They have been in successful use in Holland for one hundred years, and in this country, at Charleston, W. Va., without any repairs, for twenty-five years; in Columbus, O., Galesburg, Ill., Omaha, and other cities, for ten to fifteen years, and are now the standard pavement for Chicago, Cincinnati, Cleveland, St. Louis, New Orleans, Atlanta (the home of granite), and our own Montgomery, Ala. Many other cities North and South are adopting vitrified brick for paving their streets.

There are several interesting and instructive tests for determining the value of a brick for paving purposes; notably the rattler or abrasion test, the compression test, the absorption test.

In the abrasion test the bricks are put in a foundry rattler, together with 300 pounds of scrap iron, and revolved for 2,000 revolutions. They are weighed before and after taking. The percentage of loss is said to equal twenty-five years' wear in the street. In such test, Alabama brick lost 10 per cent., granite 8 per cent.; other brick lost 12 to 15 per cent.

In the compression test, Alabama brick stood 265,000 pounds before breaking. This is equal to the weight of the heaviest locomotive piled in a vertical column on one brick.

In the absorption test, after immersion for seven days, Alabama brick absorbed 22 per cent. of its weight. The average common brick will absorb 10 to 15 per cent.

Paving brick have burned up a highly tempered drill in attempting to bore through them. Jefferson county, in addition to its vast mineral resources, furnishes the material for the manufacture of paving brick that have surpassed all in tests.

REPORT OF THE SECRETARY.

Alabama Industrial and Scientific Society,
Office of Secretary,
University, Ala., May 18, 1897.

Since the last annual meeting there have been no additions to our membership, but several members have been dropped from our list, and one, Mr. Walter Crafts, has died. We number still about forty active members.

During the past year, the Proceedings of the Society have been published in two parts aggregating 78 pages. These Proceedings have been distributed to the members and also to the individuals and societies on our exchange list, to the number of about 200. An edition of 500 copies was printed at a cost of $97.50, the rate being $1.25 a page.

The usual circulars and notices have been sent out to members.

Additions to the Library: Journal of the Elisha Mitchell Society, 1896; Technology Quarterly, 1896; The Technic, 1896; Circulars of Johns Hopkins University, 1896; The McKeesport Scientific and Philosophical Society has been added to our exchange list and their Proceedings received.

Eugene A. Smith,
Secretary.

REPORT OF TREASURER FOR THE YEAR ENDING MAY 17, 1897.

UNIVERSITY, ALA., May 17, 1897.

RECEIPTS.

From cash in Treasury, as per Report of May 12, 1896,		$109 63
From annual dues,		118 00
Total receipts,		$227 63

DISBURSEMENTS.

For printing Proceedings, etc.,	$113 90	
For postage,	10 50	
For publishing Seddon resolution,	10 10	
For lithographic work,	3 28	
For advertising meeting,	1 00	
For exchange,	10	
Total disbursements,	$138 88—	$138 88
Balance in treasury,		$ 88 75

HENRY MCCALLEY,
Treasurer.

PROCEEDINGS

OF THE

Alabama Industrial

AND

Scientific Society.

Vol. VII. Part II.

1897.

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AND

SCIENTIFIC SOCIETY.

Volume VII. Part II.

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PUBLISHED BY THE SOCIETY.

SECRETARY'S OFFICE:

UNIVERSITY,

ALABAMA.

ATLANTA, GA.:
The "DIXIE" Company.
1898.

OFFICERS.

1897.

PRESIDENT.

TRUMAN H. ALDRICH, ... Birmingham, Ala.

VICE-PRESIDENTS.

JAMES BOWRON, ... Birmingham, Ala.
E. A. UEHLING, ... Newark, N. J.
JOSEPH SQUIRE, ... Helena, Ala.
JAMES H. FITTS, ... Tuscaloosa, Ala.
JAMES A. MONTGOMERY, ... Birmingham, Ala.
J. W. MINOR, ... Thomas, Ala.

TREASURER.

HENRY McCALLEY, ... University, Ala.

SECRETARY.

EUGENE A. SMITH, ... University, Ala.

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REPORT OF PROCEEDINGS

—OF THE—

WINTER MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in Birmingham, Alabama, December 21, 1897.

The meeting was called to order at 3:30 p.m., on Wednesday, December 21, at the Commercial Club rooms, in the city of Birmingham, Alabama, T. H. Aldrich in the chair.

Present—Erskine Ramsey, P. G. Shook, C. E. Bowron, J. R. Harris, John Shannon, David Hancock, J. P. Willoughby, W. M. Brewer, J. C. DuBose, W. G. Oliver, J. A. Rountree, Henri Cardozo, M. H. Sherman, E. A. Smith, W. E. Horn, Wm. B. Phillips, Chas. Geohegan, representatives of the press and others.

The reading of the minutes of last meeting was dispensed with because they were already in print.

The Committee's Report on Statistics was made by Mr. W. M. Brewer, who gave a short résumé of his success, showing that at the end of the month he would be able to report the mineral production of the State within 3 per cent. of the total of 6,000,000 tons of coal, and the total production of the coke and iron.

It was moved that the statistics for 1897 be embodied in the proceedings.

The report of the Committee on the Omaha Exposition was made through Mr. Brewer, who gave the result of his correspondence with Governor Johnston. Nothing was accomplished by the committee, because there was no fund available for the purpose.

Dr. Phillips moved that the sense of the Society be that it is necessary that the State of Alabama should be represented at this Exposition by a complete and well arranged exhibit of its resources. Dr. Phillips went on to say that the West is the region from which the most desirable immigrants come, and the necessity was all the greater that this matter be urged upon the State. Motion carried.

The following names were proposed for membership and elected: Mr. Sol Haas, J. Asa Rountree, Birmingham; Geo. S. Wilkins, University; Mason H. Sherman, Ensley.

Mr. Shook moved that a committee of three be appointed to represent this Society at the River and Harbor Convention in Tuscaloosa on the 29th of this month, and the following gentlemen were appointed: Jas. Bowron, Jas. H. Fitts, Dr. Wm. B. Phillips. To this committee the President of the Society was added.

Dr. Phillips presented to the Society Mr. Henri Cardozo, a Commissioner of the French Government to investigate the labor conditions in America. Mr. Cardozo made some remarks explanatory of his mission, and the aid of the Society was tendered to him in the prosecution of his work.

The Secretary then made a report upon the condition of the Society as to members and finances, and made the suggestion that more frequent meetings might be of advantage to the Society. Mr. Ramsey proposed that hereafter there be three meetings a year, and Mr. Geohegan suggested that a banquet at the next meeting might be productive of good to the Society. Mr. Aldrich also favored the proposition for the banquet and spoke of how expenses could be met without trespassing upon the funds of the Society. Dr. Phillips then moved that a dinner be held at the next annual meeting of the Society, and that the cost of the tickets to the same be not greater than $2.00 apiece, and he recommended that a committee be appointed to take into consideration the whole matter of the banquet, of the guests who should be invited, and of the cost of the same. On this committee the President appointed Mr. Geohegan, Mr. Ramsey and Dr. Phillips.

The reading of papers being next in order, Mr. Sherman read a paper by Mr. Wm. Blauvelt on "The Semet-Solvay Retort Ovens and their Products," which paper appears in full in these proceedings.

In the discussion of this paper, Dr. Phillips congratulated the Society upon the fact that these gentlemen have become interested in the subject of Recovery ovens—a subject upon which the Society has been hammering ever since its first meeting. Dr. Phillips went on to discuss some differences of opinion entertained by prominent metallurgists as to the relative excellence of the coke made in the old beehive oven, and in retort ovens, and of the iron manufactured with these cokes. In this connection he quoted the opinions of Sir Lowthian Bell, Mr. Samuelson, Mr. John Fulton, and others. But whether the coke made by the two kinds of ovens was essentially different or not, or whether or not the quality of the iron was affected by the use of these cokes, the saving of by-products cannot be overlooked. Many thousands of dollars can be saved by the use of Recovery ovens each year that have heretofore been thrown away, and he gave instances of the very considerable markets for the coal tar, ammonium sulphate, gas, etc., and he stated that with increased production the prices of these products would inevitably go down, while at the same time their application would be increased. The universal experience is that no company which has tried the retort ovens can be induced to go back to the old beehive ovens. In regard to the strength of the coke from the two processes, Dr. Phillips further stated that the coke from the beehive oven was strong enough for all purposes, and, hence, the greater strength of the retort coke cuts no figure. Dr. Phillips then spoke of the greater density of the retort coke, but he did not think that too dense a coke was desirable; and in this connection he presented a long list of tests which had been made by him upon a great number of cokes made in Alabama during the past few years from the coals from different seams coked under varying conditions. These tests will be found in full in a paper which Dr. Phillips then presented, "On Results Reached in Washing Coals for Coking in Alabama." This paper may, therefore, be read as constituting a part of the discussion of Mr. Blauvelt's paper, and is from advance sheets of a new edition of "Iron Making in Alabama," which Dr. Phillips is preparing for the Geological Survey.

In continuation of this discussion, Mr. Aldrich stated that twenty years ago the Eureka Company built a battery of Belgian ovens—about forty in number—at Oxmoor, Alabama, and operated them for some time. These ovens were discharged by a steam ram; they were about six feet high, sixteen inches wide and some thirty feet long. The coke was not satisfactory as it varied in quality directly with the depth of the oven, the coke on the top being exceedingly porous and spongy, while that at the base was very dense—in fact, some of it came out of the oven unburnt. The watering was all done outside, and in consequence of the unskilled character of the labor it was frequently soaked with water, holding on an average at least 8 per cent. of moisture, and at times very much more; and at the same time the coke did not work well in the furnace. Upon the installation of the coke plant, at Pratt mines, these retort ovens were abandoned and torn down. It may be well here also to put on record the fact that the Eureka Company had a large coal washer at the Helena mines, known as the "Stutz" washer (which was really an adaptation of the Rittinger jig to coal washing). This washer was operated successfully for some years, or until the mines on the "Shortridge" seam were worked out and abandoned.

Dr. Phillips then exhibited to the members some samples of the carbon deposited out of the gases in the ovens where blocks of dolomite were burned. In the cracks of this dolomite, near the top, were found these thin sheets of deposited carbon possessing highly metallic lustre and somewhat peculiar structure.

Mr. Aldrich, in the course of some remarks upon the mining of gold in the eastern part of the State, spoke of the vast quantity of low grade ore containing only seventy cents to one dollar per ton of gold, but quite soft and easily worked. He made the suggestion that mining engineers of this district might find a promising field for experiments in concentration by washing on a large scale of these low grade ores, in order that the necessity might be avoided of running so much dead matter through the mill.

There being no further business the Society adjourned to meet again some time in February.

EUGENE A. SMITH, Secretary.

The Semet-Solvay Coke Oven and its Products.*

BY WILLIAM H. BLAUVELT.

Gentlemen of the Alabama Industrial and Scientific Society:

The plant of by-product retort ovens, which is being erected at Ensley, is only the sixth installation of by-product ovens in this country. In Continental Europe such ovens have become quite an old story, and, in fact, practically no beehives are built there, except in small or isolated plants. So few years have passed since by-product ovens were first introduced in America, that they are still a novelty to very many, even of those who are well acquainted with the use of coke and its manufacture in the old-fashioned way. It has, therefore, been suggested that a brief description of the plant at Ensley, and a comparison of these new ovens and their products with the old beehive type, will be of interest to your Society.

The plant of ovens now under construction at Ensley will consist of 120 retort ovens, with their accompanying apparatus for collecting the by-products from the distillation of the coal. It is probably unnecessary to say that retort ovens are essentially different in shape from the beehive oven, the coking chamber being usually about 30 feet long and 6 feet high, and varying in width from 15 inches to 30 inches or more, depending upon the coal to be coked, and the type of oven. The coal is charged through three or more holes in the top, in the same manner as in a beehive oven, except that the oven is filled

*Portions of this paper are taken from an article by the writer, which was published in "The Mineral Industry" Vol. IV., 1896, which is a copyrighted work, and such extracts are here used by the special permission of the Scientific Publishing Company, the proprietors of "The Mineral Industry."

with coal to within about eight inches of the top. The coal is heated and the volatile matter driven off by means of the heat generated by the combustion of gas in the flues or passages in the side walls of the ovens. A fourth opening in the roof of the oven is connected with a pipe or main, which carries the gas, as it comes off from the coal, to the by-product apparatus.

The Ensley ovens are of the Semet-Solvay design. This oven is the principal exponent of what is known as the horizontal flue type, in contradistinction to the vertical flue type, the principal representative of which is the Otto Hoffman oven. In the vertical flue type the gas is burned in two horizontal flues, or combustion chambers, at each side of the ovens at the bottom, which extend half way toward the other end. The products of combustion ascend through some sixteen small vertical flues, which reach to the top of the oven, where they deliver into another horizontal flue, which reaches the whole length. This connects with a similar set of small flues, which deliver the hot gases into a horizontal flue, or combustion chamber at the bottom, like the first, and thence to a regenerator of the familiar Siemens type. Every hour the travel of the gases is reversed, hot air being supplied for the combustion of the gas from the regenerators, as in an ordinary Siemens furnace.

In the horizontal flue ovens there are three horizontal flues, one above another, on each side of each oven, extending the full length of the oven, and connected with each other at the ends, so as to form a continuons flue for the gas and flame. The travel of the gases is from above downward; that is, through the top flue, then backward through the second, etc., the bottom flues being connected with a passage to the chimney. A small amount of gas is introduced at the ends of the top and second flue, along with a sufficient amount of air for its combustion. This air is preheated by a simple arrangement in the bottom of the ovens, and the combustion goes forward continuously without any attention, often for weeks at a time, it being only necessary to see that the proportions of gas and air remain the same, and are of sufficient quantity to keep up the necessary heat in the ovens. The gases after leaving the ovens are carried under boilers, and supply steam for operating the machinery of the plant. These gases go to the stack at a temperature of not much over 200° C., so that from the point of view of heat economics these ovens are very efficient.

The Semet-Solvay ovens are usually about 16 inches wide, and contain about 4½ tons of coal per charge. This charge is coked in about twenty-four hours, and when the gases are all driven off, the doors at each end of the ovens are opened, and the whole charge of coke is pushed out with a steam pusher, or ram, in a minute or two. As soon as the ram has been withdrawn and the doors are closed, the oven is ready for another charge, and practically no heat has been lost, as the quenching is all done on the outside of the oven. The whole process of discharging and recharging an oven can readily be completed in fifteen minutes.

As the gas which is distilled from the coal leaves the ovens it enters a large flue known as the hydraulic main. This extends the whole length of the block of ovens, and is partially filled with water. The gas bubbles through the water, and a portion of the tar and ammonia is condensed out. From the main the gas passes to the condensers. These are large vertical cylinders filled with tubes through which water is made to circulate. The gas passing around these tubes is cooled, and a further portion of the tar and ammonia condenses. Rotary exhausters occupy the next place in the series of apparatus, their use being to draw the gas from the ovens through the pipes and condensers, and to discharge it into the next following apparatus, which is the ammonia washer. In this vessel the final traces of ammonia are removed, and the gas thus cooled and washed is free from condensable matter and ready to be used for heating or lighting. A portion of it is usually withdrawn at this point and used to heat the flues of the ovens, but if there is sufficient demand for the oven gas for other purposes, ordinary producer gas may be substituted for it, and the whole amount produced will be available for sale. This amount varies with the coal, but is usually from eight to ten thousand cubic feet per ton of two thousand pounds. The quality of this gas is more fully described later, where the by-products of the ovens are discussed somewhat at length.

THE PRODUCTS OF THE BY-PRODUCT OVEN.

Coke.—An investigation of the subject will immediately show that the essential distinction between the operation of the retort oven and that of the ordinary beehive is that in the former the coal is coked without the admission of air, by heat applied from the outside, while in the latter the air is admitted to the oven and the combustion takes place immediately over the body of coal. The result is that in one case the hydrocarbons are simply distilled off, with a certain breaking down and deposition of graphitic carbon on the coke, so that a yield of coke greater than the so-called "theoretical" can be counted on, while in the other case the most of the hydrocarbons are burned in the ovens, some graphitic carbon is deposited, and some of the fixed carbon of the coal is burned, resulting in a yield of coke less than the theoretical. As an illustration of the difference in yield resulting from this difference in method of coking, a good yield of coke from Connellsville coal in a beehive oven is 65 per cent., while in a good retort oven it is easy to get 75 per cent., an increase of about 10 per cent. Of course this increase reduces proportionately the percentage of ash, phosphorus, etc., remaining in the coke, so that the retort oven yields more coke and a purer coke than the beehive from the same coal. This increase in yield varies with the proportion of fixed carbon, ash, etc., in the coal.

The quality of the coke made in the by-product ovens has long been a subject of discussion, especially among the blast furnace men of Europe. The English authority, Sir Lowthian Bell, made a series of careful tests a number of years ago and pronounced against the coke in comparison with that made in beehive ovens, and his conclusions were accepted by English ironmasters. But improved construction and practice have combined to produce a better coke, and it is reported that Sir Lowthian Bell has modified his views to such an extent that a plant of retort ovens is now being built at his own works—those of Messrs. Bell Brothers. On the Continent retort oven coke is now the standard, and in this country we are just beginning to realize that a coke not made in the old beehive oven and not having the famous silvery gloss of coke quenched in the oven is proving itself quite equal to it in fuel value.

The essential difference between beehive and retort oven coke lies in its hardness and shape, caused by the different application of the heat in the oven. In the beehive the coal is spread out in a layer 23 or 24 inches thick over a surface some-twelve feet in diameter. The bottom of the oven having been cooled by the quenching of the previous charge and by contact with the new one, the coking begins at the top and extends downward, reaching the bottom in from 32 to 34 hours. The coke has ample opportunity to swell and develop a cellular structure in accordance with the composition of the coal, and entirely independent of any attempts at control. The typical form of beehive coke is therefore long finger-like pieces, widening toward the bottom of the oven and with an inch or two of spongy coke at each end. The inability to control the formation of the cells makes it essential that just the right coals are used, or the requisite hard body, resistant alike to pressure and the action of hot carbonic acid in the blast furnace, cannot be obtained. The fact that the coal from the Connellsville district gives just the requisite structure when coked in the beehive oven is the reason for its present pre-eminent position as a blast furnace fuel in America.

