Date Due

Annual Report

OF THE

AMERICAN INSTITUTE

OF  THE

City of New York

FOR THE YEARS

1871-72

Albany.

The Argus Co. Printers.

1872

THIRTY-SECOND ANNUAL REPORT

OF THE

AMERICAN INSTITUTE,

OF THE

CITY OF NEW YORK,

FOR THE

Year 1871-72.

ALBANY:
THE ARGUS COMPANY, PRINTERS.
1872.

STATE OF NEW YORK.

No. 190.

IN ASSEMBLY,

April 10th, 1872

TRANSACTIONS OF THE AMERICAN INSTITUTE.

AMERICAN INSTITUTE.
NEW YORK, *April 9th*, 1872.

To the Hon. HENRY SMITH,

Speaker of the Assembly:

SIR.—I have the honor to herewith transmit, to the Legislature of the State of New York, the Thirty-second Annual Report of the American Institute of the city of New York.

With great respect, I am, sir,

Your obedient servant,

SAMUEL D. TILLMAN,

Corresponding Secretary.

AMERICAN INSTITUTE.

OFFICERS AND COMMITTEES—1872.

TRUSTEES.

PRESIDENT,

F. A. P. BARNARD.

VICE-PRESIDENTS,

CHARLES P. DALY,
ORESTES CLEVELAND,
HENRY A. BURR.

RECORDING SECRETARY,

JOHN E. GAVIT.

CORRESPONDING SECRETARY,

SAMUEL D. TILLMAN.

TREASURER,

SYLVESTER R. COMSTOCK.

MANAGERS OF THE FAIR.

JAMES KNIGHT,
NATHAN C. ELY,
GEORGE TIMPSON,
ALEX. M. EAGLESON,
CHARLES E. BURD,
JAMES H. SACKETT,
CHARLES A. COOK,
J. TRUMBULL SMITH,
EDWARD WALKER,
CLARENCE L. VAN ZANDT,
WILLIAM DEAN,
GEORGE RANDELL,
WILLIAM E. GAVIT,
B. T. BURNHAM,
ROBERT J. DODGE,
FRANK D. CURTIS,
NATH'L A. WILLIAMS,
R. H. THURSTON,
ROBERT WEIR,
ADOLPHUS J. HALSEY,
CHARLES F. ALLEN,
CHARLES S. ARTHUR,
HENRY J. NEWTON,
SAMUEL R. WELLS.

COMMITTEES.

Committee on Admission of Members—James H. Drake, J. W. Richards, John W. Chambers, Stephen R. Krom, Wesley Smith.

Committee on Finance—Thomas M. Adriance, J. De Lamater, Charles Chamberlain, Simeon Baldwin, C. H. Loutrel.

Committee on Library—John B. Rich, Dubois D. Parmelee, John E. Gavit, Edward Curtis, Edward Schell.

Committee on Repository—M. M. Livingston, Albro Howell, L. Bradley, F. A. Butler, C. Williams.

Committee on Manufactures and Machinery—Charles E Emery, George H. Babcock, Wellington Lee, Frank L. Pope, Robert Weir.

Committee on Chemistry, Mineralogy and Geology—Charles F. Chandler, J. S. Newberry, Henry Morton, L. Bradley, John Colvill.

Committee on Optical Science—John B. Rich, Lewis M. Rutherfurd, John Frey, T. d'Oremieulx, J. J: Higgins.

Committee on Civil Engineering and Architecture—William J. McAlpine, Robert G. Hatfield, John W. Ritch, Samuel McElroy, Edward S. Renwick.

Committee on Agriculture—Nathan C. Ely, John Crane, P. T. Quinn, F. M. Hexamer, Josiah H. Macy.

Committee on Horticulture—William S. Carpenter, Benj. C. Townsend, John Henderson, Isaac Buchanan, Andrew S. Fuller.

Committee on Commerce—J. V. C. Smith, Samuel R. Wells, Robert Craighead S. J. Macy, Reuben Bull.

REGENTS OF THE AMERICAN INSTITUTE.

EDWIN D. MORGAN,
GERRIT SMITH,
CORNELIUS VANDERBILT,
EZRA CORNELL,
ABIEL A. LOW,
DENNING DUER,
SAMUEL F. B. MORSE,
HAMILTON FISH,
HENRY W. BELLOWS,
HENRY WARD BEECHER,
WILLIAM H. APPLETON,
ORLANDO B. POTTER,
JOHN A. GRISWOLD.

REGENTS EX-OFFICIO.

THE GOVERNOR OF THE STATE OF NEW YORK,
THE MAYOR OF THE CITY OF NEW YORK,
THE U. S. SECRETARY OF THE INTERIOR,
THE TRUSTEES OF THE AMERICAN INSTITUTE.

FACULTY.

SAMUEL DYER TILLMAN, LL.D., Professor of Mechanical Philosophy and Technology.

JULIUS G. POHLE, M. D., Professor of Analytical Chemistry.

ROBERT P. STEVENS, M. D., Professor of Geology and Mineralogy.

JAMES A. WHITNEY, A. M., Professor of Agricultural Chemistry.

OFFICERS.

JOHN W. CHAMBERS, Clerk and Librarian.
DANIEL R. GARDEN, Assistant Clerk.

ANNUAL REPORT

OF THE

BOARD OF TRUSTEES.

To the Honorable the Legislature of the State of New York:

The undersigned, in presenting the thirty-second annual report of the American Institute of the city of New York, beg leave to state that its transactions during the year ending in April, 1872, are fully set forth in documents hereto annexed, containing,

I. A review of the operations of the Institute, presented by the retiring Trustees at the annual meeting held on the first day of February, 1872.

II. An exhibit of receipts and expenditures.

III. Annual reports of standing committees.

IV. Report of the Board of Managers in relation to the Exhibition of 1871.

V. A catalogue of specimens of skill and ingenuity exhibited.

VI. Opinions of Judges, and a list of Awards.

VII. A full account of an elaborate test of Steam Boilers.

VIII. Addresses at the Exhibition of 1871.

IX. Scientific lectures delivered before the American Institute.

X. Discussions of the Farmers' Club, including communications from all parts of the Union.

XI. Transactions of the Polytechnic Association, including a summary of Scientific advance, at home and abroad.

XII. Proceedings of the Photographical Section of the American Institute.

All of which is respectfully submitted.

F. A. P. BARNARD, *President.*
CHAS. P. DALY.
O. CLEVELAND.
HENRY A. BURR.
JNO. E. GAVIT.
S. R. COMSTOCK.
SAM'L D. TILLMAN.

New York, *April 4th*, 1872.

REPORT OF THE RETIRING TRUSTEES,

MADE AT THE

ANNUAL MEETING OF THE INSTITUTE, FEBRUARY, 1872.

THE Trustees respectfully submit a brief retrospect of the operations of the past year, which gives the gratifying assurance that, through the efforts and influence of its active members, the Institute still maintains its high position as a source of scientific information, and its well-earned reputation as an efficient organization for the encouragement of American skill and industry. In the quarterly statements made by the Committee on Finance will be found abundant evidence that the monetary affairs of the Institute have been managed with commendable care and fidelity. Its financial engagements have been promptly met, and its surplus funds have been invested in the best securities. The par value of the Government registered bonds now belonging to the Institute is $75,000. During the past year the total receipts amount to $54,157, and the disbursements to $28,245.20, leaving in the Treasury $25,912.62; from this sum must be deducted the amount required to pay several unsettled bills for expenditure at the late Exhibition, which will probably reduce the sum to about $23,500.

The property on Broadway and Leonard street, New York, belonging to the Institute, has been let to three tenants at a total rent of $12,500 per annum. In order to conform to the custom now generally approved by merchants, the year of each lease given will commence on the first day of February instead of the first of May. For a detailed account of the doings of the several subordinate organizations of the Institute, reference is made to the reports of the committees respectively in charge. While fully appreciating the important services rendered by all these committees, the Trustees deem it their duty to direct special attention to the effective labors of the present Board of Managers. The Exhibition of 1871 was a marked success. Its arrangement, ornamentation, and appointments were admirable. The extent and variety of the useful and beautiful works of nature and art displayed reflected the highest credit on the exhibitors; and the fact that these works were examined by the largest number of visitors yet drawn to an exhibition by the American Institute is sufficient evidence that their commendable qualities were fully appreciated by the public. The receipts from all sources at this Exhibition were $85,253.10, and the disbursements thus far $64,028.84. Several bills still unpaid will reduce the net profits to about $18,500. To this sum should be added the amount expended for materials, which can be used at future exhibitions, $8,400, which shows the actual profit of this one to be $26,900. For this gratifying result the Institute is mainly indebted to the indefatigable exertions of the managers, under whose agency and personal supervision all the important operations and multifarious business of the Exhibition were conducted.

Unabated interest has been evinced during the past year in the weekly meetings of the Farmers' Club. The discussions of questions relating to practical agriculture are carried on, not only by the members present, but by correspondents from all parts of the Union, and, in this manner, the opinions of the club are very widely disseminated.

The weekly sessions of the Polytechnic Association, now held on Friday evenings, so as not to interfere with the regular meetings of the Institute, are devoted chiefly to science and its application in the useful arts. Papers by distinguished mechanicians, engineers and chemists, and notes on the progress of invention and discovery, occupy that portion of time not used in examining plans and models of new labor-saving devices.

Monthly meetings of the Photographical Section are held, which are now open to the whole fraternity of photographers. The chemical action of light, the formation of sensitive compounds, the construction of the camera and the new improvements proposed for taking sun pictures, are the principal topics discussed by this society.

Those who have recently visited the library of the Institute, must have been favorably impressed by the changes made under the direction of the committee in charge. The appearance of the room has been greatly improved, and the new furniture has increased the comfort and convenience of visitors. Valuable additions of books have been made, from time to time, during the past year.

The very large attendance at the Academy of Music, during the delivery of the last course of scientific lectures before the American Institute, was the best proof that the action of the Trustees, in relation thereto, met the approval of their fellow-members. Their aim was to secure lecturers of acknowledged ability, who could give the results of the most recent investigations on the subjects to be elucidated, and who could demonstrate every scientific announcement by convincing experiments. Heretofore there has been great difficulty in making such an experiment simultaneously visible to a large number of spectators. Recent improvements made in this country have obviated this difficulty, and enabled the lecturers of this course to fortify their positions by presenting illuminated representations of minute phenomena, and of the most delicate movements, which could be distinctly seen from all parts of the house. This new method of exhibiting the relations of cause and effect brings the law intended to be explained within the comprehension of the most ordinary capacity. It is gratifying to know that the ocular demonstrations, made under the direction of the American Institute during these scientific lectures, were far superior to any yet seen in European lecture rooms. The amount placed at the disposal of the trustees to defray the expenses of these lectures was $2,500; of this sum $1,675.70 have been used, for which vouchers have been examined and approved by the committee on finance.