In the retort oven the coal lies in a high narrow mass, about 5 feet high and from 16 to 20 inches wide. The previous charge having been pushed out rapidly by machinery and quenched outside, the oven is hot when the fresh charge is introduced and the evolution of gases begins immediately from the coal lying in contact with the hot sides. The flow of gases being from the sides, they meet in the center and rise to the top, where they escape, forming a sort of cleavage plane midway between the two walls. Thus the pieces of retort coke are stouter than the long, slowly developed "fingers" of the beehive oven, and are a little shorter than half the width of the oven. The end of the piece next the wall is denser and the end next the cleavage plane is more spongy than the main body.

The cellular structure is more compressed than beehive coke, principally on account of the narrow retort that permits no expansion in the direction of the flow of the gases, and also because the depth of the charge is usually about two and one-half times as great as in the beehive. The cellular structure of retort coke is dependent somewhat on the proportions of the ovens, the temperature and the time of coking.

The ability of the retort oven to coke coals that cannot be used in the beehive is due to the more rapid application of the heat, fixing the pitchy or coke-making portion of the coal before it has time to escape and the formation of a firm cellular structure by the pressure.

During the past year a conclusive test has been made indicating the relative values of retort and beehive coke made from the same high grade coal, of a quality adapted to both the retort and beehive practice. For a year or more a blast furnace has been run either entirely or largely on retort coke made from the Connellsville coal. The furnace was blown in on retort coke, and run for some months without any signs indicating anything unusual in the fuel. Subsequently a portion of beehive coke was used in the fuel charge, and from time to time the fuel was changed from all retort coke to all beehive coke, or to a portion of each, without any indications in the working of the furnace that there was any difference in the fuel.

It is probable that prolonged and accurate comparisons would show that the hardness of the retort coke would result in a somewhat lower fuel consumption and a cooler furnace top, owing to the weaker action of the furnace gases on the harder coke; also, that the blast pressure would have to be slightly higher than with the beehive coke.

It is quite within the bounds of possibility that some of our American coals, equal in chemical purity to the Connellsville, yet inferior to it in adaptability to the conditions of the beehive oven, may prove to make a coke in the retort oven that will be of equal value in every respect with the Connellsville beehive coke. Indeed, experiments already made would seem to point in that direction.

Objection has been made to the retort coke on the ground that it is watered outside of the oven, thereby destroying the carbon glaze found on coke quenched within the oven and increasing the percentage of moisture in the coke. Careful tests have proved that retort coke is somewhat more resistant to the action of hot carbonic acid in the top of the furnace than is beehive coke from the same coal, which seems to show that the carbon glaze has in practice no value. The absence of a glaze on retort coke is no indication that carbon is not deposited from the gases, for in the first place the yield of coke is always higher than the so-called "theoretical" yield, and in the second place, as the coke is leaving the oven the glaze can plainly be seen, but its brightness is destroyed by the water.

A long series of tests have shown that coke properly quenched outside of the oven need not contain over ¼ to ¾ per cent. of moisture, but the amount of moisture in the coke after its arrival at the furnace is altogether another question, and depends more on the time it is on the road and on the humidity of the atmosphere than on the method of quenching.

The effect of moisture in the upper part of a blast furnace is an open question. Experiments have been made by leading furnacemen which indicate that its cooling action on the ascending gases saves the coke in a measure from solution in the hot carbonic acid and permits more coke to reach the zone of fusion, with the result that the fuel consumption is noticeably lowered.

The Connellsville beehive coke is, perhaps, the most perfect blast furnace fuel in the world, and it is not claimed that retort coke made from this coal is a superior fuel to the beehive product. But to the great bituminous coal fields of this country, to which the Connellsvile district does not bear the relation of one to the hundred, the retort oven comes with a promise of help. Many coals that, although pure enough chemically for metallurgical use, make a soft coke in the beehive oven, when coked in the retort oven give a structure so hardened and strengthened that the product is an entirely acceptable metallurgical fuel. In other cases, when the impurities are too great for furnace or foundry use, or the structure is hopelessly weak, or when the coal is dry and lies dead in the beehive without a suggestion of coking, a coke can often be made in the retort oven that is easily salable for domestic purposes, brewers' and malsters' use, and for many other uses where a clean-burning fuel, free from smoke, is desired. The demand for coke for these purposes is growing rapidly, and the supply of this market should be very profitable in a properly located and designed plant, from which the gas and other by-products would have a ready sale.

The ability of the retort oven to coke coals that have hitherto been considered non-coking, brings into prominence the subject of laboratory tests of coals for coking purposes and of the coke made. A chemical analysis of the coal or coke, while important, does not fully indicate its value, and physical tests are quite as important.

The coking qualities of a coal are hardly shown at all by an ordinary chemical analysis, and an actual test in the oven is the usual method for determining this point. A laboratory method for making this test has been recently developed by Louis Campredon in the laboratory of the Vignac Works, France. His method is similar to that used in ascertaining the binding power of cement. The principle is the mixing of the coal with an inert body and carbonizing the mixture in a closed vessel; the greater the binding or coking power of the coal the more inert matter will it bind into a solid mass. The practical operation of the method is as follows: Pulverize the coal finely, passing it through a sieve of fine mesh. A suitable inert body is a fine siliceous sand of uniform grain, but somewhat coarser than the coal. Several equal portions of coal (say of 1 gm. each) are mixed with variable weights of sand, and the mixtures are heated to a red heat in closed porcelain crucibles, so as to carbonize the coal. After cooling, either a dry powder or a more or less hard coked mass is obtained. After a few trials it is easy to determine what maximum weight of sand a coal can bind together.

Taking the weight of coal as unity, the binding power will be given by the weight of the agglomerated sand. The binding power is nil for a coal giving a powdered coke, and it has been found to be 17 for the most binding coal yet tried by the experimenter, while pitch is 20. Experiments by this method show that there is no relation between the proximate analysis and the binding power of coals, confirming actual oven experience.

THE BY-PRODUCTS.

These consist primarily of ammonia, tar and gas, and in addition to the increased yield of coke are the sources of profit from the by-product oven which are wholly lost in the ordinary beehive. Some retort ovens, such as the Otto-Coppée, for example, are without the by-product apparatus, and burn the gas to heat the ovens without washing it. These recover no ammonia or tar, but use the excess gas for raising steam, evaporating about 1.5 pounds water per pound of coal coked. But the by-products are so easily saved and the profits therefrom make such an acceptable addition to the right side of the ledger that they can hardly be neglected. A brief consideration of each one may be of interest.

Ammonia.—This substance is given off from the coal in the oven very slowly at first, but as the temperature of the charge rises the quantity increases, and after some ten hours the evolution is quite rapid. As the coking approaches completion the yield becomes much less and stops altogether, although usually a quarter or more of the nitrogen originally in the coal still remains in the coke. The yield of ammonia varies very much in different coals, and depends partly on the amount of nitrogen and oxygen in the coal. It varies also with the temperature at which the coal is coked. Perhaps the most reliable method to determine the yield from any coal, except by an actual oven test, is by the distillation of a sample of the coal in a small retort, under the same temperature and conditions as are present in the oven. But the results are liable to be misleading unless the operation is conducted by an experienced person, as it is hard to maintain the proper conditions.

The ammonia from the ovens is collected in the hydraulic main and condensers, along with the tar, by the cooling and scrubbing of the gas. The ammonia occurs in two forms in the liquor: "fixed" and "volatile;" the former containing the sulphates, chlorides, cyanides, etc., while the latter contains the carbonates, sulphides, and, according to some, free ammonia. The bulk of the fixed salts is condensed first and the volatile later. The ammonia liquor is quite weak when it is first drawn from the tar, usually containing from $\frac{3}{4}$ to 1 per cent. of ammonia. This weak liquor may be either converted directly into sulphate, and sold as a fertilizer, or by purification and concentration it may be converted into aqua ammonia or anhydrous ammonia, which is used so largely through the South and elsewhere in refrigerating and other apparatus.

Ammonia liquor was formerly valued by the hydrometer, but this method is deceptive, as the density of the liquor is affected by the condition in which the ammonia occurs. The more accurate method is the distillation of the liquor with some caustic lime or soda, which drives off all the ammonia, volatile and fixed. The distilled ammonia is absorbed in standard acid, and the excess of acid is afterward titrated with a standard alkali solution. The yield of ammonia is usually reckoned as ammonium sulphate, although it may be sold as liquor or sulphate, or in a more concentrated form, according to the market.

The yield of ammonia from the coals in the vicinity of Pittsburg is from 16 to 22 pounds of sulphate per ton of coal.

Tar.—Since the manufacture of illuminating gas by the water-gas process has attained prominence the market for tar is very much improved. Very large quantities are used for roofing, paving, etc., and in Europe much is distilled and separated into pitch and the various lighter oils, which are further treated for the almost endless number of valuable substances which they contain. In this country but little of this is done as yet, and the tar is used mainly for the cruder purposes. Properly developed, its manufacture into the more valuable products should yield very satisfactory profits. Our chemical manufacturers are beginning to realize this fact, and plants for the distillation of tar are growing in number and in importance. The rapid increase of by-product ovens, and the consequent large amount of tar which will be put on the market in the near future makes it necessary to find another outlet for it than the cruder uses, and it is probable that tar distillation will be an important industry in this country before many years.

The main products of the distillation of tar are, light oil, creosote or heavy oil, naphthaline, anthracene and pitch.

The yield and quality of tar from retort ovens depend on the coal and also on the temperature at which the distillation takes place. The tar from the leading retort ovens is usually of excellent quality and commands the best price. The yield of the coals in the vicinity of Pittsburg is from 70 to 80 pounds per ton of 2,000 pounds of coal. Some coals yield as much as 100 pounds or more.

Gas.—The gas that is obtained from retort ovens is a by-product, the value of which varies greatly with the locality in which the ovens are situated. When the ovens are at the coal mine the gas is frequently valuable only for steam raising purposes, and at the usual prices of coal at the mines would be worth but a very few cents per thousand feet. An intermediate condition would be when the ovens are adjacent to an iron or steel works, where the gas could be used for heating furnaces, soaking pits, etc., where it would supplant producer gas, being much more conveniently applied and easily freed from all impurities. The most favorable locations for obtaining a good value for oven gas are those adjacent to large towns, where there is a demand for illuminating or fuel gas. The discovery and use of natural gas in this country has caused a great demand for fuel gas, especially for domestic purposes, and many hundreds of thousands of dollars have been spent in attempts to supply this demand. But while these experiments have been going on the beehive coke ovens of Pennsylvania alone have been quietly burning to waste nearly 1,000,000,000 feet a week of a very superior quality of fuel gas without exciting any special attention.

Coke oven gas from properly managed retort ovens is approximately the same article as that from the retorts of a gas house, the processes of manufacture being similar. It usually contains rather less illuminants, however. Its quantity and composition vary with the coal used and the temperature of distillation, but made from good gas coal it may be used for illuminating purposes after being passed through the ordinary lime boxes to remove the sulphur, etc. If from the nature of the coal the illuminating power of the gas is low, it can either be enriched by any of the well known methods or burned with incandescent burners or used as a fuel gas; for the lack of 1 or 2 per cent. of illuminants will not appreciably affect its fuel value.

In arranging an oven plant for the supply of fuel or illuminating gas, it is necessary either to provide a holder of rather large dimensions or with a smaller holder, to have not less than, say, twenty-five or thirty ovens, that shall be drawn in rotation at approximately even intervals; for in common with other substances containing hydrocarbons, when coal is distilled in an oven or elsewhere the gases given off are not at all uniform in composition, but change constantly as the distillation progresses.

The following are analyses of retort-oven gas from European and American coals:

	Percentage by volume				
	I.	II.	III.	IV.	V.
Carbonic acid	3.0	0.90	1.4	3.27	.3
Carbonic oxide	8.8	4.90	6.5	7.95	7.4
Hydrogen	58.0	58.57	53.3	52.77	51.7
Nitrogen	2.4	5.74	0.5	1.99	5.5
Methane	24.7	27.56	36.1	31.45	32.3
Olefines	3.1	2.33	2.2	2.57	2.8
Totals	100.0	100.00	100.0	100.00	100.0

It is often asked—what is the difference between coke oven gas and natural gas? This is readily answered by a comparison of the above analyses with the following, which is from gas sold in Alleghany and Pittsburg by the natural gas companies:

Carbonic acid	0.3 per cent.	Nitrogen	0.2 per cent.
Carbonic oxide	0.0 " "	Methane	96.9 " "
Hydrogen	0.0 " "	Olefines	0.8 " "

It will be noticed that this latter gas is almost pure methane, or marsh gas, while the coke oven gas is practically a mixture of methane with hydrogen. The natural gas of the above analysis contains about 980 British thermal units per cubic foot, while the coke oven gas usually contains from 560 to 590 heat units. It is a familiar fact to those who have seen natural gas burned for lighting purposes that the large amount of methane causes it to burn with a smoky flame, and the light from it is therefore poor, although the proportion of olefines or illuminants, is not always as small as in the analysis given above. It has been stated by good authorities that when a gas having such a large proportion of methane is burned in the ordinary way without regeneration of the air by the products of combustion, that the available heat units are not greater than those from a gas of similar composition to the coke oven gases given above, owing to the fact that such a very large amount of air is necessary to burn the methane, and the amount of heat absorbed in bringing the inert nitrogen up to the temperature of the combustion chamber is so great that it counterbalances the superior heating value of the gas. Of course, if the heat carried away in the products of combustion were returned to the furnaces by regeneration, this loss would not be nearly so great.

The principal source of luminosity in the gas is benzol. This substance is separated from the gas in some of the German by-product works, and is used for the manufacture of the aniline colors. It is a highly volatile substance, somewhat similar to the naptha products of petroleum distillation, and is very difficult to transport. Its removal from the gas renders the latter useless for illuminating purposes, but does not materially affect its fuel value. Benzol is also obtained in the distillation of tar, but not in large quantities.

To sum up briefly, then, it will be seen that the coking of coal in the by-product retort oven differs in the results obtained in the following particulars from the same operation in the beehive: From the beehive oven we obtain coke. The article is of excellent quality if the coal is just adapted to the purpose, but the yield is from 5 to 20 per cent. lower than the analysis of the coal shows should be gotten.

In addition to the coke there is a great deal of smoke, but those living near the ovens hardly look on this as a valuable product.

From the by-product retort oven, we have coke again, and always more than the analysis of the coal indicates. It has yet to be proven that any coal which makes good beehive coke will not make equally good retort oven coke. Moreover an excellent metallurgical coke can be made from many coals that are worthless for the beehive. In fact it is largely for this reason that retort ovens have been so widely introduced in Continental Europe. In addition to the increased yield of coke we have from a ton of coal, from 16 to 22 pounds of sulphate of ammonia, from 70 to 100 pounds of tar, and from 3,000 to 10,000 cubic feet of gas.

The manufacture of coke is about the only metallurgical operation that we Americans, proud of our wonderful progress in all the mechanical arts, still conduct after the manner of our ancestors before the Revolutionary war. Let us introduce the by-product retort oven into the chain of iron manufacture, confident that it will not be unworthy to be linked with the mining and haulage of our coal by electricity, the digging of our ore by steam shovels, and our blast furnaces smelting 700 tons of iron in a day.

Coal Washing.

(Fr. m advance sheets of second edition "Iron Making in Alabama," by Wm. B. Phillips.)

As coal washing in the State is entirely incidental to the production of blast furnace and foundry coke, it might be best to include the remarks on this subject in the chapter on Fuel. But the importance of it warrants separate treatment, if, indeed, merely a short one. The growth of the industry has been very rapid. While it is true that in 1890 123,189 tons of slack coal were washed, yet, in 1891 the amount fell to 8,570 tons. It seems to have begun regularly in 1892, for since that time the amount of slack washed has steadily increased.

In some establishments, *e. g.*, at Brookwood, and at Lewisburg, the lump coal is hand-picked, on long picker-belts. In all the establishments now washing coal only the slack is washed.

While the industry is of very recent date, so far as large and continuous operations are concerned, yet it was begun in the State in 1875–76 at Oxmoor. A Stutz washer was used there on Helena coal, but the records cannot now be secured. It is of interest also to note that modified Belgian coke ovens were used there at that time. Both the washer and the ovens have been torn down these many years. For most of the coking coals here washing is not necessary, except for the slack. It was to utilize this that washing was undertaken, as otherwise the slack was of little value. A large amount of run of mines coal is made into coke, but the use of washed slack is steadily encroaching upon this, and recently another large plant has entered upon the business. We may expect that the future will show an increasing proportion of coke made from washed slack, as the demand for the better grades of domestic and steam coal will make the use of slack more and more necessary.

It is difficult to state exactly the amount of slack through a

1¾-inch screen yielded by coal mining operations. So much depends upon the nature of the coal itself, and that of the seam, as also upon the system of mining, screening, etc., that only general statements can be made. It varies from 35 per cent. to 65 per cent. of the output. A coal washing plant for handling 500 tons of slack per day of twelve hours will require the mining of not less than 800 tons of coal, and may require 1,400 tons.

A table showing the character of the coal made into coke in this State is given below. It is taken from the returns made to the Division of Mineral Resources, United States Geological Survey:

	Run of Mines.				Slack.				
	Unwashed.		Washed.		Unwashed.		Washed.		
Year.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Tons.	Per ct.	Total tons.
1890	1,480,669	81.8	....	......	206,106	11.3	123,189	6.9	1,809,964
1891	1,943,469	90.6	....	......	192,238	9.0	8,570	0.4	2,144,277
1892	2,463,366	95.3	....	......	11,100	0.4	111,500	4.3	2,585,966
1893	1,246,307	61.8	51,163	2.5	292,198	14.6	425,730	21.1	2,015,398
1894	411,097	26.1	7,429	0.5	477,820	30.3	677,899	43.1	1,574,245
1895	1,208,020	49.1	....	......	32,068	1.3	1,219,377	49.6	2,459,465

In 1891 of the 2,144,277 tons of coal made into coke only 0.4 per cent. was washed slack, *i. e.*, of every 100 tons of coal sent to the ovens less than one-half a ton was washed slack. In 1893 there was 50 times as much washed slack used for coke as in 1891, and in 1895 more than 140 times as much as in 1891. There was a remarkable increase as between 1892 and 1893, viz.: from 4.3 per cent. to 21.1 per cent., as also between 1893 and 1894, viz.: from 21.1 per cent. to 43.1. From 1894 on the increase in the use of washed slack has not been so marked as in the previous years.

The use of washed slack enables the mine owners to avail themselves of what would otherwise be of little value, and to make a better coke of this material than is made of run of mines coal.

SLACK COAL—ROBINSON-RAMSAY WASHER.

Size	Through 1/8 in. to dust.		Through 1/4 in. on 1/8 in.		Through 3/8 in. on 1/4 in.		Through 1/2 in. on 3/8 in.		Through 3/4 in. on 1/2 in.		Through 1 in. on 3/4 in.		Through 1 3/4 in. on 1 in.	
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.
Per cent	27	28	16	21	10	10	16	13	15	16	9	7	7	5
Volatile matter	30.03	30.74	29.11	32.00	29.86	32.40	32.40	31.10	29.20	31.10	30 80	32.60	28.30	32.36
Fixed carbon	58.45	59.77	62.10	60.10	61.20	61.40	60.80	59.30	53.10	62.70	57.60	61.20	53.60	62.69
Ash	11.52	9.49	8.73	7.90	8.94	6.21	9.60	6.80	17.70	6.20	11.60	6.20	18.10	4.95
Sulphur	1.71	1.46	1.47	1.29	1.51	1.37	1.74	1.20	1.63	1.49	1.77	1.29	1.82	1.18

CHANGES IN THE COAL—AS PERCENTAGES OF THE RESULTS FRON UNWASHED SLACK.

	Per cent.		Per cent.		Per cent.		Per cent.		Per cent.		Per cent.		Per cent.	
	Gain.	Loss.	Gain.	Loss	Gain.	Loss.	Gain.	Loss.	Gain.	Loss.	Gain.	Loss.	Gain.	Loss.
Volatile matter	2.89	...	9.93	...	8.50	...	...	4.10	6.51	...	5.84	...	14.35	...
F xed carbon	2.26	...	...	3.22	0.32	...	...	2.46	18.08	...	6.25	...	16.96	...
Ash	...	17.62	...	9.51	...	30.56	...	29.16	...	65.00	...	46.58	...	72.65
Sulphur	...	14.62	...	12.24	...	9.28	...	31.03	...	8.58	...	27.12	...	35.16

Disregarding the changes in the volatile matter and fixed carbon as not affecting the efficiency of the washing as much as the reduction of the ash and the sulphur, some important deductions may be derived from an examination of these tables. The Robinson washer does not size its materials; everything through a 1¾-inch screen, for instance, goes direct to the washer, and no attempt at sizing is made. The above sizes of coal were obtained by using hand-screens, but they were not sent to the washer by separate sizes. Of the material going into the washer—

27	per cent.	passed a	⅛-inch	screen.				
16	"	"	¼-inch	"	but was retained	by a	⅛-inch	screen.
10	"	"	⅜-inch	"	"	"	¼-inch	"
16	"	"	½-inch	"	"	"	⅜-inch	"
15	"	"	¾-inch	"	"	"	½-inch	"
9	"	"	1-inch	"	"	"	¾-inch	"
7	"	"	1¾-inch	"	"	"	1-inch	"

Calculating the average ash from the ash in each separate size we find it to be 11.90 per cent. This was the ash in the slack going into the washer. Of the material coming from the washer, excluding the refuse slate, sludge, etc.—

28	per cent.	passed a	⅛-inch	screen.				
21	"	"	¼-inch	"	but was retained	by a	⅛-inch	screen.
10	"	"	⅜-inch	"	"	"	¼-inch	"
13	"	"	½-inch	"	"	"	⅜-inch	"
16	"	"	¾-inch	"	"	"	½ inch	"
7	"	"	1-inch	"	"	"	¾-inch	"
5	"	"	1¾-inch	"	"	"	1-inch	"

Calculating the average as before we find it to be 7.47 per cent., and the reduction of the ash is 37.23 per cent. That is, this slack lost 37.23 per cent. of its ash by being washed, a result somewhat lower than is obtained by considering the slack as a whole without regard to the ash in the separate sizes. Using the same method for calculating the sulphur in the unwashed slack we find it to be 1.65 per cent., and in the washed slack 1.35 per cent. The sulphur, therefore, was reduced by 18.18 per cent.

In other words 100 parts of ash in the unwashed slack become 62.77 parts in the washed slack, and 100 parts of sulphur in the unwashed slack become 81.82 parts in the washed slack.

Refuse Slack. Robinson-Ramsay Washer. Sampled from the Tail-Gate.

Through ⅛ in. to dust.			Through ¼ in. on ⅛ in.			Through ⅜ in. on ¼ in.			Through ½ in. on ⅜ in.			Through ¾ in. on ½ in.			Through 1 in. on ¾ in.			Through 1¾ in. on 1 in.		
P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash
11.2	1 56	41.10	8.2	2.21	66.60	6.7	2.13	62.54	16 5	2.02	57.10	22.3	1.68	50 08	15.8	1.64	49.20	19.3	1.47	42.04

Refuse Slack. Robinson-Ramsay Washer. Sampled from Railway Cars.

P. C.	Sp. G.	Ash	P. C	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash
16.7	1.42	33.15	9.7	2.17	66.26	7.8	2.04	62.80	15.5	1.95	54.09	23.3	1.65	48.90	11.2	1.46	38.80	15.8	1.59	46.40

Average Analysis of Refuse Slack. Robinson Washer.

P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash	P. C.	Sp. G.	Ash
13.95	1.47	36.34	8.95	2.19	66.41	7.25	2.08	62.68	16.0	1.97	55.62	22.8	1.66	49.47	13 5	1.57	44.85	17.55	1.52	44.00

The analysis of the sludge, corresponding to these results, was—

	Per cent.
Volatile matter	24.73
Fixed carbon	44.14
Ash	31.13
	100.00
Sulphur	4.12

(*See Table on opposite page.*)

The purest coal that could be picked out, by hand, from the coal here in discussion, had the following composition:

	Per cent.
Volatile matter	33.00
Fixed Carbon	64 60
Ash	2.40
	100.00
Sulphur	1.25

In washing operations it is, however, impracticable, if not impossible, to obtain coal of this degree of purity. Owing to loss of coal, there is a point beyond which it is impracticable to reduce the ash. This point varies with each coal, and to some extent also with the purpose for which the washed coal is intended. In this State only the slack coal is washed, and practically all of the washed slack is made into coke.

Reverting to the statement already made that all of the material through a $1\frac{3}{4}$-inch screen is called slack, and is sent to the Robinson washer without further sizing, the question is: to what point shall the ash in the washed coal be brought in order that the washing may be considered satisfactory?

There are three elements entering into this question:

1. The amount of ash in the original slack.
2. The waste of coal in the operation.
3. The demand of the furnaces for a superior coke.

The maximum amount of ash to be left in the washed slack depends to a great extent upon the demands of the blast furnaces and foundries for coke, for if the demand is active and prices good the waste in the washing is not of so much importance. It is always *important*, and should be carefully looked after, but there are times when its importance is greater than at others. Considering all the elements entering into the question, the amount of ash to be left in the washed slack, what-

COAL RECOVERED FROM REFUSE SLACK BY SOLUTION OF SP. G. 1.35.

Through 1/4 in. on 1/8 in.		Through 3/8 in. on 1/4 in.		Through 1/2 in. on 3/8 in.		Through 3/4 in. on 1/2 in.		Through 1 in. on 3/4 in.		Through 1 3/4 in. on 1 in.	
Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash
4.10	8.90	2.50	10.10	3.0	9.30	4.20	8.70	3.0	12.06	4.0	16.10

COAL RECOVERED FROM UNWASHED SLACK BY SOLUTION OF SP. G. 1.35.

Per Ct.	Ash	Per Ct.	Ash	Per Ct	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash
85	6.20	79	5.90	88	4.10	81	12.30	75	4.30	56	10.30

COAL RECOVERED FROM WASHED SLACK BY SOLUTION OF SP. G. 1.35.

Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash	Per Ct.	Ash
87	4.60	86	4.01	81	5.20	88	4.20	95	5.30	88	3.05

ever it may be, is to be termed "fixed" ash, and the difference between this and the total ash in the unwashed slack is removable ash. For instance, if the ash in the unwashed slack is 11.90 per cent., and the ash in the washed slack is 7.47 per cent., we may regard this latter as the fixed ash, and 4.43 per cent. is the removable ash. But in this particular case the reduction of the ash from 11.90 per cent. to 7.47 per cent. was not as good work as should have been done. With coal of this nature the ash should be reduced to 6.75 per cent. instead of 7.47 per cent., for the coke should not carry over 10 per cent. of ash.

The best results with this particular coal were to reduce the average ash by 43 per cent., and the sulphur by 26 per cent., taking the records over considerable periods. The four following analyses represent about the best practice on the large scale, using unwashed slack, and the Robinson-Ramsay washer. For convenience of comparison the average composition of the unwashed slack is also given :

UNWASHED SLACK—DRY.

	Per cent.
Volatile matter	30.06
Fixed carbon	58.04
Ash	11.90
	100.00
Sulphur	2.40

WASHED SLACK—DRY.

	1 Per cent.	2 Per cent.	3 Per cent.
Volatile matter	32.43	32.46	32.55
Fixed carbon	60.91	60.86	60.64
Ash	6.66	6.68	6.81
	100.00	100.00	100.00
Sulphur	1.91	1.89	1.93

The reduction of the ash was 43.5 per cent., and of the sulphur 20.4 per cent. The yield of 48-hour coke, over a 1½-inch fork, from this washed slack was 58.78 per cent., or from 5 tons of coal 2.94 tons of coke.

There may be instances in which the Robinson-Ramsay washer, on coal of the kind herein described, has done, perhaps, somewhat better work than this, but it is not thought that under average conditions the results are any better than these.

The Robinson-Ramsay washer does very well on slack in which there is little or no bone coal, and where the difference between the specific gravity of the coal and the slate is considerable. For instance, the average specific gravity of the refuse slate, as from the above tables, is 1.71, the highest being 2.21 in the material through $\frac{1}{4}$-inch and left on $\frac{1}{8}$-inch screen, the lowest being 1.42 in the material through $\frac{1}{8}$-inch screen. The specific gravity of the pure slate, without intermixture of coal, may be taken at 2.40, but there is very little such material in the unwashed slack, for the refuse slate of highest specific gravity, 2.21, had with it 4 per cent. of coal which carried 8.9 per cent. of ash.

In washing coal it is not so much a question of removing pure slate from pure coal, because this can always be done, as of separating slate-carrying coal from coal of a greater or less degree of purity. The question as to what is coal, is not general, but special, and has to be answered in the light of each individual case. With the coal under discussion, and with this washer, the writer is inclined to think that material above 1.35 sp. gr. cannot well be considered coal, for the lowest ash in coal recovered from refuse slate by a solution of this specific gravity was 8.70 per cent. Perhaps the limit should not be above 1.30. Taking it at 1.30, and the specific gravity of the refuse slate, with coal attached to it, at 1.71, the difference in specific gravity is 0.41.

With this difference, and with this particular coal, this washer may be depended upon to handle a large amount of slack every day, and to do its work very well. But it is not designed to treat coal in which the specific gravity of the impurities, such as bone coal, etc., approaches that of the coal itself.

Possibly if the slack were properly sized, and each size sent to its own washer, better results could be obtained.

What was said to be the Luhrig system was introduced into the Birmingham district in 1890-91, but the machines were neither properly constructed nor properly managed, and the washing operations soon came to nothing. It is much to be regretted that this was the case, for when the Luhrig system is designed after a study of the coal itself, there is no better coal washing system. In Alabama, however, only two systems are in use, on a large scale, the Robinson-Ramsay and the Stein. The Campbell tables have been introduced to work some of the Walker county coals, and have given fair results. Until the fall of 1897 the Standard Coal & Coke Co., Brookwood Tuscaloosa county, Alabama, was the only establishment using the Stein washer, but the Jefferson Coal & Railway Co., Lewisburg, Jefferson county, has recently had built, under the personal direction of Mr. Stein himself, a very complete washing plant of a capacity of 40 tons an hour. At Brookwood the Stein washer has given excellent results. It is to be regretted that no detailed investigations of the washing operations there are accessible. In the Proceedings of the Alabama Industrial and Scientific Society, Volume VI., Part I., Mr. F. M. Jackson said in regard to

THE STEIN WASHER:

"It has enabled the Standard Coal Company to produce a coke of uniform quality and of extraordinary structure, the average analysis of which invariably runs below 10 per cent. of ash and 1 per cent. of sulphur. The analyses for the last six months show the average ash to be 8.80 per cent., and sulphur 0.74 per cent., whereas the coke formerly carried as much as 18 per cent., and never under 13 to 15 per cent., with sulphur 1.50 per cent. to 1.75 per cent. The loss in washing is from 6½ per cent. to 9 per cent. of the weight of the slack, and the loss in coal is never over 3½ per cent. under ordinary conditions, and often is as low as 2 per cent."

Mr. Jackson refers to Mr. John Fulton's book on coke for further information in regard to the Stein washer at Brookwood. From this authority we learn that it was the first of its kind erected in the United States, having been built in 1890, and has a daily capacity (10 hours) of 500 tons. The following analyses, taken from Fulton, show the reduction in ash:

	Ash			
	Unwashed Coal.	Washed Coal.	Coke.	Per Ct. of reduction of ash in coal.
	15.32	8.15	10.10	46.9
	14.10	7.50	9.50	46.9
	15.07	6.50	......	56.8
	20.83	8.10	10.50	61.3
	17.18	7.60	10.50	55.5
	16.38	6.50	9.27	60.2
	20.90	5.50	......	73.5
	17.37	5.40	......	69.0
	18.63	7.15	......	61.7
	21.12	4.81	6.10	77.5
Average...	17.69	6.72	9.33	60.93

This is certainly an excellent record. So far as concerns the making of coke from this coal the information is satisfactory, but inasmuch as the Stein system is based on the sizing of the coal before it goes to the jigs, it would have been more complete had the efficiency of the washing as referred to each size been given. We must, therefore, in the absence of specific data infer that these results are averaged from the separate results, and yet the variation in the efficiency of the washing forbids this assumption, for the removal of the ash varies from 46.9 per cent. to 77.5 per cent. The Robinson-Ramsay washer, on some coals, removes *from certain sizes* as high as 72.65 per cent. of the ash, but does not reach anything like so high a result, considering all the coal that goes into it. One may be permitted to doubt if the results at Brookwood represent all the sizes of coal. For instance, a certain coal had 21.12 per cent. of ash before washing and 4.81 per cent. after washing, a reduction of the ash of 77.5 per cent., and the ash in the coke was 6.10 per cent. But one would like to know what size this was, and what proportion this particular size bore, in weight, to the total amount of slack sent to the jigs. Looked at from the standpoint of actual results, certainly these figures leave but little to be desired, and this, after all, is the main consideration. To remove 77.5 per cent. of ash from coal carrying 21.12 per cent. is certainly good work, but one cannot refrain from asking why this result was not reached with coal of 14.10 per cent. ash? If 77.5 per cent. of ash were removed from this kind of coal the resulting coal would carry only 3.18 per cent., instead of 7.50 per cent., which it did carry under a removal of 46.9 per cent.

Two facts stand out prominently from these analyses, viz.: the best results were from the dirtiest coal, and that from a coal practically useless for coke-making there was obtained a coal that makes excellent coke.

There are two points of view in coal washing operations—practical and scientific—and to some it might appear that if the practical results are satisfactory the scientific aspect of the matter may be left to take care of itself. But it will generally be found that the best practical results are reached by the aid of the best scientific information, and that there is a very real and a very vital connection between good practice and good theory. A careful study of what is going on very often leads to improvements; and from an examination of what *is* done we come to a decision as to what *should be* done.

Report by Statistical Committee.

To the President and Members of the Alabama Industrial and Scientific Society:

GENTLEMEN—It is the pleasure of your Committee to report the following:

At the fall meeting in 1896 of this Society, it was determined to make an endeavor to obtain monthly returns from the various producers in the State who mined mineral or ore and who manufactured products therefrom. In this list your Committee has included all the ironmasters, operators of collieries, manufacturers of the various grades of brick and of lime, as well as the operators of quarries. So far as our knowledge extends this was the first attempt made by any society to obtain such statistics, and had it not been for the assistance of Dr. Eugene A. Smith, State Geologist, your Secretary, who has paid the expense incurred in this work, it could not possibly have been carried on. The following is the list of producers we have been applying to monthly for the information desired:

ALABAMA PRODUCERS.

Tennessee Coal, Iron & Railroad Co., Birmingham.
Sloss Iron & Steel Co., Birmingham.
Pioneer Mining & Mfg. Co., Thomas.
Woodward Iron Co., Woodward.
Trussville Furnace & Mining Co., Trussville.
Sheffield Coal, Iron & Steel Co., Sheffield.
W. G. Robinson & Co., Birmingham.
Standard Coal Co., Brookwood.
Dr. J. T. Searcy, Tuscaloosa.
Palos Coal Co., Palos.
Cahaba Southern Mining Co., Hargrove.
Coal City Coal & Coke Co., Coal City.
Corona Coal & Coke Co., Corona.
Howard-Harrison Iron Co., Bessemer.
Swansea Coal Co., Swansea.
Leon Fuel Co., Delmar.
Dora Coal Co., Horse Creek.