In conclusion, the trustees refer with satisfaction to the volume of Transactions recently published. They regard it as a true exponent of the principles and objects of the American Institute, and a reliable record of scientific progress; and they believe the proceedings of the present year will form a volume fully as interesting and important as that to which attention is now specially directed.

WILLIAM B. OGDEN,
CHARLES P. DALY,
ORESTES CLEVELAND,
HENRY A. BURR,
EDWARD N. DICKERSON,
SYLVESTER R. COMSTOCK,
SAMUEL D. TILLMAN,
Trustees.

New York, *February* 1*st*, 1872.

REPORTS OF COMMITTEES.

FINANCE.

Receipts and Disbursements of the American Institute of the City of New York, for the year ending January 31st, 1872.

Balance in the treasury January 31, 1871.............		$2,407 66
RECEIPTS.		
Rental of property....................	$13,500 00	
Admission fees and dues, and from life members..........................	5,592 00	
State appropriation, 1870	2,315 63	
Interest on investments...............	4,821 75	
From managers of the 39th annual fair..	302 39	
From managers of the 40th annual fair..	25,160 54	
Miscellaneous sources..................	57 85	
		51,750 16
		$54,157 82
DISBURSEMENTS.		
Taxes on property No. 351 Broadway and No. 89½ Leonard street	$2,369 00	
Fire insurance and repairs.............	487 97	
Books, periodicals and binding.........	1,023 87	
Rent of rooms in Cooper Union and gas-light	2,382 00	
Printing and stationery...............	598 11	
Freight and expenses—Transactions from Albany..........................	43 15	
Balance of course of scientific lectures, 1870, 1871.......................	475 08	
Course of scientific lectures, 1871, '72..	1,675 70	
Reporting Polytechnic and Photographical Sections	540 00	
On account of 38th annual fair.........	215 00	
On account of 39th annual fair	1,094 37	
Carried forward..................	$10,904 25	$54,157 82

Brought forward		$10,904 25	$54,157 82
On account of Fortieth Annual Fair.			
Salary of superintendent of exhibitions, 7⅓ months	$1,833 33		
Appropriation to chairman of finance committee of fair	500 00		
Rent of four lots Second avenue, between 63d and 64th streets	1,000 00		
Sun lights	450 00		
Rent of Allen boiler	300 00		
		4,083 33	
On account of fitting library		1,243 75	
Insurance on building adjoining the rink, and property thereon		350 00	
Examining rink building		50 00	
Newspapers, advertising, postage and incidental expenses		711 04	
Salaries		5,190 33	
		$22,532 70	
Invested in U. S. 5-20 bonds 1867		5,712 50	
			28,245 20
Balance in bank January 31st, 1872			$25,912 62

New York, *January* 29, 1872.

THOMAS M. ADRIANCE,
CYRUS H. LOUTREL,
SIMEON BALDWIN,
CHARLES CHAMBERLAIN,
JAMES DE LAMATER,
Finance Committee.

ADMISSION OF MEMBERS.

The Committee on the Admission of Members beg leave to report their doings during the past year.

They have made ten reports to the Institute, recommending 192 candidates for admission as members, who have been duly elected as follows:

On March 2,	1871	23
April 10,	"	10

On May 4,	1871	20
June 1,	"	30
September 7,	"	48
October 5,	"	32
November 2,	"	8
December 6,	"	4
January 4,	1872	13
February 1,	"	6
Total		194

It will be observed that the number of members admitted during the past year falls short of those admitted the last year by 358. This may be accounted for in consequence of the raising of the admission fee and annual dues, and likewise from the fact that only five life members were recommended during the last exhibition in place of 416 received during the exhibition of 1870.

The following is the number of members belonging to the American Institute:

Honorary members		85
Corresponding members		249
Life members	1,413	
Less deceased	263	
		1,150
Annual members		2,316
Total		3,800

The following members have deceased during the year:

Wm. B. Taylor	February	12, 1871	New York city.
Wm. S. Watkins	February	14, 1871	New York city.
Thos. Williams, Jr.	March	4, 1871	New York city.
Joseph P. Pirsson	March	17, 1871	New York city.
A. P. Cumings	May	13, 1871	Nice, France.
Louis Burger	May	25, 1871	Brooklyn, N. Y.
Paris G. Clark	June	26, 1871	Orange, N. J.
James R. Smith	July	4, 1871	New York city.
John N. Chester	October	1, 1871	Elizabeth, N. J.
Geo. F. Barnard	October	18, 1871	Hudson, N. Y.
Andrew Bridgeman	December	7, 1871	Astoria, L. I.,
John Johnson			Saco, Me.
Hiram Young	December	9, 1871	New York city.
Francis Barretto	December	25, 1871	Blythe, W'chester Co.

William Kelly	January	14, 1872...	Torquay, England.
Joseph B. Lyman....	January	28, 1872...	Richmond Hill, L. I.

Respectfully submitted.

JAMES H. DRAKE.
GEORGE RANDELL.
J. W. RICHARDS.
JOHN W. CHAMBERS.
S. R. KROM.

New York, *January* 31, 1872.

MANUFACTURES AND MACHINERY.

The Committee on Manufactures and Machinery respectfully report:

At the first meeting after the election, your committee reappointed Prof. S. D. Tillman chairman of the Polytechnic Association, and Robt. Weir secretary of the same.

The work accomplished by the association, under the able management of the chairman, is such, that it is now looked upon as a regular institution of instruction, where information is eagerly sought upon all subjects pertaining to the arts.

It was found necessary to change the time of the meetings from Thursday to Friday evenings, so that the meetings of the American Institute, which are held on the first Thursdays of the months, should not interfere with the regular course. The change has proved satisfactory, and has continued for the past four months, with the exception of one evening which was given up to the general course of Institute lectures.

The number of new inventions which have been presented to this body has not been numerous; but the subjects which have been brought up for discussion have been treated with such ability as to command a full attendance at all times, and your committee can truthfully state that the association is in a most flourishing condition, as a perusal of the careful reports by our able stenographer will show.

WELLINGTON LEE.
CHAS. E. EMERY.
GEO. H. BABCOCK.
FRANK L. POPE.
ROBT. WEIR.

New York, *February 1st*, 1872.

AGRICULTURE.

The Committee on Agriculture respectfully report, that their duties for the year have been confined to the Farmers' Club, which, we are enabled to say, is doing a great work, and every year its influence is extended, and its good influence is felt and acknowledged throughout the land. Its meetings each week are attended by full audiences, many from remote points, and thousands of inquiries by letter on agricultural subjects have been received and responded to. Many valuable papers have been read before the Club by distinguished gentlemen, which have been of great interest and much benefit to all engaged in agriculture. Your committee feel it their duty to acknowledge, in this report, the obligations they are under to Professor George H. Cook, geologist of the State of New Jersey, Dr. J. V. C. Smith, H. L. Reade, of Jewett City, Conn., Professor Phin, and others, for their gratuitous services in this particular.

As heretofore, committees from the Club have visited many places both near and far off, collecting information, and testing in the field agricultural implements, attending agricultural fairs, and, in this and other States, ascertaining the results of different kinds of culture, as regards all crops, fruits and vegetables, promulgating, through the Club, the results of their observation, and, as heretofore, the Institute has not paid one dollar for services or expenses of these committees, it being a "labor of love."

To Rev. Samuel Griswold, of Old Saybrook, Conn., a debt of gratitude and thanks is due for over six thousand papers of flower seeds, which have been sent out to gladden the hearts and beautify the homes of thousands.

The press is largely represented at each meeting of the Club, and publish each week the proceedings, which go broadcast throughout the land to the great benefit of millions of readers, and from whom the Club receive thousands of letters of acknowledgement.

All of which is respectfully submitted.

NATHAN C. ELY,
F. M. HEXAMER,
P. T. QUINN,
JOHN CRANE,
JOSIAH H. MACY.

REPORT OF THE BOARD OF MANAGERS.

The Board of Managers of the fortieth Industrial Exhibition of the American Institute respectfully report:

On February 16, 1871, they organized by electing a chairman, vice-chairman, and secretary, appointed committees, and defined their duties. From that time until the opening of the Exhibition meetings of the Board were held nearly every week, generally very largely attended, and never without a quorum.

The building known as the Empire Rink had already been secured for the fortieth exhibition. This, comprising 61,250 square feet, together with the 18,970 square feet which had been added by the Institute during its exhibitions of 1869 and 1870, was known to be inadequate to the increasing demands for space in which to exhibit in 1871. It was, therefore, determined to make a farther addition, to contain at least thirteen thousand square feet. And even now, with nearly 100,000 square feet of exhibiting space, the present dimensions are not adequate to the growing demands. In order to limit the entry of comparatively unimportant articles the entry fee was increased, and yet the demand for space was so great that, to the exceeding regret of the Board, it became necessary to exclude many bulky articles of great merit in order that the much larger number of small but equally meritorious products might be received, and the injudicious policy of favoring the few, to the exclusion of the many, avoided.

Preparations for the reception of heavy machinery were completed August 15th, and for reception of all other articles August 28th. On the day previously announced, September 7th, at two o'clock, P. M., the Fortieth Industrial Exhibition of the American Institute was formally opened with prayer by the Rev. Dr. Deems, a poem written for and recited on the occasion by Walt. Whitman, and an appropiate address by Hon. E. G. Squier. For the first time in the history of our exhibitions machinery was in motion at the opening.

Even on the opening day the exhibition of our national industries was well worth seeing, but it required the lapse of several days before it could be seen in all its attractiveness. Then it was pronounced by visitors far superior to any preceding exhibition in all essential points, whether in the number, the beauty, the utility, or the novelty of its exhibits, the roominess and convenience of the circling avenues and approaches, or the fine effect of the decorations, the great fountain and other artistic embellishments. To add to the attractions a large orchestra discoursed excellent music.