New River Coal Co., Natural Bridge.
Jasper Coal Co., Jasper.
Ragland Coal Co., Ragland.
Clem & Belser, Delmar.
Tidewater Coal Co., Tuscaloosa.
Virginia & Alabama Coal Co., Birmingham.
Climax Coal Co., Maylene.
Galloway Coal Co., Galloway.
Chickasaw Coal Co., Galloway.
Coaling Coal & Coke Co., Coaling.
Little Warrior Coal Mining Co., DeBerniere.
Zenida Coal Co., Helena.
Ivy Leaf Coal Co., Horse Creek.
Montevallo Coal & Coke Co., Dogwood.
Montevallo Coal & Transportation Co., Aldrich.
Milner Coal Co., New Castle.
Gaslight Coal Co., Oakman.
Watts Coal, Coke & Iron Co., Warrior.
Helena Coal & Mfg. Co., Helena.
Chris. Obal, Gadsden.
Bessemer Land & Improvement Co., Bessemer.
Birmingham Water Works, Birmingham.
Sand Mountain Coal Co., Attalla.
Pearson Coal & Iron Co., Warrior.
Tutwiler Coal & Coke Coke Co., Blossburg.
Mabel Mining Co., Warrior.
Elliott & Carrington, Jasper.
Thomas Coal Co., Birmingham.
Jefferson Coal & Railroad Co., Lewisburg.
Hendon Coal Co., Horse Creek.
McDonald Coal Co., Carbon Hill.
Imogene Coal Co., Montevallo.
Mountain Valley Coal Co., Oakman.
Victor Coal Co., Horse Creek.
O'Brien, Superintendent Lockhart Mines, Corona.
John G. Cook, Patton.
Tupelo Coal Co., Tupelo, Miss.
Parker Coal Co., Cullman.
American Coal & Coke Co., America.
Colbert Iron Co., Sheffield.
Woodstock Iron Works, Anniston

Rock Run Iron & Mining Co., Rock Run.
Round Mountain Iron Co., Chattanooga, Tenn.
Tecumseh Iron Works, Tecumseh.
Shelby Iron Works, Shelby.
Clifton Iron Works, Ironaton.
Chewacla Lime Works, Chewacla.
Anniston Lime Works, Anniston.
J. B. Randall, Calera.
T. H. Hardy, Siluria.
Standard Lime Works, Ft. Payne.
Robert Stevens, Ensley.
Marvel City Brick Works, Bessemer.
Coaldale Brick & Tile Co., Coaldale.
Bessemer Fire Brick Co., Bessemer.
Bickerstaff Bros. & Howard, Brick Yard.
Kloss Brick Co., Bessemer.
B. F. Holt, Montgomery.
Robinson Sylvester, E. Birmingham.
Birmingham Brick Co., Avondale.
J. D. Leek, E. Birmingham.
J. R. Copeland, Birmingham.
C. T. Hardman, 1630 Third Ave., Birmingham.
George Burbank, Cherokee.
T. L. Fossick & Co., Sheffield.
T. H. Wildman, Tuscaloosa.
Dixie Tile & Pottery, Oxford.
Alabama Flint Co., Riverton.
Southern Bauxite Co., Cave Springs, Ga.
Republic Mining & Mfg. Co., Rock Run.

This list has grown from month to month because when the work was first commenced in January, 1897, only the leading and best known among the producers were applied to, but as progress was made other names were added to the list as your Committee gradually ascertained the location of their works and the nature of their operations. Consequently a portion only of the producers made the monthly returns during the early part of the year, but those firms whose names were added later, complied with the request and gave their production for the back months; except in the case of the brick-makers and lime-burners who were only asked for the production during the year, in consideration of the amount of work that would have been entailed on the clerical force, had they attempted to make monthly returns.

Each month at as early a date as possible, the returns were compiled and the totals sent to the various technical journals in the United States in which the tables were published promptly and correctly. Through this means the production in the State of Alabama has been published in the various large cities of the country, extending from Boston to San Francisco, as well as by most of the daily and weekly papers published in the State.

The advertising which the mineral resources of the State have received through this system, has been very extensive and certainly quite valuable; and not only has the State derived the benefit from this advertising but our Society has received due credit for the work of this Committee because these tables were invariably published as embracing the statistics obtained under the auspices of the Geological Survey and this Society through the efforts of Dr. Eugene A. Smith.

While it is almost impossible to obtain statistics which are absolutely correct and reliable, yet the work of this Committee has been done with a view to being able to furnish the most reliable statistics obtainable, and when the tables accompanying this report are compared with the official figures which will be published later by the Chief Mine Inspector of the State, the Government of the United States, and the Scientific Publishing Company in their work entitled "Mineral Industry," it is hoped that the differences will be so slight as to be practically immaterial.

MINERAL PRODUCTION OF ALABAMA FOR YEAR 1897.

Short tons	Short tons	Long tons	Long tons	Long tons	Cubic feet	Long tons
Coal*	Coke*	Pig Iron†	Iron Ore†	Limestone†	Building Stone†	Bauxite†
5,910,109	1,384,236	923,895	3,241,846	494,655	80,000†	10,583‡

*From returns made to Chief Mine Inspector, Jas. D. Hillhouse. These figures may be slightly increased when final summation is made.

†From returns made to State Geologist and Secretary of Industrial Society.

‡In addition to the above Alabama should be credited with 2,500 tons or more of bauxite, hauled in wagons from mines in Alabama to Cave Spring, Ga., and shipped by rail from there and credited to Georgia.

The final summation of the Chief Mine Inspector is as follows:—Coal, 5,893,771 tons; Coke, 1,395,252 tons. Owing to the departure of Mr. Brewer, who had charge of the collection of statistics, some of the returns of iron ore production have been counted twice, and the figures given in the table above is thus at least one-third too large.—E. A. S.

PARTIAL RETURNS OF BRICK AND POTTERY PRODUCTION FOR 1897.

Common brick—Birmingham and Montgomery districts only,	15,850,000
Vitrified "	120,000
Pressed "	380,000
Fire "	3,860,000
Pottery	10,000 gallons.

The number of employees in these industries averaged about 13,000 daily.

It will be seen that the totals only are published in this report: this because producers have received the assurance from your Committee that individual returns would not be published. It may easily be seen that the publication monthly of individual returns might furnish to competitors information which could be used to the disadvantage of some of the companies.

This work is to be carried on during 1898, in the same manner that it has been done during 1897, but larger experience will enable your Committee to obtain more satisfactory results, especially with reference to those materials which have not been considered monthly, and those concerning which we have not been able to get complete returns, such as clays, lime and building stone.

WM. M. BREWER,
For the Committee.

PROCEEDINGS

OF THE

Alabama Industrial

AND

Scientific Society.

Vol. VIII.

1898.

PROCEEDINGS

OF THE

ALABAMA INDUSTRIAL

AND

SCIENTIFIC SOCIETY.

Volume VIII.

1898.

PUBLISHED BY THE SOCIETY.

SECRETARY'S OFFICE:

UNIVERSITY,

ALABAMA.

ATLANTA, GA.:
The SOUTHERN INDUSTRIAL PUBLISHING Co.
1899.

OFFICERS.

1898.

PRESIDENT.

Truman H. Aldrich, ... Birmingham, Ala.

VICE-PRESIDENTS.

Joseph Squire, ... Helena, Ala.
James H. Fitts, ... Tuscaloosa, Ala.
John A. Montgomery, ... Birmingham, Ala.
J. W. Minor, ... Thomas, Ala.
J. G. Moore, ... Blocton, Ala.
Chas. J. Geohegan, ... Birmingham, Ala.

TREASURER.

Henry McCalley, ... University, Ala.

SECRETARY.

Eugene A. Smith, ... University, Ala.

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REPORT OF PROCEEDINGS

—OF THE—

ANNUAL MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in Birmingham, Ala., March 4, 1898.

The Society met at 5 o'clock P. M. on Friday, March 4, 1898, in the Rooms of the Commercial Club, in Birmingham, Alabama, President T. H. Aldrich in the chair.

There were present Col. J. A. Montgomery, Eugene A. Smith, R. M. Newbold, Dr. Wm. B. Phillips, John Shannon, Jas. D. Hillhouse, Jr., Henry McCalley, Maj. J. W. Johnston, R. F. Manly, J. R. Harris, Erskine Ramsey, H. Harding, J. M. Garvin, W. G. Oliver, Geo. S. Wilkins, J. W. Minor, J. T. McDonald, John Foster, J. H. McCune, H. H. Sherman, J. A. Rountree, and representatives of the press.

The retiring president, Aldrich, then read his address, which will be found printed in full below.

The reading of the minutes of the last meeting was dispensed with, since they had been printed and distributed.

The Committee on Statistics made a report, in which it was stated that about ninety per cent. of the coal, coke, iron ore and pig-iron production had been reported monthly by the producers, who have been exceedingly courteous in promptly sending in their returns.

At the suggestion of the Society a committee, consisting of Jas. D. Hillhouse, J. A Montgomery and the Secretary, was appointed to consider the matter of recommending legislative enactment to secure greater completeness in the returns of the mineral production, and to report at the next meeting.

The report of the Council was made, recommending a change in the by-laws requiring two nominations to be made by the Council for each office, to the effect that only one name be hereafter proposed for each of the offices, members having, as heretofore, the privilege of substituting for the name proposed by the Council any other names of their own selection.

Nominations were made of the following as new members of the Society, and they were subsequently elected:

Maj. J. W. Johnston, Mr. Roger M. Newbold, Mr. John Shannon, Mr. Wm. G. Oliver, Mr. W. H. Kettig, Maj. F. Y. Anderson, all of Birmingham.

The reports of the Secretary and of the Treasurer were then presented, and Messrs. Manly and Hillhouse were appointed to audit the account of the Treasurer. This was done and the account was reported as being correct and according to law.

There being no formal papers presented, Dr. Phillips gave the Society some notes on the iron ore deposits near Leeds, and afterwards spoke of his experiments at the Semet-Solvay establishment at Syracuse, New York.

The election of officers for the ensuing year, being next in order, the nominees, as given in the notice of the Secretary, sent out to members previous to the meeting, were voted on with the result that the following officers were elected:

President, Prof. M. C. Wilson, of Florence, Alabama; Vice-Presidents, Mr. J. G. Moore, of Blocton; Mr. Chas. J. Geohegan, of Birmingham, Ala.

The Secretary and the Treasurer were continued in office.

The President-elect not being present, his induction into office could not be carried out at this time.

The Society then adjourned, after which the members and their invited guests assembled at Paul's restaurant where they partook of a banquet prepared under the direction of Dr. Phillips and Mr. Geohegan.

EUGENE A. SMITH, Secretary.

ADDRESS OF RETIRING PRESIDENT, TRUMAN H. ALDRICH.

It seems to be the custom for your retiring President to give a sort of farewell address, not exactly like the Father of our Country, nor yet in the nature of a funeral oration, and as the writer is a great believer in precedent he proposes to follow the example of our previous presiding officers and review the business of the past year, and make some observations on the future.

Information received from our seaside ports—and I include Pensacola as one of our outgoing stations—shows that there has been a steady and continuous growth of foreign trade. Pensacola has handled a very large amount of coal, shipping principally to Galveston, Texas, although Jamaica, Cuba, Mexico and Central America have all taken some.

A grain elevator is now building there, which, when completed, will make the general shipping facilities unsurpassed in our Southern ports.

Mobile shows a large increase in business, and is gradually adding to its imports as well. No port can handle a large export trade without imports also. Vessels going to any port generally take a cargo out, but if they come to a port empty the outgoing cargo bears the expense of both trips in the freight charges. The foreign steamships now take their coal at Mobile, as well as the fruit steamers. The Continental lines are now carrying a great deal of pig-iron, and this character of freight, with cotton, makes a desirable cargo.

Turning now to domestic matters, we note that our coal and pig-iron production is the largest in our history. We are making steel, good mercantile steel, and making it every day without any trouble. It is standing all the tests and comparing favorably with that made elsewhere.

Our machine-shops have had a good business during the past year. We can point to two large new cotton factory plants, involving the addition of over $1,000,000 to our manufacturing capital; the Semet-Solvay coke oven plant, at Ensley, already described in our proceedings; a large fertilizer factory, and other minor industries, will complete the list in our neighborhood.

All signs point to a good business for the coming season, and some of our industrial concerns are already provided with orders ahead sufficient to keep them busy for several months.

The great need in our section is still a steel plant; one to make billets and rods; the raw material of a dozen minor industries. Next, we want more foundries and machine-shops, something to use up our pig-iron and coal, and, above all, we want our waterways improved, by which we hope to get a cheaper route to the sea. Give us a 50-cent rate to the ocean for our pig-iron and coal, and we will have the world for our market.

Our society is small; its members are not always able to be present at its meetings, and many have doubted the desirability of keeping it up, but if our members will consider the multitude of people who are reached through our proceedings, and their reproduction by the local and industrial papers, they will realize its educational value to the people, and we all know Alabama is sadly in need of more light—at least educational light. Let us stick together, do what we can, and our little bantling will be remembered as an important factor in our industrial progress.

REPORT OF PROCEEDINGS

—OF THE—

AUTUMN MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in Birmingham, Ala., November 5, 1898.

The meeting was called to order at 4:50 P.M. on Saturday, November 5, 1898, in the Rooms of the Commercial Club, in the city of Birmingham, Ala., Professor M. C. Wilson, President, in the chair.

The minutes of the last meeting were read by the Secretary and adopted without change.

The Committee on Mineral Statistics reported as follows:

"The committee appointed to consider the matter of recommending legislative enactment to secure more complete returns of mineral statistics have had the subject under consideration. In view of the fact that most of the producers have been sending in monthly returns, it was at first thought inadvisable to ask for legislation; but the State Mine Inspector has expressed a desire to have the State Mining Law amended so as to secure monthly returns of the production, not only of coal and coke, but also of iron ore, limestone, dolomite and pig-iron, and, in fact, of all of the minerals produced in the State. To this end we have had a conference with the State Mine Inspector, and have agreed to recommend an amendment to the State Mining Law as follows:

"Be it further enacted, That Section 18 of the State Mining Law be amended so as to read as follows:

"Be it further enacted, That the owners, agents, or operators of all underground mines, lime quarries, stone quarries, ore mines, fire clay and bauxite mines, iron and steel furnaces, coke plants, clay industries, etc., in this State, shall, on the first day of each month, or within four days thereafter, furnish to the Chief Mine Inspector a statement of the actual product of said mines and works, for the preceding month, and that between the 1st and 10th of each January they shall make a similar report for the preceding year. The report shall be in such form and give such information regarding said mines and works as may from time to time be required and prescribed by the Chief Mine Inspector. Blank forms for such report shall be furnished by the Chief Mine Inspector."

(Signed) J. A. MONTGOMERY,
J. DE B. HOOPER,
EUGENE A. SMITH, } Committee.

The report was discussed by the Secretary, Mr. Hooper, and Mr. McCalley, and then adopted.

The report of the Council next followed. The Council recommended for membership in the Society Dr. John Y. Graham, Dr. H. A. Sayre, and Professor A. A. Persons of the University of Alabama; Professor J. J. Wilmore, Professor B. B. Ross and Professor A. F. McKissick of the Alabama Polytechnic Institute, and Mr. G. C. Hewitt of Corona, and they were elected.

The subject of a banquet at the next meeting was discussed by several members, all of whom were in favor of it, and in accordance with a motion the President appointed a committee consisting of Messrs. Geohegan, Aldrich and Anderson to make the necessary arrangements for the banquet which it was decided to have on the occasion of the next meeting.

In order to secure, if possible, for future meetings, some formal papers, it was recommended that the Secretary correspond with members, urging them to contribute to the proceedings of the Society, and, if desirable, suggesting the topics.

A communication from the Commercial Club was then read calling attention to some resolutions adopted by that body, October 7, 1898, in reference to an Alabama exhibit at the Paris Exposition, and the discrimination on the part of France, against iron from the United States.

The subject of these resolutions was discussed by several members of the Society, and the following action was taken by the Society:

"*Resolved*, That the Alabama Industrial and Scientific Society heartily indorses the action of the Commercial Club of Birmingham in its resolution of October 7, 1898, requesting the Governor to embody in his message to the legislature a recommendation that appropriation be made to provide for suitable representation of the State at the Paris Exposition of 1900; and also that the legislature be requested to memorialize Congress to take steps towards securing a change in the French tariff laws as regards American iron.

"*Resolved further*, That the Secretary be requested to communicate these resolutions to the Governor."

There being no formal papers presented before the Society, and no further business before it, the Society was adjourned.

EUGENE A. SMITH, Secretary.

REPORT OF THE SECRETARY.

UNIVERSITY OF ALABAMA, March 1, 1898.

The roll of the Society shows 39 active members and 3 honorary, a total of 42. Of these 17 have paid up all their dues to date, 7 owe for 1 year, and the others from 2 to 4 years. All these take an interest in the Society and can be counted on to make good their deficiencies at a later date. Five new members have been added to the Society since my last report, and two resignations, viz.: Mr. J. H. Pratt and Mr. L. A. O. Gabany.

The usual notices to members have been printed and sent out, as occasion required, during the year, and the proceedings of the Society for the year 1897, aggregating 63 pages, have been printed in two parts, in order to get them out promptly.

The additions to the library have been the current numbers of the *Journal of the Elisha Mitchell Society*, *The Technology Quarterly*, of Boston; *The Technic;* the Circulars of the Johns Hopkins University.

EUGENE A. SMITH,
Secretary.

REPORT OF TREASURER FOR THE YEAR ENDING MARCH 3, 1898.

University, Ala., March 3, 1898.

RECEIPTS.

From cash in Treasury, as per report of May 18, 1897		$ 88 75
From dues received since May 18, 1897		135 00
Total receipts		$ 223 75

DISBURSEMENTS.

For printing Proceedings	$ 102 35	
For Postage	8 00	
For notices of meetings	6 35	
For Express charges on Proceedings from Atlanta	3 55	
For clerical work in sending off Proceedings	2 50	
For reporting Proceedings	2 00	
Total disbursements	$ 124 75	—$124 75
Balance		$ 99 00

Henry McCalley,
Treasurer.

PROCEEDINGS

—OF THE—

Alabama Industrial

—AND—

Scientific Society.

Vol. IX. Part I.

1899.

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The Southern Industrial Publishing Co.
1899.

OFFICERS.

1899.

PRESIDENT.

James H. Fitts, ... Tuscaloosa, Ala.

VICE-PRESIDENTS.

John A. Montgomery, ... Birmingham, Ala.
J. W. Minor, ... Thomas, Ala.
J. G. Moore, ... Blocton, Ala.
Chas. J. Geohegan, ... Birmingham, Ala.
J. M. Garvin, ... Rock Run, Ala.
J. H. McCune, ... Woodward, Ala.

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Henry McCalley, ... University, Ala.

SECRETARY.

Eugene A. Smith, ... University, Ala.

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ANNUAL MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in Birmingham, February 1, 1899.

The annual meeting of the Alabama Industrial and Scientific Society was held in the Rooms of the Commercial Club, in Birmingham, Ala., on February 1st, 1899.

The Society was called to order at 3:45 P.M., by ex-President F. M. Jackson, in the absence of the President, Prof. M. C. Wilson, who was detained by a late train. The minutes of the last meeting were then read by the Secretary. That part of the minutes containing report of the committee appointed to recommend changes in the State Mining Laws, came under discussion. Several members, including President Sol Haas of the Sloss Iron & Steel Company, thought that the recommended changes went too far, and that it would be a hardship to many operators to be compelled to make returns within four days after the first of each month, and within ten days after the first of January of each year. After full discussion of the matter, it was resolved that the recommendations of the committee, as reported in the proceedings of the last meeting, be modified in some particulars. The present mining laws require only the producers of *coal* and *coke* to report annually to the Chief Mine Inspector the amount of their production. The Society now recommends that this requirement be enlarged so as to include all *ores*, *limestones*, *dolomites*, *bauxites* and *clays* mined in the State.

In the report of the Council there were recommended for membership in the Society—Dr. P. H. Mell, of Auburn; Mr. Percy R. Jones, of Florence, and Mr. Kenneth Robertson, of the Sloss Iron & Steel Company, and these gentlemen were subsequently elected members.

The Council also reported favorably upon four papers which were afterwards read.

The reports of the Secretary and of the Treasurer were then read. These reports will be found on pages 39 and 41.

Under the head of new business a resolution was adopted favoring the passage of United States Senate Resolution No. 205, to establish a Division of Mines and Mining in the United States Geological Survey, and the Secretary was instructed to communicate this action of the Society to the Alabama Senators and Congressmen, and also to bring the matter to the attention of the Birmingham Commercial Club, with request that like action be taken by them.

At this point President Wilson came in, and, after explanation of cause of his delay, read his address as retiring President, which address will be found in full on page 9.

Reading of papers being next in order, Mr. J. W. Castleman of the Sloss Iron & Steel Company, read a paper on "The Brown Iron Ore Mines at Leeds," which will be found in full on page 13.

Dr. John Y. Graham then read a paper on "Trichina spiralis," illustrated by charts and numerous microscopic specimens, to be published later.

A paper on "Good Roads in the South" was then read by Colonel Horace Harding, which paper will be found in full on page 19.

Mr. Brewer's paper on the "Mineral Resources of British Columbia" was read by title, because of the lateness of the hour, but it will be found in full on page 29.

Similarly, the "Section through Red Mountain," by Mr. Allen W. Haskell, was brought before the Society only by title, and will be printed in the next number of the Proceedings.

The election of officers for the ensuing year was then taken up, with the following results:

President—James H. Fitts, of Tuscaloosa.

Vice-Presidents—J. H. McCune, of Woodward; J. M. Garvin, of Rock Run.

Treasurer—Henry McCalley, of University.

Secretary—Eugene A. Smith, of University.

Upon motion of Mr. J. W. Johnston, it was decided at the next meeting, which was fixed for May 3d, to devote the day, beginning at 10 A.M., to the meeting. It was also agreed that each member should exert himself to secure at least one new member by the next meeting.

The thanks of the Society were then, by resolution, tendered to the authorities of the Commercial Club for the use of their rooms, and the hour for the banquet having arrived, and there being no further business, the Society was adjourned.

Eugene A. Smith,
Secretary.

ADDRESS OF RETIRING PRESIDENT MARSHALL C. WILSON.

The task set itself by this society is a twofold one. On the part of some of its members, it is to devote itself to the creation of new knowledge, to the promotion of pure research in fields where no observation has been made; on the part of others, it is to make practical application of this knowledge to the arts and industries; to promote the development of the material resources of the State.

It occurs to me that a scientific and industrial society of a great State should have hundreds of members from all sections of the State. Birmingham, the center of the industrial interests of this State, is a fit place for the meetings of this Society. In every community where there is any intellectual activity there should be one or more members. With a large membership gathering a mass of information from genuine first-hand observations, there would necessarily be some new knowledge gained. Certainly it would be a glorious thing for this Society to set to work the means by which some people in every community would be induced to use their faculties in making real observations on the phenomena surrounding them. How to enlarge the membership, would, of course, be a matter for discussion by the Society.

It is not necessary to cite examples to prove that the steady, systematic pursuit of any one science is always followed by growth in some industry bearing upon that science. In fact it has come to be generally recognized that the study of pure science must necessarily precede industrial growth. In all great manufacturing centers there are schools or institutes where the elements of science may be studied. What these institutions have done in our own manufacturing cities, is too well known to require mention here. It is well within the function of this Society to do all it can in promoting the study of natural science in the public schools.

In obeying the law as laid down in the Constitution of this Society, making it the duty of the President to deliver an address at its annual meeting, I shall endeavor, in the few words

I have to say, to keep within the limits prescribed, viz: the review of the work of the past year, and the outlining of plans for the next year's work.

Two meetings were held during the past year. At the first, important papers were read and interesting discussions held; at the last meeting a number of new members were received.

It is always difficult to realize just what a quietly working force has done in a limited time. Looking for results, perhaps we could not point out any one great good that has come within the last year from the work of the Alabama Industrial and Scientific Society. Time is needed for these results to show themselves. Because a body of men is working quietly and not trying to make a noise, it is not necessarily failing to accomplish its purpose. We have cause to congratulate ourselves on the record of the year's work. Genuine research has been made, as is evidenced by the papers read, and the predicate has been laid for work that may be far-reaching in its results. It should be a matter of pride to each individual member of this Society to exert himself to the utmost to keep up the work; some of the most important scientific societies of the world have had more modest beginnings than this one. So far as I know there is no other scientific society in the State. There is, of course, research being made by isolated individuals. Now, the scientist, almost more than any other man, knows how to appreciate the value of co-operation; almost all great discoveries come from the combined research of several workers. The individual needs the sympathy, the suggestions, the encouragement of men engaged in similar pursuits. A mere hint thrown out by some one has often set into motion investigations of tremendous importance.

In reviewing the history of the Alabama Industrial and Scientific Society since its organization in 1890, one cannot fail to note the scarcity of papers read before the Society. This means not an uninterested membership, but rather that the members being men of little or no leisure, have had no time to devote to investigation. Many of us have only a few breathing spells from our daily routine of hard work, and anything like exhaustive investigation is out of the question. But this is not expected of all members. An observation of some phenomenon, an account of some work on which science bears, anything, in fact, of interest to a body of scientists, may properly be presented in these meetings. There are thousands of investigations to be made; any one of sound common sense who can see things as they are, is competent to make these observations. It is a mistake, too often made, to associate matters scientific with what is attainable only by the few. Science is based upon common knowledge derived from experiment and observation. It only insists upon absolute truthfulness in these observations. It is one of the functions of this Society to plan work for its members, and the performance of this function would, without doubt, increase the number of papers presented, and arouse a greater interest on the part of the members. Wherever there is life there must be work. It is of vital importance that every member of this Society should take part in its proceedings. We have all heard the story of the man who did not enjoy the meeting because he could get no chance to speak. While most of our members have not been clamorous for a chance to speak in meetings, the fact remains that their interest would be very much greater if they could be induced to present papers occasionally. If we would have our members attend the meetings we must in some way get them to work.

Agriculture is still the principal industry of Alabama. There are certain branches of natural science having the closest, most intimate relations to farming, which are practically unknown outside of our great institutions of learning. The study of entomology, at least so much of the science as has a direct bearing upon fruit culture and gardening, would go very far toward making this State prosperous. It would most surely be followed by the planting and proper care of orchards, an industry which, in the neighboring State of Georgia, brings in every year such handsome returns. A practical knowledge of soils and plants, widely diffused among the people, could not possibly fail to be of great economic value. Our own plant, the cotton, its growth, and especially its fiber, might be studied to great industrial advantage. There is scarcely any natural science whose pursuit would fail to yield profit in money.

The point I wish to emphasize, in my poor way, is this: that if we are to reap advantage from all the great resources of our State, we must prepare our people to see and understand them. We must not depend wholly upon outsiders to come in and develop them.

I am convinced that this Society could not possibly do anything better calculated to promote industrial growth in this city, its home, than to encourage and work for the establishment of some sort of school where every one would have opportunity to study the elements of natural science. This school would, in the beginning, have to be limited in its scope, perhaps nothing more than a night school at first, and nothing but the simplest elements of science could be taught at first; but it would form a beginning toward giving a chance to every youth within the limits of the city, for some scientific training; and it would serve as a feeder to our higher institutions. A school for the study of that branch of science bearing upon the manufacture of iron, would certainly be profitable here. If this Society could succeed in bringing about the establishment of some such school here, it would not be long before similar schools would spring up in the smaller towns and villages, and this would be followed by industrial growth as surely as day follows night.

THE BROWN IRON ORE MINES NEAR LEEDS, IN JEFFERSON COUNTY.

By J. W. Castleman.

Your Secretary, Dr. E. A. Smith, has requested that I give your Society an account of the Brown Ore Mines recently opened, under my direction, by the Sloss Iron & Steel Company, in the Cahaba Valley, a short distance below Leeds. This I will endeavor to do as briefly as possible.

A slight description of the locality is necessary to a clear understanding of what will follow.

The Cahaba Valley at the point of operations is not, as might be supposed, the trough of the main Cahaba River, but that of a comparatively small affluent known as East Cahaba.

The valley runs in a general northeasterly and southwesterly direction, and is bounded on the southeast by a high, continuous and precipitous ridge known as Big Oak Mountain, while its northwestern containing wall is a lower ridge, about two miles distant from the other, and parallel to it, locally called Pine Ridge. This, while not nearly so lofty as the other, is still of good height.

In front of each of these dominant bounding ridges runs a parallel lower ridge, between which two latter runs the main valley. The outlier of Big Oak Mountain is called Oak Ridge, that of Pine Ridge is locally known as Mill Ridge.

Oak Ridge, while much lower than Big Oak Mountain, is also precipitous and continuous. Mill Ridge, however, is more rounded in outline, and at times sinks away almost to the general level of the valley; rising again, however, further on.

The so-called valley, therefore, consists really of three parallel valleys, e. g , the main valley lying between Oak and Mill Ridges, and two much narrower ones lying, the one between Big Oak Mountain and Oak Ridge, the other between Pine Ridge and Mill Ridge.

The general aspect of the country is very pleasing. Indeed, as viewed up and down the valley from either of the ridges, it can truthfully be called picturesque; the fertile, well-farmed valleys which stretch away on either hand until lost in the blue distance, affording a piquant contrast to their dark, shaggy, bounding walls.

I have been particular in setting out these natural surface features, for the reason that these parallel hills and valleys roughly correspond with and define the different geological formations of the region.

Starting from the southeastern rim and proceeding northwesterly, we will indicate these, subject to the correction of Dr. Smith, as to any geological inaccuracies, into which, as an unprofessional, I may unwittingly fall.

Big Oak Mountain is formed by the conglomerates lying at the base of the Coal Measures of the Coosa field. The valley between it and Oak Ridge is in the shales of the Sub-carboniferous formation, the equivalent in this part of the State of the Mountain Limestone. Oak Ridge is the representative of the Red Mountain, and is consequently a triple formation; the Fort Payne chert of the Sub-carboniferous making the body of the ridge, with a thin sheet of Devonian black shale, and the sandstones and shales of the Clinton completing it. The Clinton here contains little or no red ore. Other Silurian strata underlie the valley out to and including Mill Ridge. The valley between Mill Ridge and Pine Ridge, and Pine Ridge itself, consist of Knox Dolomite measures, which extend into 'Possum Hollow, beyond Pine Ridge, where the Cambrian formation joins it. The last continues to the line of the great vertical fault which bounds the Cahaba coal field on the southeast.

Our survey across the Cahaba Valley thus virtually represents a descent of nearly two miles into the bowels of the earth, Pine Ridge being stratigraphically about that distance below Big Oak Mountain.

All these measures having been thrown up from their original horizontal position, now dip at an angle of about sixty degrees southeast. Their strike is, consequently, about 45 degrees northeast and southwest.

Hoping that the general situation is, in some degree, intelligible, I will now proceed to outline the operations of the Sloss Iron & Steel Company, in the region under my direction, up to the present time, stating, in conclusion, the inferences which it seems to me legitimate to draw from the results attained.

The preliminary prospecting of the Sloss Company covered about four miles of the southeastern face of Oak Ridge, and about six miles of the same face of Pine Ridge.

The writer expected at first to find (if anything considerable) only a series of pockets of brown ore of the usual form.

The explorations, however, soon began to develop an apparently definite strike and continuity, a conformity of inclination, and a solidity of formation in the ore, which, in any other material, the writer is bold to say, would be considered conclusive evidence of strata of ore. The writer being trained under conditions and surroundings which made the expression stratified or continuous brown ore almost sound like a contradiction in terms, long resisted the apparent evidence which every new cutting seemed to strengthen and confirm.

At last, however, this evidence became to his mind too strong to resist, and he is forced to believe, either that all that we consider evidence of such formation in other material is fallacious, or that there is a series of strata of limonite in the Oak and Pine Ridges of Cahaba Valley of fine quality and enormous thickness.

As this is the point which has naturally aroused most controversy in this matter, I wish to recapitulate the considerations which forced me to this conclusion, which, before this evidence was presented to me, I would have rejected as ridiculous:

First—The fact that I could follow the strike of the same ore for miles with a compass.

Second—Conformity of inclination with all the other branches of the measures, whether limestone, dolomite, slate or chert rock, across the entire valley.

Third—Appearance of stratification.

Fourth—Solidity of material; the ore, after getting away from the rotten outcrop, being in solid layers.

It would require personal inspection to appreciate the full force of these cumulative points of evidence.

I am aware, however, that my belief on this point will not be shared by many, perhaps not by any of my hearers, and it is fortunate that the economic importance of this ore does not depend upon whether it occurs in strata, or as our mutual friend, Dr. W. B. Phillips, felicitously expressed it, in "Continuous Pockets."

Whether it is in strata or not, it is certainly enormous in quantity and excellent in quality.

This being so, we can safely let experts differ to any extent agreeable to themselves about technical points of geological definition. I return, therefore, to my account of tangible results.

I found and cut continuously for two miles what I will call as a compromise and for peace's sake, a continuous lead of excellent brown ore on the southeast side of Oak Ridge, having apparently a stratified slate hanging wall and a chert foot wall. I hesitate to give the apparent thickness of this ore. It was over 100 feet, however.

The only objection to this ore is a relatively high phosphorus as compared with the Pine Ridge ore, its average analysis being about .80 phosphorus. A burden of one-third, however, of this ore could be advantageously used along with either the hard red ores of the district or with the Pine Ridge ores, as will be seen when we come to them. The conditions for mining this lead are most excellent, as on the ridge side over large areas the slate hanging wall has disintegrated and washed off, leaving the ore either absolutely exposed or only lightly covered with surface soil washed from above.

On Pine Ridge our cutting covered about six miles. We found there two continuous leads of ore with about 400 feet between them. The front lead is about 60 feet thick, being in two benches with a parting of about six feet of rock.

The front bench is 40 feet; the back about 15 feet.

The back vein has not yet been sufficiently developed to determine its exact thickness. This Pine Ridge ore analyzes 50 per cent. iron and only about .25 in phosphorus, and hence could be used alone in the furnaces.

When we consider that the average thickness of red ore which present conditions allow us to use is only about seven feet, the significance of the above thicknesses as indicating quantity will become obvious.

The conditions for economical mining are not so favorable on Pine Ridge as on Oak Ridge, owing to the fact that the ore on the outcrop has a heavier covering of more refractory material. Only the consideration of low phosphorus determined the location of the mine on this ridge in preference to the other.

We have adopted, however, a system of hydraulic stripping, which enables us to remove this covering at low cost.

In this connection it is appropriate to notice a point that has been frequently raised, e. g., why this Pine Ridge ore has not been sooner discovered. The following considerations will indicate the answer to this question. On Pine Ridge both foot wall and hanging wall seem to be composed of chert, which deeper down I would expect to find an impure limestone or a solid flint.

The measures stand at an inclination of about 60 degrees, sloping up the hill. The continuous influence of air and water acting on the outcrop of the vein rots the iron ore first to an ochre, then leaches this ochre out, but acts very much more slowly on the chert, the debris of which (the iron ore being removed from under it) consequently drop finally down over the end of the ore vein, completely obscuring and covering it.

On the Oak Ridge on the contrary the conditions were reversed. The hanging wall being of slate, as stated, was more readily acted on by the aqueous and aerial influences, and consequently it was removed and the iron ore left exposed.

A short description of the present mining plant of the company may be of interest.

This consists of a large duplex Snow pump, having a capacity of 1,000 gallons per minute at 250 pounds pressure at the pump, which is located on the bank of East Cahaba, and furnishes, in the first instance, all the water used for hydraulic washing, and also for operating a number of flumes in which the ore is washed and conveyed into the cars; another pump of capacity of 600 gallons per minute, which pumps water back from a catch pond for the same purposes, and a duplex 18x36 air compressor, built by Hardie-Tynes Company, of Birmingham, just now being installed. This last is designed to run all the air drills necessary in mining the ore.