The proper limits of this report necessarily preclude even a summary of the many remarkable and useful inventions that were exhibited. But some of these novelties are of such extraordinary merit that the Board of Managers cannot avoid briefly mentioning them. One of these is what is termed "The Sand Blast," a blast of steam or air charged from a feeder with sand impelled upon the substance to be operated on, and cutting it away in simple or intricate patterns to any desired depth in such parts as are not protected by rubber or other elastic material. Thus wood, glass, iron, steel, stone, and even the diamond itself, was, by actual test at this exhibition, shown to be incapable of withstanding the force of the sand blast. The revolutions this discovery will create in architecture, in mining, in wood, and stone and glass cutting, and in the iron and other trades, it is impossible, at present, to estimate. It is one of those wonderful inventions whose greatest capacities will develop with time and occasion. To its inventor the great medal of honor of the institute has been awarded. Another very remarkable invention is an apparatus and process for compressing wood into most beautiful patterns, in the highest relief, fully equaling and even tending to excel the very finest carving. In the points of durability and cheapness of production it promises to leave the latter very far behind. Another is the great Induction Coil, made by Ritchie, of Boston, capable of throwing a twenty inch spark of electricity, and reputed to be the most powerful coil in the world. Another is the Great Electro-Magnet, also reputed unequaled in this or any other country. Another, a most ingeniously constructed machine for the setting of bristles in brush frames with the firmness of a screw, turning out the finished brushes more rapidly, while rendering them more durable than by any other process. The improved printing presses from Mr. Campbell and Messrs. Hoe & Co., the centrifugal pump, and many other surprising novelties exhibited, must be passed over. But before turning to other branches of this report, it may be well to say that the processes of industry, as well as its products, presented several very attractive features, not the least important and interesting of which was the modeling in clay of Peter Cooper and other eminent persons from life by Miss Vinnie Ream.

The entries of articles for exhibition in each department were:

First department	100
Second department	335
Third department	141
Fourth department	140
Fifth department	226
Sixth department	129
Seventh department	157
Total	1,328

The entries, however, do not at all represent the number of single articles, as many as twenty of which classified in the same group, were in many cases embraced in a single entry. All of these articles were of special value as illustrating our national progress in industrial arts. The northern, southern, eastern, middle, and far western States were all represented at this exhibition, and it is a source of gratification to this Board that the exhibition was so truly national as to include several highly creditable exhibits from California.

Under the new rules of adjudication, every article in the exhibition was judged upon its merits, and this system seems not only just to the public, but also to have given general satisfaction to the exhibitors. The judges engaged in this important duty were gentlemen pre-eminent for their ability and thorough knowledge of the subjects which they investigated. To these gentlemen, who performed their arduous duties without renumeration, the Board of Managers tender their grateful thanks.

The exhibition continued open for fifty-one days, closing as per announcement on the evening of November fourth with an address by Dr. James Knight, chairman of the Board, and the announcement of money awards for perishable products.

During its continuance it was visited by fully 600,000 persons. Among the visitors were many persons of eminent distinction in our own and other lands, and every effort was made by the Board and its officers to render their visits enjoyable. It was especially gratifying to them to offer the hospitalities of the Institute to Mr. Hosokarroo Jungero, the Japanese commissioner of agriculture, and suite, and there is no doubt that the results of his intelligent observation of the industries of America, as seen during his visit to our national exhibition, will largely benefit and develop his own interesting country, and increase commercial intercourse and trade between the two nations.

The receipts and expenditures have been as follows:

RECEIPTS.

Total receipts at the doors, including coupon, mechanics, excursion, hotel and school tickets	$73,998 65
From entry fees	5,265 00
Rent of restaurant stands and privileges	7,485 40
Third avenue railroad company	500 00
Gas consumed by exhibitors	119 75
Sales of old tickets	12 05
	$87,380 85
Less one day's receipts given to the sufferers by the Chicago fire	2,127 75
	$85,253 10

EXPENDITURES.

Committee on Location.			
Rent of rink and two lots		$8,500 00	
Committee on Carpenters' Work and Building.			
Building	$3,150 00		
Architect's plans	100 00		
Roofing	715 64		
Lumber, sashes, frames, etc.	1,289 83		
Water closets, drain pipe, laying, etc.	168 60		
Whitewashing, kalsomining and painting	907 11		
Glazing	120 70		
Hardware	265 21		
Carpenters' work, pay rolls	1,414 00		
		8,131 09	
Committee on Police and Firemen.			
Meals for police and firemen		1,109 43	
Committee on Light.			
Gas and carburetting	$4,023 18		
Sun lights, use of	841 50		
Naphtha for outside light	54 30		
Gasfitting	1,495 74		
Plumbing work connected with gas test	70 58		
		6,485 30	
Carried forward		$24,225 82	$85,253 10

Brought forward		$24,225 82	$85,253 10
Committee on Music.			
Music afternoons and evenings		3,468 00	
Committee on Decorations.			
Painting, decorating, covering tables, etc.		982 51	
Committee on Printing and Advertising.			
Printing circulars, tickets, blanks, posters, etc.	$4,701 36		
Advertising	1,762 20		
Posting bills, banners	2,883 55		
Stationery, postage stamps, etc.	335 39		
Certificate for judges' reports	205 00		
Clerk hire and labor	451 27		
		10,338 77	
Committee on Finance and Tickets.			
Ticket sellers and receivers		958 00	
Committee on Steam Power and Machinery.			
Steam fitting, setting boilers, water pipes, water, etc.	$3,076 57		
Fuel	2,614 54		
Tubes and thermometers connected with boiler test	158 00		
Engineers, firemen and laborers	3,707 90		
		9,521 01	
Superintendent of Exhibition.			
Salary in part		1,166 67	
Clerks, Floor Clerks and Laborers.			
Pay rolls		4,938 99	
Committee on Refreshments.			
Refreshments for managers, judges and guests, including Japanese commissioners		2,973 93	
Carried forward		$58,573 70	$85,253 10

Brought forward		$58,573 70	$85,253 10
Poet and Orator.			
Expenses of		181 69	
Horticultural Department.			
Premiums in money		747 00	
Miscellaneous.			
Experiments, sand blast	$52 68		
Fixing room for photometer test	13 95		
Expenses modeling in clay, etc.	150 00		
Badges	43 16		
Insurance	201 00		
Spittoons	20 00		
Watering street	15 00		
Signs	46 70		
Feather dusters	24 25		
Appropriation for workman injured at the exhibition	25 00		
Cartage, express charges and petty expenditures	351 38		
		943 12	
			60,445 51
			$24,807 59
Paid treasurer of American Institute			24,000 00
Balance in bank			$807 59

In addition to the above expenses		$60,445 51
The Institute has paid the following amounts on account of the fair:		
Salary of the superintendent of exhibition	$1,833 33	
Rent of four lots on Second avenue, between Sixty-third and Sixty-fourth streets	1,000 00	
Hire of the Allen boiler	300 00	
Purchase of four sun lights	450 00	
		3,583 33
Total		$64,028 84

In making up the account it is manifestly proper to add to the net receipts of money the value of other assets purchased this year by the board and available for future exhibitions.

The receipts will then stand as follows:

Building on Third avenue, extension of machinery department on Second avenue, fencing, etc.	$6,000 00
Gas fitting and new gas brackets	600 00
Steam fittings	1,500 00
Decorations, good for next year	300 00
Total	$8,400 00

Which, added to the net receipts of money, makes the total profit to the Institute from the exhibition equal to $29,624.26. There is still, however, some outstanding indebtedness, amounting to about $2,500, which will reduce the profit to about $27,124.26.

Besides the receipts above enumerated there were also received during the exhibition:

From five candidates for life membership, $40 each	$200 00
From arrears of fees and dues from members	2,105 00
Total	$2,305 00

A very thorough and satisfactory test was made of the comparative economic value of the steam boilers exhibited. This was done by agreement of the exhibitors themselves, and the mode adopted for the test at the suggestion of the judges was different from any ever before attempted in any country.

The report upon this novel test will be presented to the Institute when completed.

The judges' reports have all been carefully classified by the several department committees and confirmed by the necessary majority of the Board of Managers.

Great as has been the success of this exhibition, the management feel confident that the contemplated National Industrial Exhibition of 1872 will be still more pecuniarily successful.

In closing their report the Board desire to impress upon the Institute the necessity of securing without delay a suitable place for future industrial exhibitions; and they would also suggest to their successors in management the importance of issuing the usual official announcement for the next exhibition at the very earliest possible moment, so that sufficient time to manufacture and other preparation may be given to all our skilled countrymen who may desire to exhibit in 1872.

All of which is respectfully submitted.

JAMES KNIGHT.	WALTER SHRIVER.
J. GROSHON HERRIOT.	JAMES H. SACKETT.
GEORGE TIMPSON.	C. McK. LEOSER.
GEORGE PEYTON.	CHARLES E. BURD.
CHARLES H. CLAYTON.	WILLIAM COLLINS.
CHAS. WAGER HULL.	A. M. EAGLESON.
NATHAN C. ELY.	W. H. BUTLER.
CHARLES A. COOK.	EDWARD WALKER.
STEVENSON TOWLE.	HENRY H. ROGERS.
WILLIAM BURDON.	J. TRUMBULL SMITH.
E. S. DICKINSON.	JAMES B. YOUNG.
GEORGE WHITFIELD.	THOMAS RUTTER.

New York, *January* 4, 1872.

CATALOGUE

OF

ARTICLES IN THE FORTIETH ANNUAL EXHIBITION.

I.—DEPARTMENT OF FINE ARTS AND EDUCATION.

Under the direction of George Peyton, Edward Walker, Charles H. Clayton.

GROUP 1.

Paintings on canvas, glass, and other surfaces; Pastels, Cartoons, Miniatures.

260. Oil Paintings, portraits, pastels, etc. A. Harcq, 806 Broadway.
668. Oil Paintings. H. Wood, Jr., 639 Broadway.

GROUP 2.

Engravings, Lithographs, Chromo-Lithographs, Chemical Etchings, plain and colored Enamel Work. Designs and Drawings relating to Architecture, Landscape Gardening, Mechanical and Civil Engineering.

267. Engravings. William Roberts, 36 Beekman street.
660. Engravings and Monogram Designs. H. Tremper & Co., 62 Liberty street.
603. Engravings, wood. Edward Sears, 48 Beekman street.
680. Engravings, wood. Engraving class, Cooper Union.
1313. Wood Engravings, specimens of. Winham & Arnold, 14 Ann street.
616. Monograms in water colors. Charles D. Wells, 47 and 49 Worth street.
1302. Monograms, Wedding Cards, etc., framed. Gavit & Co., Albany, N. Y.
671. Lithographic Portraits, steel plate cards, and steel plate portraits. Thomas Bonar, 97 Nassau street.
652. Chemical Etchings on Glass, in connection with Gilding and Painting. Otto Stietz, 155 Centre street.
454. Chromos. L. Prang & Co., Boston, Mass.
547. Crayons. Frank M. Senior, Sun building, N. Y.
511. Drawings, framed, Mining, Mechanical and Metallurgical. Students of Columbia College School of Mines, Forty-ninth street and Fourth avenue.
810. Drawing, colored. Russell Dart, Glenham, Dutchess county, N. Y.
45. Embroidered Work: "The Last Supper." Mrs. J. R. Houghton, 105 East One Hundred and Fifteenth street.
1542. Embroidered Work Picture. Mrs. James Gopsill, Jersey City.
229. Embossed Glass. David N. Smith & Bro., 1366 and 1368 Broadway.

GROUP 3.

Photographs, plain and colored, Daguerreotypes, Ambrotypes. All other impressions by the action of light.

668. Photographs. H. Wood, Jr., 639 Broadway.
442. Photographs. Theodore Gubelman, 79 Newark avenue, Jersey City, N. J.
814. Photographs. W. Kurtz, 872 Broadway.
696. Photographs. J. Gurney & Son, 108 Fifth avenue.
936. Photographs. C. D. Fredricks & Co., 587 Broadway.
500. Photographs. G. F. E. Pearsall, corner Tillary and Fulton streets, Brooklyn, L. I.
471. Photographs. John O'Neil, 949 Broadway.
825. Photographs. W. Kurtz, 872 Broadway.
833. Photographs. William R. Howell, 867 and 869 Broadway.
278. Photographic Views. Silas A. Holmes, 596 Broadway.
483. Photographs and Photo-engravings. Rockwood & Co., 845 Broadway.
631. Photographic Goods. Scovill Manufacturing Company, 4 Beekman street.
809. Albert-types, or photographs in printing ink. Edward Bierstadt, superintendent, 932 Broadway.
817. Crayon Photographs. W. Kurtz, 872 Broadway.
815. Crayon Drawings. W. Kurtz, 872 Broadway.
730. Daguerreotype Pictures. Henry R. Meade, 242 West Thirty-fifth street.
284. Stereoscopic Views. Peter F. Weil, 643 Broadway.
816. Porcelain Miniatures. W. Kurtz, 872 Broadway.

GROUP 4.

Sculpture, Cameos, Intaglios, Medals, Medallions, Reliefs, Embossed Work, Fine Castings in Bronze, Zinc, and other metals.

693. Statuary, 24 groups. John Rogers, 212 Fifth avenue.
697. Sculpture and Modeling in Clay. Miss Vinnie Ream, Washington, D. C.
759. Bas-relief, marble. C. L. Maurer, 414 Bleecker street.
1539. Bronze Figures. Maurice J. Power, 218 East Twenty-fifth street.
429. Artistic Designs in Silver. Tiffany & Co., New York.
283. Photo-relievos and Illuminated Mirrors. Sidney S. Norton, 39 Dey street.
820. Plaster Casts and Bronzes. Edward Kemeys, 70 Irving place.
1522. Specimen of cutting hard substances by sand-blast process. B. C. Tilghman 1119 Girard avenue, Philadelphia.

GROUP 5.

Musical Instruments—Pianos, Harps, Organs, Melodeons. Portable Instruments used in bands and concerts.

811. Upright Grand Piano. Edward Fischer, 1182 Broadway.
687. Instructor, self, for the piano. Cornelius Mahoney, 305 West Twenty-eighth street.

GROUP 6.

Specimens of Printing and Bookbinding, Books, Stationery, Ornamental Penmanship, Globes, Maps, Charts, and all apparatus for instructing in science. Tables and Machines for calculations.

962. Correspondences of Numbers. Jacob Brinckerhoff, 710 Broadway.
819. Panoramic School Apparatus. Jeffers, Beecher & Jeffers, 14 Bond street.
264. Printing, fine. James Sutton & Co., 23 Liberty street.
89. Printing, fancy. C. H. Jones, 114 Fulton street.

1147. Printing, Zebra, examples of. Edward S. Willson, 822 Arch street, Philadelphia, Pa.
242. Printing and Lithographing. Ames & Van Campen, 59 Duane street.
477. Electrotype and Stereotype Plates and Pictures. Actinic Engraving Co., 113 Liberty street.
228. The Hub and N. Y. Coachmakers' Magazine. Valentine & Co., 88 Chambers street.
840. Saturday New Yorker. Martell & Co., 2279 Third avenue.
683. Binding, Printed Books. E. Walker's Sons, 55 Dey street.
207. Blank Books. Slote & Janes, 93 Fulton street.
1548. Blank Books. McGee & Reynolds, 60 Liberty street.
1736. Books. G. P. Putnam, corner of Fourth avenue and Twenty-third street
1574. Books. George Sayres, Jamaica, L. I.
438. Account Books, spring back. Francis & Loutrel, 45 Maiden lane.
241. Lead Pencils. The Joseph Dixon Crucible Co., Jersey City, N. J.
286. Lead Pencils, American. American Lead Pencil Co., 483 and 485 Broadway
418. Blotting Paper and Writing Book, combined cover. Philip F. Van Everen, 191 Fulton street.
417. Book Slate and Blackboards, Silicate. N. Y. Silicate Book Slate Co., 191 Fulton street.
293. Pencils, Self-sharpening; Self-supplying Penholders and Ink-extracting Crayons. B. L. Goulding, 6 State street.
1106. Envelope, Congress-tie. E. C. Bridgman, 5 Barclay street.
232. Envelope, Document Box. Jacob T. Cammeyer, 36 Beekman street.
440. Letter Writers, Manifold; Diaries and Daily Journals. Francis & Loutrel, 45 Maiden lane.
588. Writing Books, Printed, Manifold. Lebbens H. Rogers & Co., 61 William street.
291. Scrap-Book and Adhesive Letter File, Shipman's. Asa L. Shipman & Sons, 25 Chambers street.
713. Dampener, Revolving Letter-Book. J. Wesley Edmonds, 261 West street.
633. Book Cover, Adjustable. P. F. Van Everen, 191 Fulton street.
294. Planetarium. Vincent S. Worth, 84 Cumberland street, Brooklyn, N. Y.
271. Tellurian, Long's. Marshall Long, 226 East Seventy-ninth street.
735. Numbers for Library Books, Perforated Self-sealing. Philip F. Van Everen, 191 Fulton street.
462. Penmanship, Lincoln Memorial. Samuel Taylor, 81 Jefferson street, Brooklyn.
263. Penmanship, Ornamental and Engrossing. D. T. Ames, 756 Broadway.
457. Drawing Instruments. Benoit & Wood, 148 Fulton street.
64. Drawing Materials. Keuffel & Esser, 116 Fulton street.
27. Drawing Board. Alonzo Hitchcock, 845 Eighth avenue.
94. Album, Postage Stamp. J. W. Scott, 75 Nassau street.
812. Business Directory, Goulding's. Lawrence G. Goulding, 132 Nassau street.
776. Labels, Colored Embossed. Robert Sneider, 37 John street.

Group 7.

Philosophical Instruments, Mathematical and Measuring Instruments, Dials, Chronometers, Watches and Clocks, Telescopes, Microscopes, Lenses, Cameras, and other optical instruments, including Stereoscopes, Spectacles and Opera Glasses.

674. Philosophical Instruments. Guiseppe Tagliabue, 302 Pearl street.
434. Philosophical and Mathematical Apparatus. Chas. B. Kleine, 217 Centre street.

441. Induction Apparatus, Electrodes, Electric Machines, Batteries, etc. Curt. W. Meyer, Cooper Union, N. Y.
916. Induction Coil. Stevens Institute of Technology, Hoboken, N. J.
1747. Geslier Tubes. Stevens Institute of Technology, Hoboken, N. J.
296. Physical Glass Instruments. Henry Guth, 299 Bowery.
93. Medicine Dropper, Tweed's. Henry A. Tweed, 18 Park place.
985. Gold and Silver Watches. Howard & Co., 855 Broadway.
790. Watch Movements. John F. Krugler, for the New York Watch Company, 8 Maiden lane.
480. Clocks. Jacob Cohen, 942 Third avenue.
474. Clocks. Mitchell, Vance & Co., 597 Broadway.
808. Clocks, Tower. Stevens, Hodgens & Co., 5 Cortlandt street.
281. Clocks, Electric and Patrie. Vitalis Himmer, 55 Stanton street.
249. Time Detectors, Watchman's. Imhaeuser & Co., 45 New street.
67. Microscopes and Microscopic Accessories. Thomas H. McAllister, 49 Nassau street.
66. Stereopticons, Dissolving View Apparatus, Microscopes and Microscopic Accessories. Thomas H. McAllister, 49 Nassau street.
435. Photographic Apparatus, Camera Boxes. Otto Loehr, 131 and 133 Mercer street.

II.—DEPARTMENT OF THE DWELLING.

Under the direction of Alexander M. Eagleson, George Whitfield, Charles A. Cook.

GROUP 1.

Apparatus for Warming, Cooling, and Ventilating Rooms. Cooking Stoves, Ranges and Refrigerators, Water Filters and Coolers. Apparatus for Illumination—Ornamental Lamps, Chandeliers, and Gas Fixtures.

372. Cook Stove, Golden City. George Starrett, 229 Water street.
371. Cook Stove, Medallion. George Starrett, 229 Water street.
216. Cooking Stoves. Fuller, Warren & Co., 236 Water street.
421. Cook Stoves. A. Ingraham & Co., 238 Water street.
347. Stoves, Heating and Cooking. N. L. Ely & Ramsay, 207 Water street.
645. Stove, Superb Parlor. Burtis, Graff & Rice, 206 Water street.
218. Stove, Stewart Parlor. Fuller, Warren & Co., 236 Water street.
423. Stoves, Parlor. A. Ingraham & Co., 238 Water street.
375. Stove, Emblem Heating. George Starrett, 229 Water street.
374. Stove, Winter-proof Heating. George Starratt, 229 Water street.
53. Stove, Juniata Heating. A. F. Kibbe, 256 Water street.
217. Stove, Keepside Burner. Fuller, Warren & Co., 236 Water street.
458. Stove, Vapor. William A. Mountcastle, 708 Broadway.
406. Stove, Kerosene Oil, "Tom Thumb." S. A. H. Marks & Co., 28 Barclay street.
84. Stoves and Fixtures. National Stove Works, 239 Water street.
643. Range, Walker. Burtis, Graff & Rice, 206 Water street.
214. Ranges. Fuller, Warren & Co., 236 Water street.
536. Range, Magee Improved. John Q. A. Butler & Co., 92 Beekman street.
549. Range, Magee Portable. John Q. A. Butler & Co., 92 Beekman street.
370. Range, Portable. George Starrett, 229 Water street.
301. Range, Elevated Oven, and Cast-iron Range setting. Barry & Lane, 985 Third avenue.