The mines are located on a branch of the Southern Railroad, about four miles in length, which leaves the main line a short distance beyond Henry-Ellen.

Their present output is between three and four hundred tons per day, which will be rapidly increased to at least 1,000.

In conclusion, it seems pertinent to call attention to the probable effect of the development of this new ore territory, both at home and abroad. This effect should be very far-reaching.

The ridges in which these ores occur extend for at least thirty miles either way from Leeds, and the writer's information is that the conditions and ore indications are the same along this entire sixty miles. The region constitutes, in fact, a Brown Mountain, parallel to our Red Mountain, and in the writer's deliberate judgment this Brown Mountain contains ten times the workable ore existing in Red Mountain.

My information is that an iron furnace working on an exclusive high grade brown ore burden will make a ton of iron on half a ton less coke than when using our red ores, and will also make materially more of it.

This will mean an economy of at least 75 cents per ton. The significance of such a revolution as this is apparent at a glance. The situation as between us and our Northern competitors in iron-making has been previously this: They have had costly high grade ores. We have had cheap low grade ores. They have now apparently exhausted all means of cheapening their ores. If now we can develop a cheap high grade ore their competition in the lines for which our irons are adapted is manifestly at an end, and no other resource will remain to them but to follow their cotton mills south.

GOOD ROADS IN THE SOUTH.

By Horace Harding, C.E.

All industries, either in securing their supplies or in delivering their products, are more or less dependent upon the common roads. The proper construction of these roads is due to the intelligent application of scientific principles. It will not be inappropriate, therefore, for the Industrial and Scientific Society of Alabama to give some consideration to the subject of Alabama roads.

We claim to be a progressive people, but in some things we are very conservative. We are apt to cling to methods and systems that we have inherited and grown up under, our sense of their inconveniences being blunted by long usage. Especially has this been the case in regard to our highways. As our fathers made them, so we maintain them. But a spirit of unrest is beginning to manifest itself on this subject. It is gradually dawning upon us that our roads and the method of maintaining them, however well adapted to pioneer days, do not suit present conditions. A demand for better roads comes from many portions of the State and a discussion by this Society of the best method of obtaining them may elicit information or bring out suggestions that will be timely and valuable.

In this paper our roads will be considered wholly from an industrial point of view, that is, as designed primarily for hauling and not for driving. A good road, then, would be one over which the wagons in common use could be hauled when loaded to their full capacity. Probably twelve bales of cotton, making, with the wagon, a gross weight of about 7,500 pounds, would be the limit of safety for ordinary wagons, and this will be assumed as the load for which the roads should be so improved that a four-horse team could haul it over all portions of them.

A corresponding load of six bales for a two-horse wagon would give a gross weight of about 4,000 pounds, or 2,000 pounds to the horse.

It is a prevalent opinion that a good road must necessarily be a macadamized road. This is generally true in the Northern States, where the ground freezes to a depth of three feet or more. A thaw leaves the ground soft to the depth that it was frozen, and to guard against the consequent mud and the effects of frost upheaval, a thick macadam or Telford protection is needed. Here, where a freeze seldom extends more than an inch or two below the surface, the mud from a thaw is thin and, on a well drained road, quickly disappears, so that a protective coating is not essential.

For hauling uses macadam roads are, with us, more of a luxury than a necessity. For, although on a level macadam in good condition a two-horse team can draw a gross load of 10,000 pounds, wagons would seldom be subjected to such strains even if able to resist them safely, for teams traveling on the macadam would usually have reached it from farm and neighborhood roads with loads limited by the conditions there existing. Hence the facilities offered by a macadam could not for the most part be fully utilized. But even if macadam roads were very desirable, and however desirable they may be, their cost is a bar to their general use. In the most favored localities the cost would hardly be less than $3,000 a mile, and since the public road mileage in the State is from 500 to 1,000 miles to the county, probably no county would be able or, at any rate, willing to incur the expense of macadamizing in a general system of road improvement. Suburban districts, where density of population would lighten the individual burden, may indulge in macadam roads; elsewhere throughout the State they would be classed among Mr. Ingalls' "iridescent dreams."

A GOOD DIRT ROAD.

We must then, generally, and for the present, rest content with dirt roads, and it is the object of this paper to suggest for discussion how and to what extent they may be improved without exceeding the ability or willingness of the people to meet the cost of such improvement.

Our public roads require improvement in the three main features that determine their degree of excellence, viz: location, surface resistance and grade per cent., *i. e.*, the rise in feet per 100 feet used in surmounting hills. These will be considered in order mentioned.

As to location of alignment, it is enough to say that, at least for much traveled, it should be such as to the shortest distance consistent with easy grade; and the best ground for road construction. Zigzagging along section lines should be done away with. The length of the diagonal of a section is six-tenths of a mile less than the sum of two sides. To withhold this saving in distance from the public is virtually to lay an onerous tax upon it for the convenience of an individual.

The road surface, to give the minimum resistance, should be hard and smooth, *i. e.*, clear of ruts, mud, dust, loose stones or free sand. With dirt roads this ideal condition cannot be fully reached, and they cannot therefore be made absolutely good. But they can be made practically good, that is, good enough generally to allow full loads to be hauled over any and all portions of them.

The degree of excellence that can be attained in improving the surface of dirt roads and the facility with which this can be accomplished depends largely upon the nature of the soil. Generally speaking, any soil that can be packed when dry will make a good road as long as it can be kept dry or but slightly moist. A soil, then, is good or bad, for road purposes, in proportion to the thoroughness with which it may be kept free from saturation.

Nearly all our soils become saturated after continued rains, and when traveled over in that condition become muddy if not miry. On our roads this saturation, to a great extent, can be, and to have them good, must be prevented. The means for accomplishing this object are generally well known, but as they are also quite as generally neglected, or at least inadequately used, it may be well to call attention to them.

The three essential preventives to saturation are crowning the surface, compacting the roadbed and thorough drainage. Crowning is needed to carry off the rainfall and prevent standing pools. Four inches for a 16-foot road is the crown recommended by the best authorities; but since, on a road of that width, the traveled track would be in the center, which would wear down, it would be better to make the crown originally six inches. On hills the crown slope must exceed the grade slope, that the rainfall may reach the ditches and not run down the road.

ROAD-ROLLERS AND WIDER TIRES.

Compacting the roadbed is required to reduce the porosity of the soil and make it incompressible under heavy loads. This compacting can be best accomplished, in fact, can only be satisfactorily accomplished by the use of road-rollers, and every county undertaking to improve its roads should have such implements in its road equipment. Expensive steam rollers are not necessary; two-ton horse rollers have been found quite efficacious, but requiring more rollings.

But most soils, even if well rolled, are, when moistened, liable to rut-cutting from narrow tires under heavy loads. To maintain dirt roads in good surface, we must, therefore, use wide tires on our wagon wheels. In the Atlanta experiments, conducted by the office of Road Inquiry of the Department of Agriculture, it was found that on the clay road, wetted, 2-inch tires made ruts and required double the pull that 4 and 5-inch tires needed for the same load. In the latter case, also, the track was packed and smoothed by the tires. Similar results have been repeatedly obtained by other experimenters, and the advisability of using wide tires, especially for dirt roads, seems to have been well established. It is difficult to change methods long in use, and persuasion alone, therefore, can hardly prevail in introducing the use of wide tires. Some direct inducement must be offered. A road-tax on vehicles with exemption for wide tires, and, if necessary, a bonus for the latter, may bring them into use.

In this connection it may be well to mention another recommendation of the office of Road Inquiry, since it concerns the efficiency of teams in hauling. It was found that the often recurring slackening and tightening of the traces caused by slight irregularities in the road surface, give rise to a series of jerks that momentarily increase the pull, often as much as five times the normal traction. These jerks are transmitted by the collars as severe blows to the shoulders, tending to bruise them, and to fatigue and distress the team. To absorb these jerks, and render them comparatively harmless, the use of a spring connection between tug and singletree is advised. Such springs are on the market, and though not generally kept in stock by the hardware stores, can be ordered through them. The principle involved is the same for wagons as for cars. For these, traction springs are essential, for if the drawheads were rigidly attached to the car frames, hauling long trains would be impracticable. The couplings would be breaking continually, just as we sometimes see a trace-chain snap or a singletree break from a sudden surge of the team.

To return to the subject of road surface, any soil composed of clay, mixed with sand or gravel, can be rolled to a good surface that, with wide tires, can be maintained. Pure clay should be given a coating of sand or sandy material, for, though it might give a good wheel track, the horse track would be tramped into mud in wet weather, unless given some protective coating. A sand bed should be given a top dressing of clay and then rolled. If, in any case, the clay cannot be conveniently applied, the road should not be ditched. It should rather be depressed to retain moisture, for moist sand (not quicksand) offers a firmer bed to a wheel than dry sand.

PRAIRIES AND CANEBRAKES.

Probably the most difficult roads to deal with are those in the prairie and canebrake sections. As summer roads they are excellent, and could hardly be improved as to surface; but in winter, when the wheels travel one or two feet under ground, they are almost impassable. The soil so readily becomes soft and sticky when wet, that macadamizing or some equivalent protection seems essential in order to have good roads. Unfortunately, macadamizing, to any great extent, would be too costly to be practicable, as suitable rock for the purpose would have to be obtained by rail, the country rock being too soft for use as road material.

But with good drainage, rolling and wide tires, these roads could be greatly improved. In many localities, perhaps generally, gravelly clay, or clay of some kind, can be procured within reasonable hauling distance, and if this be spread and rolled on the prepared roadbed a fairly good surface can be secured.

An experiment tried near Keokuk, Ia., may be worth repeating on roads of this character. Crude petroleum, costing 90 cents a barrel, was sprinkled over a width of twelve feet at the rate of 53 barrels to the mile. The oil, it is reported, formed a waterproof crust, and prevented the formation of both dust and mud. An experimental test of a few hundred feet could be made at a cost of $5 to $10 and, if results similar to those reported were obtained, a simple and cheap method of prairie road improvement would be indicated. The test should be made on a piece of road thoroughly dry and smooth.

To get the best results from drainage, the roads should be as narrow as the convenience for travel will permit. In ordinary cases sixteen feet will probably be found sufficient. The ditch bottom should be at least two feet below the road surface, for a sixteen-foot road and the fall in the ditches should not be less than six inches to the 100 feet; that the water may pass off readily and not, by standing, saturate the roadbed. They should be narrow in the bottom to concentrate and give velocity to the flow at small depths, the capacity needed for large discharges being obtained by sloping the sides. Side outlets should be given with sufficient frequency to prevent overflow and to check, on grades, the scour that is liable to occur with full ditches. In the latter case, if the side outlets cannot be secured often enough or in case of material likely to wash, the ditches should be planked or otherwise lined to prevent the formation of gullies.

THE MAXIMUM GRADE.

It has been assumed in this paper that our roads should be so improved that the maximum load for a horse may reach 2,000 pounds. In the Atlanta experiments it was found that the resistance to traction on a level dirt road in good condition was 5 per cent. of the gross load. A horse of average strength can, according to Trautwine, exert during a day's work a mean traction force of 100 pounds at a gait of 2½ miles an hour. As 5 per cent. of 2,000 is 100, the assumed maximum load is in accordance with these data.

In ascending hills the grade per cent. must be low enough to allow the load for a level to be hauled over them. In this case, in addition to the surface resistance (which may be termed the friction per cent.) that due to gravity—the grade per cent.—must be overcome, and this must be applied to the weight of the horse as well as to that of the load, since the horse in ascending has to lift his own weight. The grade per cent. for a given load and friction per cent. may be ascertained by the use of a simple formula:

Let t equal the traction force in pounds.
Let h equal the weight of the horse.
Let l equal the weight of the gross load.
Let g equal the grade per cent.
Let f equal the friction per cent.

Then $g = \frac{t - l\,f}{h + l}$, or, in words:

From the tractive force deduct the product of the load into the friction per cent. Divide the remainder by the combined weights of horse and load. The quotient will be the grade per cent.

In applying this rule two facts must be taken into account: first, that within the limits of one to three miles an hour, a horse's pulling power increases as his speed decreases, and, second, that a horse may for a few minutes double his normal traction, if allowed rest after this extra exertion. If, then, in pulling up a hill, the gait be reduced from two and one-half miles to one mile an hour, the normal traction will be increased from 100 pounds to 250 pounds. Doubling this amount as the result of brief extra effort, makes 500 pounds as the possible draft power obtainable.

It was found at Atlanta that a team of four small mules was stalled with an indicated pull of 1,900 pounds or 475 pounds to the mule. For an average horse this might become 500 pounds, as calculated above, but for a conservative estimate 475 pounds may be taken as the maximum pulling power of a horse. The weight of the average horse is about 1,000 pounds.

Taking the figures as above given, the grade with maximum draft would be, by the rule, 12½ per cent. for a dirt road in good condition, and for a gross load of 2,000 pounds per horse; but in establishing such a grade it would be necessary to allow for frequent level resting places ten feet to fifteen feet in length, because it requires much more power to start a loaded wagon than to keep it in motion, and if a team is stopped on a grade, where it is using its full strength, it could not start again. On a well kept macadam road, where the friction resistance is 2 per cent., the full load for a horse would be 5,000 pounds, which, by the rule, would give a maximum grade of 6½ per cent. Therefore, in improving dirt roads where ultimate macadamization is contemplated, this grade per cent. should not be exceeded.

On our roads as they now exist many grades occur exceeding the limit proposed. Some of these can be avoided altogether by a re-location of the roads, on others the grade must be reduced either by cutting down the hill or by ascending it diagonally to its slope. The former method would in some cases require heavy excavation, the latter would give light grading with increased distance. The more economical method for each case would be determined by the conditions affecting it.

Steep grades also occur frequently on all our common roads that are unnoticed by the eye as such, though the fact is recognized by the teams. The short undulations that exist on a mile of level road, so-called, may easily give fifty feet of ascent to be overcome by grades of 15 to 20 per cent. or even more. These may not be more than five or ten feet in length, and therefore do not attract attention, but they nevertheless strain the teams and limit their loads.

THE MATTER OF SUPERVISION.

Under our road laws as now executed good roads cannot be expected. They do not provide either for proper supervision or for suitable equipment. Overseers are appointed and left to their own devices, as if road-making were a natural instinct, or as if a man could evolve the requisite knowledge from his inner consciousness instead of from training and practice. As a consequence, we occasionally see a passably good road temporarily converted into an almost impassable bad one. Sometimes, for instance, a road of stiff material, which travel during dry weather has packed and smoothed, is plowed up and the clods thrown to the middle, furnishing a bed of boulders for wagons to jolt over. Overseers selected to direct the work of the road hands should themselves be directed and instructed that they may be able to perform their duties efficiently. Moreover, in making and repairing roads they should not be confined to the use of material that is within casting range of a shovel. Where better material is needed they should be provided with the means for hauling it. Farm wagons and teams could generally be hired for this purpose, when the crops are laid by, at reasonable rates. A mile of road could be coated for a width of 12 feet and to a depth of six inches for $500, if the average haul did not exceed one mile, or of $300, if the haul was not more than one-half mile.

In making macadam roads professional aid is, of course, employed, because maps and profiles must be drawn, estimates and specifications prepared and proper inspection given. Now, it is quite as necessary for a county wishing to get the best results from the work done on its dirt roads to have a supervisor of some engineering knowledge and experience in charge, for the roads, to be good, should be prepared as if they were to be macadamized. This engineer-supervisor is equally needed, whether the improvement is to be made by contract, by the county with paid overseers and hired labor, or with overseers and labor as provided by existing laws. In either case the engineer is needed to lay out the work and see that it is properly done, and in the last, moreover, to advise and instruct the overseers as to the times, places and methods that would yield the most satisfactory results for the work performed.

In the desire to meet the demand for better roads some counties, anxious to secure as soon as possible the advantages expected from them, may find it expedient to issue bonds to raise the large sum needed for the purpose. This may or may not be a wise policy, but generally, it is probable, experience has engendered such a dread of indebtedness, public as well as private, that the people of most counties in the State would be inclined to reject any plan involving a bond issue. Such issues require a fixed annual payment for interest and sinking fund charges, and are usually made with the sanguine expectation that improved conditions will lighten the burden incurred as the years roll by. Not unfrequently the reverse happens. The load remains the same while the ability to bear it grows less.

PAY AS YOU GO.

A safer and more flexible plan for a county contemplating a bond issue would be for it to levy a road tax sufficient to meet the annual charges of such a bond issue as it might, at the time, feel able to carry. Then let the money thus raised be paid out directly for road improvement instead of on interest account. From the results obtained and from the financial conditions then existing the tax rate for the next year could be determined and in like manner for the next, and so on. Should the assessed value of property increase, the same tax rate would give a larger road fund, or the same fund could be raised with a smaller tax rate. In prosperous years the tax rate could be increased; in adverse years, diminished. In any year the rate could be adjusted according to the ability of the tax-payers to meet it

Road improvement under this plan would be slow, but continuous, and would not require a recasting of the road laws, though some amendments might be needed. If the county commissioners have not now the authority, they should be empowered to employ a competent supervisor at a salary sufficient to enable him to devote his entire time to the roads. He should be furnished with a suitable road equipment and a permanent force, or nucleus of a force, of paid laborers or county convicts, the expenses thus incurred to be paid from the road funds. Overseers, selected for their fitness, and, if practicable, paid for services rendered, should be placed under the orders of the supervisor and be responsible to him. Among other things it would be the supervisor's duty to see that the overseer of each road used the hands apportioned to it to the best advantage, doing no work not pressingly needed on the passable portions of his road until the worst places had been brought up to the standard required. The improvement of a steep hill, a sand bed, or a muddy piece of road, would, according to the urgency of the case, be the first work undertaken, the apportioned hands to be assisted, when necessary, by the floating force of paid or convict laborers. The general rule, to which there should be few exceptions, should be not to patch but to complete thoroughly any work undertaken.