223. Range, Boynton's Elevated Oven, No. 9. Richardson, Boynton & Co., 234 Water street.
644. Range, Empire Heating. Burtis, Graff & Rice, 206 Water street.
226. Range, Cabinet or Stove, No. 9. Richardson, Boynton & Co., 234 Water street.
224. Range, American Kitchen, Plain Front. Richardson, Boynton & Co., 234 Water street.
369. Ranges, Single and Double Oven Palace. George Starrett, 229 Water street.
672. Range, French Cooking, and Utensils. Bramhall, Deane & Co., 247 Water street.
422. Furnace. A. Ingraham & Co., 238 Water street.
215. Furnaces. Fuller, Warren & Co., 236 Water street.
227. Furnace, Boynton's Improved Hot Air, No. 14. Richardson, Boynton & Co., 234 Water street.
452. Furnace, Hot Air. Alexander M. Lesley, 605 Sixth avenue.
534. Furnace, Littlefield's Base-burning. John Q. A. Butler & Co., 92 Beekman street.
646. Furnace, Burtis' Base-burning. Burtis, Graff & Rice, 206 Water street.
222. Furnace, Portable Salamander, No. 36. Richardson, Boynton & Co., 234 Water street.
925. Furnace, Chadwick & Cozard's Portable Kitchen. James C. Harriott, 153 Broadway.
447. Furnace, Portable, Moist Warm Air. Hyslop Whittingham, 206 and 208 E. Twenty-ninth street.
448. Furnace, Moist Warm Air. Hyslop Whittingham, 206 and 208 E. Twenty-ninth street.
535. Furnace, Walker Double Dome. John Q. A. Butler, 92 Beekman street.
376. Heater, Self-feeding Parlor. George Starrett, 229 Water street.
373. Heater, Plain Parlor. George Starrett, 229 Water street.
225. Heater, New Baltimore Fireplace. Richardson, Boynton & Co., 234 Water street.
52. Heater, Sunnyside Fireplace. A. F. Kibbe, 256 Water street.
4. Heaters, Fireplace. William C. Lester, 1279 Broadway.
647. Heater, Burtis' Fireplace. Burtis, Graff & Rice, 206 Water street.
276. Heater, Fireplace. John M. Thatcher, 602 Broadway.
533. Heater, Improved Baltimore Fireplace. John Q. A. Butler, 92 Beekman street.
277. Elbow for base of Hot-air Flues. John M. Thatcher, 602 Broadway.
268. Elbow, Corrugated Stovepipe. H. R. Kidd, 45 Cliff street.
95. Ventilator, Portable Window. Underhill & Co., 95 Duane street.
91. Register, Gas Heating. D. A. T. Gale, Poughkeepsie, N. Y.
650. Refrigerator, Market size. Joseph H. Fisher, Chicago, Ill.
290. Refrigerator, Fisher's Patent. H. C. Van Schaack, Jr., Chicago, Ill.
34. Refrigerator, Ice King. H. M. Diggins, Cincinnati, Ohio.
524. Refrigerator. John Savery's Sons, 97 Beekman street, N. Y.
449. Refrigerator, Family. Alexander M. Lesley, 605 Sixth avenue.
450. Refrigerator, Cabinet. Alexander M. Lesley, 605 Sixth avenue.
473. Refrigerators. George A. Banta, 1304 Broadway.
1322. Refrigerator and Water Cooler Combined. Anderson & Bogardus, Yonkers, N. Y.
41. Cooler, Camphbell's Air-tight Metallic Croton Water. John W. Campbell, Sr., 131 West Sixteenth street.

451. Coolers, Zero. Alexander M. Lesley, 605 Sixth avenue
915. Filter, Water. Parrot & McCauley, Morristown, N. J.
637. Chandeliers and Reflectors. Buckley & Cothren, 189 Chatham street.
497. Chandeliers and Reflectors. U. S. Reflector Company, 611 Broadway.
2. Lamp, St. Germain. C. F. A. Hinrichs, 29 and 33 Park place.
1305. Fireproof Mica Lamp Chimney, Safety Lamp, Chimney Cleaner, and Safety Lamp Attachment. Vansyckle & Co., 21 Cortlandt street.
627. Safety Lamp and Student Lamp, Sanford's American. Hawkins & Tunison, 48 Cortlandt street.
219. Lantern and Hand Lamps. R. E. Dietz, 54 Fulton street.
684. Gas Fixtures. Joshua Kidd, 18 Dey street.
475. Gas Fixtures and Bronzes. Mitchell, Vance & Co., 597 Broadway.
1400. Gas Burner, Self-closing. George E. Smith, 159 East Thirty-eighth street.
832. Lamps and Prismatic Lantern. Richard Douglass & Co., 97 Chambers street.
1734. Chandelier. Nichol & Davidson, 686 Broadway.
841. Electric Gas Lighting Burner. B. F. & L. W. Rogers, New York city.

Group 2.

Kitchen Ware and Utensils; Machines and Implements for Washing, Wringing and Drying Clothes; Mangles, Iron and Fluting Machines, etc.

97. Knife and Fork Scourer. Tyler P. Shaw, Jr., 13 Washington square.
14. Egg-Beater, Mackay's National. M. W. Robinson, 79 Chambers street
270. Boiler, American. Henry R. Kidd, 28 Barclay street.
1745. Compartment Kettle. Mrs. Carrie Jessup, New Haven, Conn.
91. Griddle, The Reversible. Chase & Foot, 82 Chambers street.
59. Mop, Keystone Self-wringing. H. H. Wessel, 21 Jane street.
55. Mop and Brush Holder, Combined. E. J. Emmons, 14 Charlton street.
426. Sifter, Coal and Ash, Weaver's Patent. William Liddell, 457 Broadway.
712. Sifter, Flour. Robert I. Powell & Co., 116 and 118 Fulton street, Brooklyn.
20. Sieve, Metallic. Charles T. Sutton, 21 John street.
75. Potato Parer and Scraper, Combined. Theodore Searing, S. Norwalk, Conn.
68. Tinware, Japanned, for household use. Benhams & Stoutenborough, 270 Pearl street.
250. Tin and Japanned Ware. Musgrove & Son, 348 West Forty-first street.
239. Tin, Polished and Enameled Wrought-iron French Ware. Lalance & Grosjean Manufacturing Company, 89 Beekman street.
715. Blacking Case Library Step Combined, and Children's Folding Commode. Elder & Brown, 450 West street.
21. Blacking Cases, for cleaning shoes. Mobley, Skidmore & Co., 66 Boerum street, Brooklyn.
355. Fruit Jars, Glass, and Fruit preserved by same. John L. Mason, 17 Dey street.
354. Nurse Bottles. John L. Mason, 17 Dey street.
62. Fruit Preserver, Payne's. Chase & Foot, 82 Chambers street.
405. Coffee Filter, with Silvered Strainer, Sargeant's French. E. R. Sargeant. Boonton, N. J.
57. Coffee Percolator. Hiram Young, 24 John street.
282. Meat and Vegetable Chopper, American. D. A. Newton & Co., 20 Cortlandt street.
259. Meat and Vegetable Chopper, Excelsior. Artisan Manufacturing Company, 136 West Thirty-eighth street.

651. House Furnishing Goods. New York Manufacturing Company, 21 Cortlandt street.
476. Raisin-seeder, Locke's. George H. Mellen, 752 Third avenue.
678. Kettle, Saul's Odorless. D. G. Stranahan & Co., 544 Nostrand avenue, Brooklyn.
410. Presses, American Rotary and Lever Fruit and Lard. Chase & Foot, 82 Chambers street.
414. Implements, Household, Garrick's. David Heaton & Co., Providence, R. I.
629. Milkman's Signal, Blake's. S. B. Hoffman, Tarrytown, N. Y.
428. Washer, Little. William Manson, 69 Myrtle avenue, Brooklyn.
970. Washing Machine. Thomas L. Robinson, Flushing, L. I.
40. Washing Machine. Assman & Gilmore, Rahway, N. J.
779. Washing Machine. William Kyle, One Hundred and Twenty-fourth street and Harlem river.
407. Washing Machine, "Continental." Southard & Corliss, 55 Beekman street.
465. Washing Machine. C. E. Hartshorn, 119 Walker street.
557. Washing Machine, Hand. Eccentric Laundry Co., 32 Dey street.
563. Washing Machine, Hand or Power. Eccentric Laundry Co., 32 Dey street.
562. Washing Machine, Power. Eccentric Laundry Co., 32 Dey street.
1186. Washing Machine. J. C. Hollenbeck, Chatham Four Corners, N. Y.
821. Washing Machine, Nonpareil. Oakley & Keating, 40 Cortlandt street.
822. Washing Machine, Nonpareil, Power. Oakley & Keating, 40 Cortlandt street.
831. Washing Machine. Joseph Matthias, 349 Pearl street.
1710. Perforated Labor-saving Wash-board. Emory Cummings, 168 Fulton street.
679. Washtubs, Crockery Stationary. Bernard Morahan, 12 First street, South Brooklyn.
69. Wash Boiler, The Annular Self-acting. Moody & Co., 7 Murray street.
793. Wringer, King Clothes. Metropolitan Manufacturing Company, 542 and 544 Broadway.
558. Wringer, Power. Eccentric Laundry Co., 32 Dey street.
559. Wringer, Hand. Eccentric Laundry Co., 32 Dey street.
755. Washer, Boiler and Wringer, Combined. Steuben T. Bacon, 36 Marcella street, Boston.
403. Dryer, Clothes. Benoni S. Brown, 168 Fulton street.
630. Dryer, Clothes. Ackers' Improved. S. B. Hoffman, Tarrytown, N. Y.
626. Holder, Clothes Line. Charles H Sleight, Mount Vernon, N. Y.
87. Holder, Clothes Line. A. A. Weeks, 105 John street.
230. Clothes Bar, Riverside. L. Van Buskirk, 2 Desbrosses street.
494. Ironing Mangle, Portable, and Clothes Wringer, Putnam's. Charles P. Fay, Jr., 33 Platt street.
560. Mangle, Power. Eccentric Laundry Co., 32 Dey street.
561. Mangle, Clothes, Hand or Power, Eccentric Laundry Co., 32 Dey street.
269. Fluting Machine. Henry Cromwell, 28 Barclay street.
823. Fluting Machine, Gas Heating. Edward M. Deey, 37 Union square.
736. Fluting Machine. Mrs. H. H. Cole, 441 West Twenty-third street.
60. Fluting and Smoothing Flat-iron, Combined. Myers Manufacturing Company, 104 John street.
431. Iron, Sad and Stand, Combined. Myers Manufacturing Company, 104 John street.
432. Iron, Sad and Polishing, Combined. Myers Manufacturing Company, 104 John street.

1506. Iron Holders. Wilson, Lockwood, Everett & Co., 51 Murray street.
1307. Ash Sifter, Air-tight. G. W. Rogers, 11 Baxter street.

GROUP 3.

Carpets, Oil Cloths, Matting, Paper Hangings and Tapestry, Window Curtains, Shades and Screens, Encaustic Tiles, and specimens of Ornamental Flooring, Fresco Work and Ornamental Plastering.

453. Carpet and Druggets, Seamless Woven. Atlantic Manufacturing Company, 82 and 84 Worth street.
834. Felt Druggets. Hoyt, Spragues & Co., Franklin street.
634. Paper Hangings. F. Beck & Co., 206 West Twenty-ninth street.
22. Wood Hangings. G. L. Kelty & Co., 722 and 724 Broadway.
550. Curtain Clasp. Martin H. Mosman, Waterbury, Conn.
23. Fringes, Gimps, Cords and Tassels. G. L. Kelty & Co., 722 and 724 Broadway.
698. Shade Fixtures, Patent Buckle. George K. Ryan, 787 Broadway.
780. Shade Fixtures, Window. Moore Bros. & Co., 678 Broadway.
231. Curtain Fixtures, Window. B. Moser, 7 Murray street.
659. Shade Rollers, Window. Stuart Hartshorn, 486 Broadway.
838. Reversible Curtain Fixture. Chas. Eaton, 98 Liberty street.
1780. Window Shade Rollers, Automatic. Wm. B. Bulkley, 330 Gold street, Brooklyn, N. Y.
202. Stair Rods. American Stair Rod Company, 310 Broadway.
170. Floor of Wood, Mosaic. John George Kappes, 614 East Eleventh street.
463. Wood Carpet. National Wood Manufacturing Company, 480 Broadway.
794. Setting Tile, Burnham's New Method of. M. A. Burnham, 165 West Sixteenth street.

GROUP 4.

Furniture, Mirrors, Upholstery, Beds, Bed Springs, Mattresses and Room Conveniences, Secretaries and Ornamental Safes, Ladies' Toilet and Work-Boxes.

636. Bedstead, Walnut. Lang & Nau, 292 and 294 Fulton street, Brooklyn.
81. Bedstead, Secretary. J. F. C. Pickhardt, 169 Bleecker street.
750. Bedstead, Cradle. Moore & Nichols, 379 Pearl street.
275. Bedstead, Walcutt's Sofa. David C. Sturges, Appraisers' Store, Church street.
661. Bed, Improved Sofa, with Spring and Hair Mattresses. Julius Werner, 405 Fourth avenue.
9. Beds, Spring, Fox's Patent. Millville Manufacturing Co., 171 Canal street.
33. Bed, Sofa, Nedham's Patent. W. S. Humphrey, 634 Broadway.
601. Bed, Spring, Rich's Metallic Union. S. C. Keeler, 242 Canal street.
11. Bed, Folding, and Settee, Combined, Case's Patent. Millville Manufacturing Co., 171 Canal street.
1563. Bed Lounge, Office. Julius Werner, 405 Fourth avenue.
274. Bed Bottom, Metallic Spring. S. H. Reeves & Co., 157 Canal street.
455. Bed Bottom, Bolster Spring. Henry Baker, 328 Seventh avenue.
213. Mattresses, Cushions, etc., Elastic Felt. Patent Elastic Felt Co., 95 Duane street.
966. Mattresses, Woven Wire and Hair. John H. Wilcox & Co., 59 Fourth avenue
90. Mattress, Spiral Spring. D. A. T. Gale, Poughkeepsie, N. Y.
769. Interlaced Spring Steel for Beds and Seating. F. B. Crowell, 105 Washington avenue, Brooklyn.
31. Chairs, Folding. New Haven Folding Chair Co., New Haven, Conn.

682. Chair, Folding Parlor and Dining-room. Wm. Gardner, Glen Garden, N. J.
721. Chair, Portable. George Gardner, Clarksville, N. J.
640. Chair, Gilt, in Satin. Lang & Nau, 292 Fulton street, Brooklyn.
255. Chair, Adjustable Iron. Wm. Diack & Co., 435 Third avenue.
262. Chair, Revolving Rocking. Platt C. Ingersoll, Greenpoint, L. I.
72. Chair, Extension Recumbent. Hopkins Thompson, 70 East Broadway.
415. Chair, Baby's. L. O. Colvin, 94 Waverly Place, Newark, N. J.
71. Chair, Extension Recumbent Wheel. Hopkins Thompson, 70 East Broadway.
10. Chair and Step Ladder Combined, Leische's. Millville Manufacturing Co., 171 Canal street.
43. Stool, Store, Earl Lock, Pivot. American Store Stool Co., 25 Howard street.
42. Seat, Counter, Pomeroy's Patent Bracket. American Store Stool Co., 25 Howard street.
1342. Ottomans and Hassocks, in velvet. Mounter & Cooper, 5 Chatham square.
1196. Ottomans, Turkish, and Hassocks. E. G. Gainard, 32 Reade street.
19. Table, Invalid Adjustable Leaf. Chas. T. Sutton, 83 Woodhull street, Brooklyn.
749. Table, Dining, with Sets. John McAdams, 528 Kent avenue, Brooklyn.
461. Table, Extension. Chas. P. Lenz, Poughkeepsie, N. Y.
506. Table, Extension. Bernhard Welteck, 92 Clinton street.
205. Table, Kitchen. Bernhard Welteck, 92 Clinton street.
1311. Furniture, School, Folding—and Reading Desk and Settee combined. National School Furniture Co., 111 and 113 William street.
704. Furniture, Rattan. A. Cummings, 3 Barclay street.
36. Furniture, Chamber, Suite of. E. W. Baxter, 202 and 204 Canal street.
26. Furniture, Parlor and Library. G. L. Kelty & Co., 722 and 724 Broadway.
302. Furniture, Knock-Down (Book-Cases, Writing Desks, Wardrobes, etc.). Gardner Manufacturing Co., 110 Bowery.
80. Suite, Bed-room. B. L. Solomon & Sons, 657 and 659 Broadway.
1333. Folding Cot, Settee, and Table Combined, Bedstead Attachment, Combined Chair and Cane. D. O. Parker, M. A., Liverpool, Nova Scotia.
1332. Folding Cradle, Portable; Folding Nursery Chair, Wash Stand, Camp Stool, Child's High Chair, Lady's Work Table, and Crib Bedstead Attachment. D. O. Parker, M. A., Liverpool, Nova Scotia.
729. Washstand, Inclosed. J. E. C. Pickhardt, 169 Bleecker street.
18. Writing Desk, Portable. Chas. D. Pratt, 41 Maiden lane.
28. Desk and Back Seat, School, "Ne Plus Ultra." Nathaniel Johnson, 490 Hudson street.
619. Furniture, Church. J. & R. Lamb, 59 Carmine street.
648. Pew, Church, and Furniture. Jas. P. Tibbetts, 183 Broadway.
1748. Cottage and Suite of Furniture (in miniature). Joseph F. Stage, 160 East Ninety-second street.
1761. Cradle, American Portable. Mrs. W. R. Evans, New Orleans, La.
1763. Furniture, School. G. W. Hildreth, Lockport, N. Y.
1835. Stool, Piano. Francis Neppert, 390 Canal street.
24. Cornice, Bay Window. G. L. Kelty & Co., 722 and 724 Broadway.
25. Cornice, Telescopic. G. L. Kelty & Co., 722 and 724 Broadway.
287. Cabinet and Pedestal. Herts & Co., 806 Broadway.
639. Easel Portfolio, Walnut and Gilt. Lang & Nau, 292 Fulton street, Brooklyn.
642. Case, Dressing. Lang & Nau, 292 Fulton street, Brooklyn.
641. Commode. Lang & Nau, 292 Fulton street, Brooklyn.

472. Mirrors and Engraved Glasses Silvered by a New Process. Wm. A. Walker, 28 Prince street.
3. Mirror, Adjustable, Scottron's. Samuel R. Scottron, 181 Canal street.
839. Looking Glasses. W. A. Willard, 177 Canal street.
285. Work-Boxes, Ladies', and Albums, in Russia. Paul Liptay, 316 Broome street.
490. Papier Mache Goods, Household Articles. American Papier Mache Goods Co., 29 Barclay street.

GROUP 5.

Table Furniture — Cutlery, Castors, Glass, China, Porcelain, Silver, and other Ware used for holding food and condiments.

382. Cutlery. Meriden Cutlery Company, 49 Chambers street.
1725. Cutlery. Will & Finck, San Francisco, Cal.
618. Knives, Pocket. Northfield Knife Company, 94 Chambers street.
1344. Ice Pitcher, Patent Solid Walled; and Communion Service. Adams, Hallock & Co., 20 John street.
240. Pitcher Stand, Gibson's Tilting. Bogardus, Hasbrouck & Dimon, 59 Murray street.
211. China Ware. E. D. Bassford, Cooper Union.
635. China Ware; Glassware; Machine for Engraving Glass; two large Bronzes. Nicol & Davidson, 686 Broadway.
665. Glassware and Fancy Articles. Jeremiah Quinlan, 136 and 138 William street.
209. Glassware, Engraved. E. D. Bassford, Cooper Union.
602. Glassware, Cut and Engraved. Quinnell, Harris & Co., 48 East Fourteenth street.
1334. Nickel Plated Goods. American Nickel Plating Co., 17 Howard street.
667. Nickel Plated Goods. R. & L. Crooke, foot West Fifteenth street.
244. Nickel Plated Goods. L. L. Smith & Co., 6 Howard street.
468. Nickel Plated Goods. Beardslee Nickel Manufacturing Company, 120 and 122 Wooster street.
464. Plated, Nickel, Silver, Forks and Spoons. Hall, Elton & Co., Wallingford, Conn.
58. Silver-Plated Ware. Hiram Young, 24 John street.
7. Silver-Plated Ware. H. C. Reed, Jr., 1267 Broadway.
210. Silver-Plated Ware, Simpson, Hall, Miller & Co. E. D. Bassford, Cooper Union.
429. Silverware. Tiffany & Co., N. Y.
828. Glass Engraving. Carl Mattoni, 2½ Murray street.

GROUP 6.

Ornaments for the Dwelling-House, excepting those embraced in the First Department, Wax Flowers and Fruit, Ornamental Hair Work, Worsted Embroidery, and Crochet Work. Passe Partout, Picture Frames and Mouldings, Brackets, etc. Billiard Tables, Chessmen, Draught and Backgammon Boards and Tables; all other Contrivances for in-door recreation and amusement.

446. Fountains, Parlor. Wm. S. Carr & Co., 106 and 110 Centre street.
604. Fountains, Parlor, Pitt's, for Perfumed, Colored and Plain Waters. Wm. A. Pitt, with J. W. Fiske, 99 Chambers street.
204. Aquaria, 3. Joseph Bagot, 29 Fulton street.
984. Wax Flowers. Mrs. Mary J. Reed, Ninety-third street, between Second and Third avenues.
74. Wax Flowers. Carrie Flynn, 4 Second street.
73. Wax Flowers. Matilda A. Tingley, Fourth street, near Centre, Plainfield, N. J.