Working along the lines indicated by this plan, the varying and alternative details of which cannot be discussed in this paper, a county might expect to see a steady and progressive improvement of its roads going on throughout its whole area, giving as a final result a much greater aggregate length of good roads than could be obtained for the same cost with money raised from the sale of bonds. The latter method would give quickly built roads, limited to a few favored localities, but loaded with an annual interest charge; under the former the county, though by a slower process, would have all its roads improved and free from debt or incumbrance.

BRITISH COLUMBIA AND ITS MINERAL RESOURCES.

By Wm. M. Brewer.

British Columbia, with her boundaries extending from the easternmost foot-hills of the Rocky Mountains to the Pacific ocean, and from the northern boundary line of the United States to Atlin Lake, impresses the visitor as a province of magnificent distances. More especially because of the comparatively limited facilities for rapid traveling. The entire area may be considered as mineral bearing, and a very large extent of it practically unexplored by the white man. These conditions apply with equal force to Vancouver and Queen Charlotte Island as to the mainland.

Considering the facts, it will readily be seen that in this paper the writer can only briefly describe the various mining districts and their mineral resources. During a residence of some ten months he has personally visited the camps of Rossland, Nelson, and Sandon in the West Kootenay mining district; Bridge River, Blackwater, and Lillooet River in the Lillooet district; Harrison Lake, Skookum Chuck and Squamish in the New Westminster district; Leach River and Goldstream in the Victoria district; Bear River and Deer Creek in the Cloyoquot district. The last two named districts are situated on Vancouver Island, while the remainder are on the mainland.

It was the California miners who first discovered placer gold on the Fraser river, in British Columbia, in 1856, and it was chiefly Idaho miners who first discovered the Kootenay gold, copper and silver-lead mines in 1892. Therefore to the United States and her citizens really belongs the distinction of discovering the mineral wealth, and to a very great extent developing the same, of the Dominion of Canada. These results have demonstrated the wisdom and farsightedness of the Dominion and Provincial Parliaments in passing laws which permit any person, no matter of what nationality, who has first purchased a free miner's license, to prospect and acquire mineral property within the Dominion.

Until the discoveries in the Kootenay district, mining in

British Columbia was confined to the placer deposits on the Fraser, Quesnelle, Thompson, Similkameen and other rivers and their tributaries which drain the watershed formed by the Gold and Cascade ranges of mountains. Stampedes during the early 70's occurred up the Stickene and Skeena rivers, and into the Cassiar and Omineca mining district. Only the richest diggings, though, could be worked at that early date because of the excessive cost and difficulty of transporting supplies from the commercial centers into these remote districts. The Hudson Bay Company had its forts or trading posts located at various points in the districts, but usually long distances intervened between these and the scenes of mining activity, and besides these posts were built to encourage the Indians and white trappers to develop the fur trade. As prospecting would naturally tend to injure that trade it may be presumed that the powerful corporations did not encourage prospecting to any great extent. Therefore after a few seasons the placer diggings in these remote districts were practically abandoned, until within late years when hydraulic propositions in the Cariboo and Omineca districts attracted the attention of capitalists, who have since expended vast sums in constructing dams, ditches and flumes. The operations carried on during 1898 by some of these companies have been on a larger scale than anywhere in the United States.

With hydraulic mining came the dredge boat as used in New Zealand, for the purpose of winning the gold secreted in the beds of such rivers as the Fraser and Quesnelle. This method of mining required less capital than hydraulicing but more mechanical skill. It was soon found that dredges used in New Zealand and other countries successfully were not of the type required on the rivers of British Columbia. Consequently until the winter of 1897–98 dredge mining was a failure, because the beds of the rivers were composed of enormous boulders and cement rather than sand and fine gravel. The suction dredge which worked successfully in some countries was absolutely powerless to raise the material in the bed of the Fraser. The bucket or chain dredge was only in a slight degree more successful. But the spoon, armed with steel teeth and guided by a very powerful arm or handle with a force of 75 horse-power pushing the teeth into the compact cement and lifting boulders weighing several tons was introduced at the time mentioned and has since been working successfully at Boston Bar, near North Bend, on the Fraser river.

North of the Canadian Pacific Railroad but little attention was given until within the past two years to quartz mining. Although very rich outcroppings have been discovered on Bridge river and Cayoosh creek, yet up to the present winter, 1898–99, no mines have become producers on a profitable basis. Indeed, the dismal failure at the Golden Cache Mine, near Lillooet on Cayoosh creek, has given that entire district a very serious backset. The rich outcroppings developed into pockety ore bodies, which carried so much barren quartz that the pockets were not rich enough to give it sufficient value to pay to work on the small scale attempted, while the capacity of the mine and extent of the ore body were not sufficient to warrant the installation of extensive crushing machinery.

On Bridge river and Cadwallader creek the work so far done on prospects has been too limited in depth to demonstrate the future possibilities of these camps. Many beautiful specimens of native gold in particles as large as wheat grains, scattered in profusion through a white chalky quartz, have been taken from these prospects near the surface and from outcroppings.

But prospecting has only been going on in those camps since the autumn of 1897. As the season is short, because of the heavy snowfall, there has been only a comparatively limited area yet prospected notwithstanding about three hundred prospectors were working around those camps during the summer of 1898.

The difficulties to be overcome by the prospector not only in the northern districts, but throughout the entire province, can not be fully realized until an attempt is made to explore virgin territory. The heavy growth of underbrush, dense forests, precipitous mountains and numerous glaciers prohibit the use of packhorses to transport camp outfit and supplies, except where trails have been cut. Consequently the prospector must either be prepared to cut his own trail or else pack his outfit himself. Traveling by canoe up the numerous watercourses is the favorite method, but this is dangerous unless Indians are employed to handle the canoe. But few white men, even in this country, are sufficiently expert canoemen to accomplish a trip on the swift running streams in safety.

The Indians are fairly reliable guides, excellent packers, and comparatively honest. They drive a hard bargain, especially if they catch a man in a tight place. They are naturally shrewd and pride themselves on their smartness and ability to cheat a white man. One language, or jargon, was introduced by the Hudson Bay Company years ago, so that today Indians from any tribe can understand and make themselves understood by any other tribe, while white men can easily learn this jargon in a few weeks and converse with the natives sufficiently to trade. The Indians themselves, though, very often both understand and speak English, but many of them very cleverly hide their knowledge except when it is to their own advantage.

The mineral wealth of the Kootenays has been the main factor in bringing British Columbia into prominence during the past few years. To this is now added the promising prospects of the Boundary district lying westerly from Rossland and immediately north of the international boundary line. The railroad now being constructed by the Canadian Pacific Railway Company through this last named district promises to develop it to such an extent that it is expected within a few years it will prove a powerful rival to the camps in the Kootenays.

The ores in these districts are usually smelting propositions, although a few occurrences of free milling quartz are being treated by stamp mills and amalgamation. In nearly all of these instances, though, concentration becomes advisable as depth is attained, and undoubtedly before long chlorination and cyanide plants will be installed at the majority of these mines. Throughout the entire province free milling ores are of rare occurrence and the average prospector has little faith that he will discover any.

The absence, or at least the scarcity of veins with both walls well defined, is very noticeable in all the districts visited by the writer. There is no doubt but that this fact had a very important influence on the reports made on the Rossland camp during the early days of its existence. But extensive development has demonstrated that the fissures are persistent as depth has been attained and the ore bodies, which are really impregnations of sulphide ores of varying thicknesses extending from the one well defined wall into the country rock, are permanent.

The following table published in the Report of the Minister of Mines for the year ending December 31, 1897, demonstrates the permanency of the ore bodies in the Rossland districts as well as the comparative maintenance of value as depth has been attained:

NET PRODUCTION PER SMELTER RETURNS.

Year.	Tons. 2,000 lbs.	Gold, oz.	Silver, oz.	Copper, lbs.	Value.
1894	1,856	3,723	5,357	106,229	$ 75,510
1895	19,693	31,497	46,702	840,420	702,457
1896	38,075	55,275	89,285	1,580,635	1,243,360
1897	68,804	97,024	110,068	1,819,586	2,097,280
Totals	128,428	187,319	251,412	4,346,870	$4,118,609

The following table gives the actual yield values of the ore as paid for by the smelters, or 95 per cent. of the assay values in gold and silver, and the amount of the wet assay in copper, less 1.3 per cent.:

Year.	Gold.	Silver.	Copper.	Value.
1894	2.00 oz.	2.89 oz.	2.85 %	$40.69
1895	1.60 oz.	2.41 oz.	2.10 %	35.67
1896	1.45 oz.	2.34 oz.	2.08 %	32.65
1897	1.42 oz.	1.60 oz.	1.32 %	30.48
Average, 128,428 tons	1.46 oz.	1.96 oz.	1.73 %	32.05

In connection with these tables it must be remembered that up to the end of 1897 the shipping mines in the Rossland district were confined practically to the Le Roi, War Eagle, Centre Star, and Iron Mask. During the present year, 1898, the district has been the scene of considerable activity, and although the number of shipping mines has not been largely increased yet quite extensive development work has been carried on by several companies, which ought to result in adding several mines to the shipping list during 1899.

The most important feature to be considered with regard to the Rossland district during 1898 are the sales of the Le Roi to the British-American Corporation, limited, for $3,500,000, of the Centre Star to Toronto capitalists for $2,000,000, and of the completion of the power plant at Boddington Falls on the Kootenay river, thirty miles distant, and the installation of machinery to transmit electricity generated by this power to the various mines to furnish motive power to take the place of steam.

With regard to the geology of this district, a survey was made during the summer of 1896 by Mr. R. G. McConnell of the Dominion Geological Survey. He says: "The region examined formed part of the southern continuation of the Selkirk range, and is everywhere of a rugged and mountainous character. It is traversed by several large and deep valleys running in different directions, the principal ones being those of the Columbia, the Kootaine, the Slocan, the Beaver, and the Salmon." Regarding the prevalence of igneous rocks he says: "The most noticeable feature in the geology of the district examined is the marked predominance of rocks of igneous origin. Two great series are represented of which the older consists mostly of porphyrites, diabases, gabbros, tuffs, and agglomerates, and the younger granite." On the distribution of ore bodies the same authority says: "The auriferous iron and copper sulphide ores at Trail Creek (Rossland district) occur almost exclusively in the massive members of the eruptive series, and most of the important ore bodies which have so far proved productive, are situated either on or close to the line of contact between the gabbros and surrounding porphyrites and diabases, the Le Roi, War Eagle, Cliff and a number of other leads west of Centre Star workings almost immediately east of it in the gabbros."

The Slocan mining district, of which Sandon is the principal camp, has experienced a remarkably successful growth since the first discoveries about 1892. The following tables giving the net smelter returns of ore from that district sold during 1895–7, taken from the reports of the Minister of Mines for the year ending December 31, 1897, demonstrate the progress of the district. The tonnage is the dry weight of the crude ore and concentrates shipped, *i. e.*, with the moisture deducted. The silver and gold values represent 95 per cent. of the assay values, and the lead 90 per cent., as the smelters do not pay for the balance. The average market values at New York have been taken, or for silver for 1896, 67 cents, and for 1897, 59.8 cents per ounce. For lead for 1896, $2.98 per 100 pounds, for 1897, $3.58.

NET PRODUCTION PER SMELTER RETURNS.

Year.	Tons, 2,000 lbs.	Silver, oz.	Lead, lbs.	Gold, oz.	Values.
1895	9,514	1,122,770	9,666,324	6	$1,045,600
1896	16,560	1,954,258	18,175,074	152	1,854,011
1897	33,576	3,641,287	30,707,705	193	3,280,686
Totals	59,650	6,728,315	58,549,103	351	$6,180,297

ACTUAL YIELD VALUES PER TON.

Years.	Silver.	Lead.	Value.
1895	118.0 oz.	50.8 %	$109.90
1896	118.0 oz.	54.9 %	111.95
1897	108.5 oz.	45.7 %	97.71
For 59,650 tons	111.12 oz.	49.1 %	103.60

The actual amount paid in dividends cannot be stated, as some of the Slocan mines never make their profits public, such as the Payne, but it is known that the total amount up to the end of 1897, was at least $1,800,000, of which $960,000 were paid during that year. The following mines have stated publicly their dividends to December 31, 1897: Slocan Star, $400,000; Reco, $287,500; Idaho, $220,000; Rambler Cariboo, $40,000; Goodenough, $32,500; Last Chance, $37,000.

Besides the dividend paying mines mentioned some twenty others have been shippers of ore intermittently. Because of the lack of tramways, and wagon roads the camps in the Slocan witness the greatest activity in mining operations during the winter months when ore can be rawhided down the mountain sides along trails made in the snow. By this method one horse can haul down about one and a half tons of ore, while the same animal could only pack at most three hundred pounds in the summer season.

The ore bodies in this district are usually found in argillites. Because of the numerous faults the veins are very difficult to follow, and often the dead work necessary is very expensive, but the high grade of the orė, whenever a body occurs, amply repay for the outlay. The thickest body of ore in the district is in the Slocan Star Mine, where the maximum thickness is from thirty-five to forty feet, and minimum one foot. At the Sovereign the ore body averages five feet in thickness. At the Ruth, four feet.

The richest ore in all the mines in the Slocan is found where the body is the thinnest; this is usually solid galena, but where the veins widen out the ore is of a concentrating character, carrying so much gangue matter that it will not pay to ship direct from the mine.

No ore is smelted in this district; in fact, up to the present time all lead ores have been shipped to United States smelters for treatment, but a good deal of discussion has been indulged in during 1898 urging the Dominion Government to adopt legislation which will tend to promote lead smelting in the Province of British Columbia. The present duty on pig lead in the United States, and limited demand for that article in the Dominion are amongst the main reasons why the Slocan ores are shipped across the line for treatment.

The opening of the Crow's Nest Pass Railway will encourage smelter building in British Columbia, because the coal fields of that pass are very extensive, the coal an excellent quality for coking, and the freight to the towns of Slocan and Kootenay sufficiently low to enable the coalmasters to successfully compete with those of any other locality.

Since 1897 prospecting has been carried on quite extensively on the west coast of the mainland around the vicinity of Shoal Bay, on the west coast of Vancouver Island as well as on Tezada Island lying in the Straits of Georgia between Vancouver Island and the mainland.

The writer has only visited the west coast of Vancouver Island, where he saw some very rich occurrences of iron and copper pyrites, and in some instances pyrrhotite. Samples from these assayed from 4 per cent. to 32 per cent. copper, with low values in gold and silver. The outcroppings throughout the mineral zones on Vancouver Island are usually magnetite of a very pure quality. The zones apparently extend the entire length of the island, nearly three hundred miles, but have only been prospected for a short distance up the streams which empty into the many sounds and inlets along the west coast. The reason for this is that the country lying between those watercourses is at present too difficult of access because of dense growth of timber, underbrush and moss. Besides, no roads or trails have been made through that portion of the interior of the island.

The advantages obtained on the coasts of the mainland and the islands by reason of easy access to ocean transportation for the shipment of ore to coast smelters are so pronounced that it is generally considered most probable that during the next few years more attention will be directed to these districts than to those in the interior lying to the north of the Canadian Pacific Railway.

Vancouver Island has certainly great possibilities, because along the northeast and extreme northwest coasts are situated extensive coal fields, the quality of the coal being good for coking. Deposits of magnetite of unknown extent, as well as inexhaustible limestone quarries, also occur in several localities. Consequently there are opportunities for iron and steel making, as well as mining for gold, silver and copper. A large portion of the interior has never been explored, but this neglect will gradually be remedied, because each season the prospectors are pushing farther inland from the coast and their efforts are usually rewarded by the discovery of good mineral claims.

The ore bodies on Vancouver Island are found either at the contact of igneous rocks and crystalline limestone, or else along the line of fissuring in the igneous rocks. These latter occurrences bear much similarity to those in the Rossland district, and the ores carry about the same average value. Usually, though, the yield in gold and silver is less, but that of copper greater. Sufficient work has not yet been performed to warrant any unqualified opinion as to the extent or permanency of these ore bodies.

Easterly from the zones of sulphide ores, but very closely associated, occurs a belt of auriferous quartz veins. These have only been prospected along the Alberin canal and on Bear river which empties into Bedwell Sound some distance north of the canal. The fact that placer mining was carried on in both these localities years ago prompted prospectors to search for the sources of the placer gold, with satisfactory results, so far as shallow working has determined.

In the foregoing paper the writer has attempted to describe in a general way the present conditions and mineral resources of British Columbia, but the task is such a difficult one to accomplish in a paper of this character, that he feels impressed with its imperfectness.

REPORT OF THE SECRETARY FOR THE YEAR ENDING JANUARY 31, 1899.

University of Alabama, January 31, 1899.

Since the last report rendered there have been added to the Society thirteen new members, and there has been one resignation, viz: Mr. H. B. Christiansen, Rock Run.

We have on our books the names of fifty-one active members, nearly all of whom have paid up their dues fully, or are at most only one year behind.

During the past year, while our meetings have been lacking in formal papers, we have had discussions that have been of interest and profit, and the promise for the future seems to be better than it has been for many years.

The proceedings for the year 1898 have not yet been printed, but will be sent to press very soon.

The Society at the winter meeting, 1897, authorized the calling of three meetings during the past year, but it was not found convenient to arrange for the third meeting, since our first or annual meeting came so late in the year (March 4).

The usual notices to members have been printed and sent out and the resolutions of the Society in regard to the Paris Exposition and Memorial to Congress relating to French Tariff laws, were communicated to the Governor.

The additions to the library by exchanges have been the current numbers of the Johns Hopkins University Records; The Technology Quarterly of the Massachusetts Institute of Technology; The Journal of the Elisha Mitchell Society of North Carolina; The Kansas University Quarterly; The University of Tennessee Record; Bulletins of the Bureau of American Republics; Proceedings of the Engineering Association of the South.

Respectfully submitted,

Eugene A. Smith,

Secretary.

REPORT OF TREASURER FOR THE YEAR ENDING JANUARY 31, 1899.

University, Ala., January 31, 1899.

RECEIPTS.

From cash in treasury, as per report of March 3, 1898		$ 99 00
From dues received since March 3, 1898		155 00
Total receipts		$ 254 00

DISBURSEMENTS.

For printing and stationery	$ 10 15	
For reporting Proceedings	5 00	
For notices of meetings in papers	4 50	
For postage and revenue stamps	4 20	
For clerical work in sending off Proceedings	2 50	
For telegrams regarding hall	94	
Total disbursements	$ 27 29	—$ 27 29
Balance		$226 71

Henry McCalley,
Treasurer.

PROCEEDINGS

—OF THE—

Alabama Industrial

—AND—

Scientific Society.

Vol. IX. Part II.

1899.

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1899.

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J. H. McCune, ... Woodward, Ala.

TREASURER.

Henry McCalley, ... University, Ala.

SECRETARY.

Eugene A. Smith, ... University, Ala.

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[NOTE.—At the Annual Meeting held Feb. 1, 1899, the Society adjourned to meet again on May 3d, but on this occasion a quorum was not present and no meeting was held.]

REPORT OF PROCEEDINGS

—OF THE—

AUTUMN MEETING

—OF THE—

Alabama Industrial and Scientific Society,

Held in Birmingham, November 16, 1899.

The regular autumn meeting of the Society was held in the rooms of the Commercial Club, in Birmingham, on the afternoon of Thursday, November 16, 1899.

Mr. T. H. Aldrich, ex-President of the Society in the chair. Present were Messrs. J. A. Montgomery, B. B. Ross, Col. Horn, E. A. Smith, representatives of the press and others. The reading of the minutes of the last meeting was dispensed with, as the printed proceedings of this meeting had already been distributed among the members.

The Secretary made the statement that on the occasion of the spring meeting so few members and no officers being present, it was decided not to have a meeting, notwithstanding the fact that Dr. Ross was present with a paper, and Mr. Bowron had consented to address the Society about Cuba.

After the regular routine of business, Dr. Ross gave an abstract of his paper on the Fertilizer Resources and the Fertilizer Industry of Alabama. This paper will be found printed in full in these proceedings. Dr. Ross also exhibited to the members present, a number of samples of phosphate rock collected recently by himself in the vicinity of Athens, in Limestone county. The samples analyzed by him contained from 15 or 20 per cent. of phosphoric acid, up to 36 or 37 per cent., and he also showed a sample of superphosphate prepared by him from this rock; the manufactured article containing 13.15 per cent. water-soluble, 0.15 per cent. reverted, and 1.24 per cent. insoluble, total 14.91 per cent. phosphoric acid.

In the discussion which followed, Mr. Aldrich said that a fertilizer manufactory in Meridian, Miss., was using lignite from the "Burning Cut," in Sumter county, Ala., as a filler, and that it contained 1.5 per cent. to 2 per cent ammonia. Mr. Aldrich had formerly sold from the Blocton mines several hundred tons of coal slack to a Shreveport company for the same uses. He also mentioned the fact that he had recently examined a lignite occurring in Mississippi, 17 miles west of Starkeville, which had only 4.5 per cent. of ash, and which made a good coke.

Dr. Smith then read a preliminary report on the Mineral Statistics of Alabama for the first three quarters of the present year, after which there being no further business before the meeting it was adjourned *sine die*.

EUGENE A. SMITH,
Secretary.

THE FERTILIZER RESOURCES AND THE FERTILIZER INDUSTRY OF ALABAMA.

The fertilizer industry, both in the Southern States and in the country at large, has attained its present large proportions by a process of extremely rapid growth, and the close relation which it sustains to the agricultural industry of the country adds sufficiently to its importance to justify a brief discussion of some of its more important features.

The manufacture of artificial manures in the South is a distinctively post-bellum industry, and although the consumption of fertilizers has increased largely in recent years the process of introduction of fertilizing materials of this character was at first somewhat slow and difficult. The first commercial fertilizer of importance to be placed upon the markets in this country was the "Peruvian Guano," obtained from a few small islands off the coast of Peru, and the good results attendant upon its use, together with the fact of its limited supply, created a demand for an artificial product, approaching in composition and fertilizing properties the Peruvian guano itself. This led to the manufacture of the complete mixed fertilizer, the basis of which was the superphosphate, produced by treating raw bone, or bone ash, with sulphuric acid. Where the raw bone was employed a fair proportion of nitrogen was secured to the product, and only the addition of some potash manure was required to obtain a material containing all three of the essential elements of fertilizers.

The discovery of the extensive beds of phosphate rock in the vicinity of Charleston led to the substitution of this raw material for bones in the manufacture of fertilizers, and the consumption of natural phosphate has been still further increased, as a result of the discovery of immense deposits of phosphate in South Florida and Tennessee. While the phosphoric acid of mixed fertilizers is derived from the above mentioned sources, the nitrogen furnished to the product was supplied chiefly in the form of some refuse material of animal origin, including, in addition to raw bone, fish scrap, slaughter-house waste, dried blood, etc. The potash in some of the older forms of mixed fertilizers was furnished by wood ashes, and the present extensive use of German potash salts has been attained in comparatively recent years. In the earlier period of the history of the fertilizer industry in this country, there was a marked neglect of materials produced within easy reach of the Southern fertilizer manufacturer, and yet unutilized for a long time on account of a lack of knowledge of their true value, as well as by reason of a prejudice on the part of the farmer against the use of mixed fertilizers, composed in part of such commonplace materials as cottonseed meal, cottonseed hull ashes, tobacco stems, etc. At the present time cottonseed meal enters largely into the composition of the mixed fertilizers of the South, but even at this late day many manufacturers are compelled to employ a small proportion of coloring materials, as well as a moderate amount of some nitrogenous material, more odoriferous than cottonseed meal, to make the product conform to the requirements of the consumer, both as regards appearance and odor.

The fertilizer industry in this State dates back to scarcely more than fifteen years, and has only assumed large proportions within the past ten years. When the first fertilizer legislation in this State was enacted in 1883, there were only one or two establishments in the State engaged in the manufacture of fertilizers for the trade, and these establishments simply mixed materials obtained from outside sources. The Troy Fertilizer Co. was the first concern in the State to erect a plant for the production of fertilizers from the raw materials, manufacturing its own supplies of sulphuric acid and superphosphate on the ground. This company was followed a year or two later by the Mobile Phosphate & Chemical Co., and the Montgomery Fertilizer Co., and in 1897 by the Birmingham Fertilizer Co., which is operating a large plant at East Birmingham. All of these establishments are manufacturers in the true sense of the term, acidulating their crude phosphates with acid manufactured on the spot, and having an aggregate annual capacity of over 100,000 tons.

In addition to the factories mentioned there are about twelve more establishments in the State which manufacture mixed fertilizers, with the employment of acid phosphates obtained from outside sources, and still another establishment manufactures its own superphosphates with the use of acid imported in tank cars. The consumption of fertilizers in this State, as indicated by the tag receipts of the State Department of Agriculture, reaches under favorable conditions, about 125,000 to 130,000 tons per year, and from this statement it will be seen that the large and complete factories above mentioned have a capacity equal to more than 80 per cent. of the annual consumption of the State. Another large and complete fertilizer plant is now being constructed by the Opelika Chemical Co., and will be completed in time to place its products on the market for the approaching fertilizer season. When this last named plant is in full operation, the productive capacity of the factories within the State will equal the consumption, while some of the factories enjoy a considerable trade outside of the limits of the State. At the same time, however, fertilizer companies from without the State supply a considerable proportion of the fertilizer demand within the State, although the relative consumption of imported fertilizers is likely to decrease in the near future, owing to the enterprise exhibited by the large fertilizer manufacturers of Alabama. Inquiries addressed to the leading factories in the State elicited the fact that nearly all of the large plants are employing pyrites instead of sulphur in the manufacture of acid, but none of the establishments which answered the inquiries addressed them had tested Alabama pyrites, though a preference for the home article was expressed, in case a sufficient supply to meet the demand could be marketed. A number of high grade specimens of pyrites have been analyzed in the State Laboratory within the past few years, but the writer did not collect any of the specimens personally and presumes that the extent of the deposits would not justify the mining of the ore on a large scale.

In 1896 mining operations were being carried on, to a limited extent, on Hatchett creek, in Clay county, and samples of the ore obtained were sent to the State Laboratory for analysis. One of the samples showed a content of 45.87 per cent. of sulphur, but other specimens fell somewhat below this proportion and the ore seemed to be somewhat lacking in uniformity. A specimen from another locality in the same county, recently analyzed in the State Laboratory, contained 34.53 per cent. of sulphur and 23.5 per cent. of insoluble matter. It has been difficult to secure detailed information on this subject, but judging from the fact that Alabama pyrites at this time is not known to the sulphuric acid trade, I presume that it is not now being mined on a commercial scale.

An examination into the character of the raw materials now employed in the manufacture of fertilizers in this State discloses the fact that excepting cottonseed meal only a small quantity of raw materials produced or occurring within the State is utilized in the fertilizer industry. As before stated, this last named product is extensively employed in compounding mixed fertilizers and is highly esteemed as a cheap and desirable source of nitrogen for fertilizing purposes. The amount of meal produced in the oil mills is largely in excess of the quantity consumed for fertilizing purposes, and yet a very large proportion of the cottonseed produced does not find its way to the oil mills, but is returned to the soil direct, or else employed for feeding purposes. Were the whole of the seed crop (excepting, of course, that required for planting), worked up at the oil mills, the amount of meal produced in this State from a million bale crop would equal about 175,000 tons, and if employed in the manufacture of mixed fertilizers it would furnish the nitrogenous material for more than 600,000 tons of complete fertilizer with a 2 per cent. nitrogen content, in addition to supplying fair proportions of phosphoric acid and potash. Cottonseed hull ashes, obtained as a product of the burning of hulls under the boilers of oil mills, constitutes an important and valuable source of potash, as it yields about 20 to 30 per cent. of potash in a readily soluble form and contains, in addition, from 7 to 10 per cent. of phosphoric acid. The production of this material, however, has fallen off somewhat in recent years, owing to the increased demand for cottonseed hulls for feeding purposes.

Fertilizing materials of animal origin have been in great demand during the past few years, and a few slaughter-houses and packing establishments in this State have placed both tankage and dried blood of good quality on the fertilizer market, the former being employed in mixed manures as a source of both nitrogen and phosphoric acid, and the latter as a source of nitrogen alone. With the extension of the packing industry and the employment of economic methods of handling the waste materials of slaughter-houses, it is hoped the production of animal fertilizers of this character will be largely increased, while there should be a corresponding diminution in the supplies of fertilizing materials imported from without the State.

Within the past few months, the production of sulphate of ammonia upon a commercial scale has been carried out successfully at the Solvay by-product plant at Ensley, although at this time, I am informed, the ammonia is not being converted into sulphate, owing to the comparatively low price of the commercial salt. The fact that this material has been and can be produced upon a commercial scale, is of importance, for the reason that this compound supplies the highest percentage of nitrogen obtainable from any material used in the manufacture of fertilizers, and its nitrogen is supplied in a particularly active and available form, so that it is highly desirable as a constituent of high grade and readily assimilable fertilizers.

Within recent years, Thomas slag has attained a very extensive consumption in Europe, and quite lately considerable importations have been made into this country. A limited amount of this product is also obtained in the United States as a by-product of the Thomas-Gilchrist steel process, and very successful results have attended its use as a fertilizer, tetrabasic phosphate of lime which it contains being quite available to the plant if the material is pulverized to a sufficient degree of fineness.

The proportion of phosphorus in the Alabama iron ores is too low to permit of the production of a high grade phosphatic slag by the Thomas-Gilchrist process, and the basic cinder obtained as a waste product of the open-hearth process has too large a proportion of iron, and too small a percentage of phosphorus, as shown by analyses made in the Alabama State Laboratory, to render it of economic value for fertilizing purposes, while difficulty of pulverization is another obstacle in the way of its practical employment.

While so far no phosphate deposits, of sufficient extent to warrant the mining and working of the material upon a commercial scale, have been found within the limits of the State, nevertheless phosphates of considerable richness exist in a number of localities in the State, particularly in middle Western Alabama.

Early in 1884 Dr. Eugene A. Smith, the State Geologist, announced the existence of phosphates in the western portion of the black belt, and commenced an investigation with regard to the extent and character of the phosphatic deposits. A considerable portion of the analytical work connected with the investigation was performed in the State Laboratory under the direction of Dr. W. C. Stubbs, at that time the State Chemist, and many of the analyses were conducted by the writer, at that time an assistant in the State Laboratory. Nearly two hundred analyses of phosphates, green sands and marls, were made during the course of this investigation, and about twenty-five samples showed a phosphoric acid content of not less than 20 per cent. while one sample contained as much as 38 per cent. phosphoric acid, equivalent to 82.84 per cent. bone phosphate. The samples of phosphates analyzed were chiefly of a nodular character, and, as stated in Dr. Smith's report, were obtained in the Hamburg region from a sandy, calcareous matrix, underlying a bed of green sand, above which is the rotten limestone characteristic of the region. The extent and mode of occurrence of these phosphates, however, have apparently not warranted their working upon a commercial scale, and the Alabama fertilizer manufacturers are still dependent upon outside sources for their supplies of phosphate rock.

Quite recently the writer has found in Limestone county in this State, samples of phosphate rock ranging in phosphoric acid content from 9 per cent. to 25.1 per cent., while a small nodular specimen contained as high as 36.7 per cent. phosphoric acid. An acid phosphate was prepared in the State Laboratory from one of these phosphates, and a product of the following composition was obtained:

Water soluble phosphoric acid.........	13.15 per cent.
Reverted phosphoric acid..............	0.51 per cent.
Insoluble phosphoric acid..............	1.24 per cent.
Total phosphoric acid................	14.90 per cent.

The samples of natural phosphate obtained from Limestone county contained considerable proportions of silica, but only small amounts of iron and alumina, while the proportion of carbonate of lime was also quite small.

Extensive beds of green sand marls are to be found in a number of localities in this State, and the value of this material for fertilizing purposes can be ascertained from the results of analyses of two samples analyzed in the State Laboratory some time since:

	Phosphoric acid.	Potash.
Sample No. 1..........	2.24 per cent.	3.78 per cent.
Sample No. 2..........	2.74 per cent.	3.86 per cent.

The successful employment of materials of this character in the reclamation of exhausted soils in New Jersey and other States emphasizes the importance of the intelligent application of such crude manurial substances as may be found already prepared for the use of the farmer.

Among other crude manurial materials occurring within the limits of the State and at the disposal of the farmer may be mentioned mucks, which are found quite abundantly and which supply good quantities of humus and a fair proportion of nitrogen. Cave earths and bat manures are found to some extent in North Alabama, and can be utilized to a limited extent as a source of all three of the chief fertilizing constituents. A sample of bat manure, obtained from a cave in the Tennessee Valley, and analyzed in this laboratory several years ago, contained 5.56 per cent. of phosphoric acid, 8.26 per cent. of nitrogen and 2.02 per cent. of potash, while its value, based upon the scale of fertilizer values in this State, was more than $30 per ton. Numerous other analyses made in this laboratory bear testimony to the existence of crude manurial resources in many localities of the State, which, if properly utilized, would aid greatly in building up the soil and at the same time diminish the necessity for the purchase of outside supplies of fertilizers.

While nitrogen, in the form of the various commercial manures supplying this element, is the most costly one of the three essential fertilizing constituents and at the same time is most readily removed from the soil, the farmer, at present, has other means of securing this valuable element from another source, much more cheaply than through the medium of artificial manures. The fact, established by Wilfarth, Helriegel and other German investigators several years ago, that many leguminous plants, under proper conditions, can take up free nitrogen from the air, is now well known and practically applied. The cowpea, the velvet bean, the clovers and the vetch, when grown in this State upon soils containing the bacteria appropriate to each particular crop, take up and assimilate through the medium of bacteria inhabiting the peculiar tubercles or nodules upon the roots of these plants, free nitrogen from the atmosphere in considerable quantities, and the supplies of nitrogen thus collected can be supplied to the soil by turning under the crop, or else by feeding the forage to cattle and stock, and carefully husbanding the manures.

At the Experiment Station at Auburn, there are now being grown annually heavy and luxuriant crops of crimson clover and vetch upon soils inoculated with the proper bacteria only a year or two since, while the same crops planted on adjacent plots of soil of the same character, but non-inoculated, yielded a sparse, sickly growth of only a few inches in height. The crops grown on the inoculated soils not only gave an immensely greater yield of forage, but the plants on analysis showed a much higher relative nitrogen content, and if plowed under would supply to the soil not only a large amount of humus, but a valuable supply of nitrogen as well.

The judicious employment of renovating crops of this character is calculated not only to protect the soil from exhaustion, by the removal of other crops cultivated thereon, but to increase the supply of the most costly fertilizing element in the soil, and at the same time improve in a most marked manner the physical texture of the soil.

B. B. Ross,
State Chemist.

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NOTE

At a called meeting of the officers (1899) of the Alabama Industrial and Scientific Society, held in the office of Col. J. A. Montgomery, First Vice-President, on January 13, 1914, the following Resolutions were unanimously carried:

Resolved, 1st, That Dr. Eugene A. Smith, Secretary of the Alabama Industrial and Scientific Society, be elected Treasurer to fill the vacancy caused by the death of Henry McCalley.

Resolved, 2nd, That certain funds of the Alabama Industrial and Scientific Society now standing to the credit of the Society in the City National Bank of Tuscaloosa, be used as follows:

First, That sufficient funds be appropriated to bind and furnish to each member of the Society in good standing at the time of the last meeting of the society, one copy of the Proceedings of the Society.

Second, That the balance of these funds be paid over to the Museum of the Geological Survey of Alabama, for the purpose of binding books now in that library and for such other Museum purposes as Dr. E. A. Smith may elect.

Signed,

T. H. Aldrich, Past President

J. A. Montgomery,
J. H. McCune,
Jones G. Moore,
J. W. Minor,
Chas. J. Geohegan,
} Vice-Presidents 1899