681. Wax Flowers. Mrs. J. W. Evans, 130 East Twelfth street.
710. Wax Flowers, Vase of. Charles S. Mills, 147 East Sixty-first street.
12. Wax Fruit, Vase of. Mrs. A. E. Park, 383 Atlantic avenue, Brooklyn.
29. Easter Morning Cross, with Flowers in Wax. Mrs. O. T. Beidlemann, 50 Willoughby street, Brooklyn.
1733. Wax Flower Baskets. Mrs. M. E. Lynch, 278 Bowery.
409. Wax Flower Materials. Benoit & Wood, 148 Fulton street.
247. Hair, Designs in. Wm. E. Moutoux, 274 Bowery.
63. Hair Pictures. Emil W. Moutoux, 243 Grand street.
243. Glass Shades in Different Styles. Thill & Wapler, 22 Warren street.
86. Black Walnut Fancy Wood Work, Brackets, &c. K. L. Speth, 179 Canal street.
554. Picture and Mirror Frames, Window Cornices. John Nonnenbacher & Co., 16 Pell street.
303. Picture and Looking Glass Frames and Cornices. The Gardner Manufacturing Company, 110 Bowery.
694. Pressed Wood Carvings and Decorations. American Decorative Wood Company, 16 and 18 Chambers street.
469. Billiard Table and Appurtenances. Kavanagh & Decker, corner Canal and Centre streets.
493. Billiard Table and Appurtenances. Phelan & Collender, 738 Broadway.
489. Billiard Table, American, with Patent Bed of Asphalt Compound. Louis A. Grill, 360 Broadway.
38. Toy Blocks, Combination, Swift's. Albert B. Swift, 89 Pierrepont street, Brooklyn.
245. Magical Apparatus, etc. Judd & Lane, 1292 Third avenue.
807. Playing Cards. V. E. Mauger, 110 Reade street.
82. Jumper, Baby, Coldwell's. John H. Coldwell, Poughkeepsie, N. Y.
479. Cages, Bird and Animal. Osborn Manufacturing Company, 79 Bleecker street
83. Cage Mat, Waterproof, Excelsior. Charles Stewart Schenck, 269½ Pearl street
288. Gravel Paper. Singer Gravel Paper Company, 582 Hudson street.
1312. Carvings, Scroll Sawings, and Mouldings. Geo. K. Helldorfer, 20 Pell street.
1320. Japanese Paper Ware. Jennings Brothers, 352 Pearl street.

GROUP 7.

Building accessories and permanent attachments; Doors, Window Sash, Blinds, Mantels, Grates, Stairs, Timber Frames, Cut and Cast Ornaments for the outside of Dwellings, Hand Pumps, Plumbers' work, Water Closet Apparatus and Baths; Bells, Door Springs, Latches, Bolts, Sash Fastenings and Weights, Hinges, Screws, Nails and other Household Hardware. Useful and Ornamental Articles for the Grounds surrounding the Dwelling.

717. Rolling Shutter and Frame. Architectural Iron Works, 624 E. Fourteenth street.
297. Blinds, Wrought-iron Fireproof. Beebe & Redman, 413 E. Fifty-third street.
1751. Wanner's Tubulated Castings for Ceilings and Partitions. Anthony Wanner Paterson, N. J.
1707. Mansard Roof, Fire-proof. J. B. & J. M. Cornell, 139 to 143 Centre street.
212. Blinds, Window. Amos A. Jaqua, 465 Third avenue.
8. Sashes, Blinds and Doors. P. A. Anner & Son, 2374 Third avenue.
754. Sash, Butler's Adjustable. Gavit & Butler, 21 Cortlandt street.
495. Sash Balance, Anderson's. G. Dewitt, Brother & Co., 90 John street.
32. Shelving, Adjustable. American Shelving Co., 21 Cortlandt street.
757. Brick, Light-Colored, for Building. Sayre & Fisher, South Amboy, N. J.

492. Brick, Diamantine Building; and Anchor, for Brick and Stone Walls. A. Hall & Sons, Perth Amboy, N. J.
280. Floor, Fireproof. Niels Poulson, Architectural Iron Works.
170. Mosaic Floor of Wood. John Geo. Kappes, 614 East Eleventh street.
54. Mantels, Marble. J. J. & P. J. Butler, 1218 Third avenue.
419. Mantels, Marble, 3. Patrick H. Slattery, 162 E. Sixty-third street.
551. Mantels, Slate, Pedestal and Tiling. The Penrhyn Slate Co., 40 W. Eighteenth street.
498. Mantels, Slate. Thomas B. Stewart & Co., 605 Sixth avenue.
1553. Sectional Portable House (Model). Andrew Derrom, Paterson, N. J.
988. Earth Closets. Isaac Davega, 1262 Broadway.
79. Earth Closets. Albert Draper, 40 Cortlandt street.
70. Earth Closets. E. W. C. Vandeveer, Elizabeth, N. J.
37. Earth Closet, Wakefield. Wakefield Earth Closet Co., 36 Dey street.
1767. Earth Closet. James Megratten, Wilmington, Del.
1782. Earth Closet, The Standard. Amos A. Jaqua, 465 Third avenue.
1785. Earth Closet. R. B. McDonnell, Wilmington, Del.
483. Commode, Cabinet. Earth Closet Co., 696 Broadway.
485. Commode, Family. Earth Closet Co., 696 Broadway.
481. Commode, Cottage, and Black Walnut Pull-up Commode. Earth Closet Co., 696 Broadway.
484. Cottage and Self-Acting Fixtures. Earth Closet Co., 696 Broadway.
482. Up-stairs Apparatus, Improved. Earth Closet Co., 696 Broadway.
401. Plumbers' Tubular Safety Joints. The Colwells, Shaw & Willard Manufacturing Co., 213 Centre street.
300. Sheet Lead. The Colwells, Shaw & Willard Manufacturing Co., 213 Centre street.
299. Tin-lined Lead Pipe. The Colwells, Shaw & Willard Manufacturing Co., 213 Centre street.
298. Block Tin Pipe and Lead Pipe. The Colwells, Shaw and Willard Manufacturing Co., 213 Centre street.
522. Bells, Electro-magnet Alarm. Edwin Holmes, 7 Murray street.
518. Bell, Electro-magnet Bank Alarm. Edwin Holmes, 7 Murray street.
519. Annunciator, House, Electro-magnet. Edwin Holmes, 7 Murray street.
521. Electro-magnet Protector. Edwin Holmes, 7 Murray street.
520. Annunciator, Hotel, Electro-magnet. Edwin Holmes, 7 Murray street.
517. Burglar-alarm Telegraph. Edwin Holmes, 7 Murray street.
798. Gong. James Gregory, 112 Cannon street.
468. Sash Lock and Window Fastener, Shailer's. Southard & Corlies, 55 Beekman street.
625. Sash Lock, Ventilating. J. C. Rankin, Mount Vernon, N. Y.
675. Sash Lock, Automatic Burglar-proof Window, for weighted sash. Joseph N. Brown, 288 Eighth avenue.
499. Lock, Double Head, for closets, right or left-hand door. William H. Mott, 288 East Eighty-ninth street.
424. Carpet Stretcher. Charles Ruckert, 407 East Twenty-second street.
649. Step-ladders. W. H. Stokes, Cortlandt street.
13. Bronze Trimmings, for houses. Russell & Erwin Manufacturing Co., 45 Chambers street.
487. Bronze Wares, Empire Safety Locks, Hardware and Sash Chains. Whitney & Rogers, 229 Third avenue.

638. Hinges, Union Spring, on frame. Bray & Rice, 20 Cortlandt street.
1347. Blind Fastening, Reed's Improved. Reed & Grundy, Chelsea, Mass.
1195. Faucet, Hydrant and Hose Pipe. Nicholas Hotz, 150 Calyer street, Greenpoint, L. I.
1398. Wrought-iron Beams, Sections of. Cooper, Hewitt & Co., 17 Burling slip.
1395. Improvement for Pocketing Inside Blinds. Jas. M. Hyde, Elizabeth, N. J.
677. Springs, Door and Blind, "Acme." Hyatt & Spencer, 54 Beekman street.
1784. Show-case of Locks, mounted. Yale Lock Manufacturing Co., 1 Barclay street.
65. Spring Door and Gate. Joseph Simpson, Newark, Ohio.
35. Butt's Spiral Spring, Single and Double. Van Wagoner & Williams, 27 Park row.
130. Sash Cord Guide Block. James M. Ford, 367 Bowery.
44. Door Fastener. John P. Frazer, 150 and 152 Broome street.
676. Raw-hide Rope and Cord for Window Sashes. Edward G. Vyse, 50 Grand street, Williamsburgh.
525. Sash and Blind Fastener (Model). August Haye, Morrisania, N. Y.
654. Spring Roller and Window Shade Ventilator, Traveling Double Action Alfred S. Dickinson, 100 Fulton street, Brooklyn.
666. Butt Hinges and Goods, Nickel-Plated. Crooke & Co., Fifteenth street and Eleventh avenue.
669. Tacks, Double-Pointed. Purches Miles, 62 Duane street.
445. Flower Vases. William S. Carr & Co., 106 to 110 Centre street.
695. Garden Vases. Jonathan Moore & Co., 75 Warren street.
253. Fountain in operation and small Conservatory Fountains. Jonathan Moore & Co., 75 Warren street.
459. Ash and Garbage Box. G. F. Godley, corner Eighty-sixth street and Third avenue.
751. Metallic House. B. J. La Mothe, 201 East Sixteenth street.
491. Boundary Monuments to designate Street Crossings and Land Boundaries. A. Hall & Sons, Perth Amboy, N. J.

III. DEPARTMENT OF DRESS AND HANDICRAFT.

Under the direction of Charles E. Burd, James H. Sackett, James B. Young.

Group 1.

Apparel for Ladies—Hats, Bonnets, Hair Work, Dresses, Hose, Boots and Shoes, Gloves, Shawls, Cloaks, Mantillas, Manufactured Furs.

818. Millinery Goods. Mary Ann Jackson, 150 Atlantic street, Brooklyn.
722. Bonnets. Miss Esther P. McCann, 1482 Third avenue.
960. Hair Work, Human, with Model of Ladies' Hair-Dressing. Robert T. Bellchambers, 317 Sixth avenue.
39. Garter, Duplex Ventilated. George Betts, 543 Broadway.
30. Stocking Supporter. Rachel Eberle, 88 Fourth avenue.
404. Stocking Supporter and Skeleton Waist Combined. Mrs. Augusta M. Stiger, 213 De Kalb avenue, Brooklyn.
77. Shoes, Machine-sewed. Edwin C. Burt, 27 Park row.
248. Boots and Shoes, Hand-sewed. Francis O'Neill, 1187 and 1189 Broadway.
92. Corsets, Yellow Moire. Miss Catherine Donnigan, 821 Broadway.
344. Corsets and Skirts, "Glove-Fitting." Thompson, Langdon & Co., 391 Broadway.
466. Skirts, Seamless. Seamless Clothing Manufacturing Company, 472 and 474 Broome street.

598. Millinery. Isaac Binns, 647 Broadway.
15. Dress Protector or Diaper Cover. Eureka Diaper Company, 532 Broadway.
289. Combs, Fancy. George Cudlipp, 16 Lispenard street.
257. Rubber Goods, Assortment of. Joseph M. Ward, 905 Broadway.
251. Kid Glove Dyeing, Cleansing, and Refinishing. Fortune Hegle, 579 Broadway.
690. Whalebone. Joseph F. Tobin, 82 Duane street.
1192. Velvet Cloak. Bradbury Brothers, 312 Bowery.
1193. Silk Suit. Bradbury Brothers, 312 Bowery.
1379. Metallic Boot and Shoe Heels, Bray's. Bray & Rice, 20 Cortlandt street.
1726. Fancy Combs and Wristlets. Elias Brown & Co., 52 Franklin street.
837. Silk Lace Nets for the Hair. A. G. Jennings, 49 Barclay street.
1547. Embroideries, Cotton and Silk. James Bailey, 298 Fulton street, Brooklyn, N. Y.
1507. Elastics, Endless. Wm. Barton, Providence, R. I.
1775. Hats, Opera. Antonio Barti, 211 Van Brunt street, Brooklyn, N. Y.

GROUP 2.

Apparel for Gentlemen—Hats, Caps, Wigs, Toupees; etc., Coats, Vests, Pantaloons, Shoes, Boots, Gloves, Overcoats, Cloaks, Under Garments, Furs.

945. Clothing, Boys' and Children's. Brokaw Bros., 28 to 34 Fourth avenue.
688. Boots and Shoes, Gentlemen's Finest Stitched. C. Benkert & Sons, 705 Broadway.
799. Boots and Shoes. John Ready, 298 Broadway.
1. Boots and Shoes. John L. Watkins, 114 Fulton street.
85. Shirts and Collars, Dress. Alanson P. Brainerd, 64 Bowery.
444. Shirts, Collars and Cuffs. John R. Crum, 373 Bleecker street.
813. Shirts, Collars and Hosiery. Van Derlip & Taylor, 96 Bowery.
653. Shirts and Furnishing Goods. Charles W. French, 569 Broadway.
796. Furnishing Goods, Gents'. Lord & Taylor, Broadway and Twentieth street.
188. Shirts, Club-House; Flannel Shirts and Perforated Buckskin Under Garments. Andrus Bros., 55 to 61 Hudson street.
203. Suspenders. National Suspender Company, 83 and 85 Worth street.
443. Laundry Work. Benjamin F. Howe, 404 and 406 Bleecker street.
1561. Wigs and Hair Work. Wm. Jay Barker, 1275 Broadway.

GROUP 3.

Cloths of Wool, Cotton and Silk; all other fabrics, woven, knit, or felted, excepting Carpets, Ribbon, Cord, Tassels, Thread, Buttons, Pins, and other materials used in combination with cloth for dresses.

49. Muslin de Laines and Reps. Gardner, Brewer & Co., 62 Leonard street.
50. Tickings, Cotton Flannels, etc. Gardner, Brewer & Co., 62 Leonard street.
48. Cottons, Fine Bleached. Gardner, Brewer & Co., 62 Leonard street.
46. Linen, Crashes and Grain Bags. Gardner, Brewer & Co., 62 Leonard street.
47. Beavers, Chinchillas and Cassimeres. Gardner, Brewer & Co., 62 Leonard street.
624. Silks, American Manufactured. John N. Stearns, 213 East Forty-second street.
420. Silk Goods. B. B. Tilt, Paterson, N. J.
628. Silk Labels, Woven. Freidhof & Michna, 113 Allen street.
265. Coat Labels, Woven. Krause & Wimpfheimer, 469 Broome street.

617. Crochet Work—Made in six weeks by a girl totally blind. Mary Mullen, 567 Seventh avenue.
78. Hosiery, "Waltham." Wheelwright, Anderson & Co., 90 Franklin street.
261. Hosiery and Underwear. J. S. and E. Wright & Co., 92 and 94 Franklin street.
599. Dress Patterns, Trimmed. Mme. A. Duval, 762 Broadway.
781. Linen Threads and Cotton Twines. Demarest & Joralemon, 100 Barclay street.
1586. Cotton Twines. Allentown Mills, Allentown, N. J.
1181. Pocket Cutlery. Smith & Clark, Bronxville, N. Y.

Group 4.

Hand Implements used in manufacturing Dress—Sewing Machines, Knitting Machines, Needles, Thimbles, Scissors, Pocket Knives, Razors, etc.

100. Sewing Machine, "Carpenter," Smooth-Surface Feed. Mary P. Carpenter, 95 and 97 Liberty street.
98. Sewing Machine, Guinness. Guinness Sewing Machine Company, Stamford, Conn.
467. Sewing Machine, "Chronometer." Thomas A. Macauley, N. Y. city.
538. Sewing Machine, The Beckwith. Barlow & Son, 26 West Broadway.
402. Sewing Machines. Wilson Sewing Machine Company, 707 Broadway.
383. Sewing Machines. William H. Nicols, 712 Broadway.
6. Sewing Machines. Manhattan Silent Sewing Machine Company, 645 Broadway.
623. Sewing Machines, Hand. Eastman, Smith & Co., 745 Broadway.
5. Sewing Machine Attachments. New York Sewing Machine Attachment Company, 645 Broadway.
437. Sewing Machine Attachments. Henry M. Hall, 319 East Twenty-seventh street.
824. Sewing Machine, Hill & Morris. Hill & Morris, 17 Park place.
656. Sewing Machine Needle, Self-Threading and Self-Setting. Mary P. Carpenter, 95 Liberty street.
293. Sewing Machine Casters. Sargent & Co., 70 Beekman street.
318. Sewing Machine Needle, Self-Threading. National Self-Threading Needle Company, 94 Tremont street, Boston, Mass.
826. Tuck Folder and Adjustable Hemmer, Improved. National Self-Threading Needle Company, 94 Tremont street, Boston, Mass.
836. Sewing Machine. Bladworth, Martin & Co., 701 Eighth avenue.
1582. Sewing Machine, Family. Lathrop Combination Sewing Machine Company, Poughkeepsie, N. Y.
1583. Sewing Machine, Manufacturing. Lathrop Combination Sewing Machine Company, Poughkeepsie, N. Y.
416. Needle-Threading Thimble. William P. Slensby, 566 Broadway.
1365. Electro-Motor for Sewing Machines. Electro-Motor Co., corner of Broome street and Broadway.
182. Hemmer and Binder, Harris'. Milo Harris, Jamestown, N. Y.
1171. Button-Hole Worker. A. W. Webster, Ansonia, Ct.
99. Bobbin Winder for Sewing Machines, Palmer's Patent. Palmer Bobbin Winder Company, 384 Broadway.
252. Walking Motion Treadle, for Sewing Machines, Sapp's Patent. Edward H. Ladd, 791 Broadway.

266. Motion for Sewing Machines. J. S. Tilley, 307 Broadway.
777. Oil Can, The "Disk" Pocket. Charles Goodenough, 41 Dey street.
96. Knitting Machine, New Haven Family. New Haven Family Knitting Machine Company, New Haven, Conn.
673. Knitting Machine, Bickford Family, and Samples of Work. Dana Bickford, 689 Broadway.
1789. Button Hole Cutter, The Crescent. John Powell, Philadelphia, Pa.
273. Twine Cutters and Safety Pins. T. B. Doolittle, Bridgeport, Conn.
279. Needle Boxes, Spool Cotton Box, Spool Cotton Bureau, Silk Spool Bureau. Joseph B. Thomas, 49½ Grove street.
618. Pocket Knives. Northfield Knife Co., 94 Chambers street.
1181. Pocket Cutlery. Smith & Clark, 100 Chamber street.

GROUP 5.

Medical and Surgical Apparatus and Instruments—Trusses, Artificial Limbs, Specimens of Dentistry and Dental Instruments.

685. Electro-Medical Generator and Apparatus. Professor Albert J. Steele, 89 Fulton street, Brooklyn.
957. Galvanic Batteries and Electro-Magnetic Machines for Medical Use. Louis Dresher, M. D., 695 Sixth avenue.
412. Permanent Galvanic Battery for Hospitals and Private Practitioners. Galvano-Faradic Manufacturing Company, 167 East Thirty-fourth street.
413. Portable Galvanic Batteries, Galvano-Caustic Battery, and Electrodes, all for Medical Use. Galvano-Faradic Manufacturing Company, 167 East Thirty-fourth street.
411. Portable Electro-Magnetic Machines. Galvano-Faradic Manufacturing Company, 167 East Thirty-fourth street.
691. Magnetic Health Scissors. Prevost & Rablat, 26 Amity street.
427. Trusses. W. Pomeroy & Co., 544 Broadway.
425. Trusses, Elastic; Abdominal Supporters, Bandages, etc. Elastic Truss Company, 683 Broadway.
430. Orthopœdic Articles, Trusses, Abdominal Supporters, Splints, etc. Darrow & Co., 1227 Broadway.
716. Surgical and Hernial Appliances. Jacob A. Sherman, 697 Broadway.
220. Invalid Bedstead. John H. Oerter & E. Dauer, 252 West Fortieth street.
236. Invalid Fracture Bedstead. Thomas McIlroy, 145 Perry street.
234. Invalid and Elevating Bedstead and Lounge. Thomas McIlroy, 145 Perry street.
235. Surgical and Speculum Operating Chair and Surgical Operating Table. Thomas McIlroy, 145 Perry street.
254. Iron Speculum Chair. William Diack & Co., 435 Third avenue.
238. Oculist Operating Chair. Thomas McIlroy, 145 Perry street.
237. Fracture Extension Appliance. Thomas McIlroy, 145 Perry street.
56. Lifting Cure Apparatus, Butler's. Lewis G. Janes, M. D., 830 Broadway.
319. Vibratory Exerciser. Allen L. Wood, M. D., 15 Laight street.
920. Reactionary Lifter. Mann's Reactionary Lifter Company, Newark, N. J.
686. Respirator or Lung Protector. Betty Kronenberger, 303 East Thirty-second street.
17. Artificial Limbs. A. A. Marks, 575 Broadway.
1123. External Adjustment for Packing of Pistons. Andrew H. Smith, 67 Chatham street.

830. Artistic Dentistry and Dental Mechanism. Alfred W. Doty & Son, Sixth avenue and Forty-ninth street.
829. Irrigator for ladies, Catarrh Syringe and Vaginal Syringe, Hard-rubber Catarrh Instruments, for physicians, and Vibratory Breast Pump. Morris Mattison, M. D., Gilsey House.
632. Dental Specimens on Rubber. Aug. Wm. Meader, 262 Sixth street.
208. Continuous Gum on Platinum Base. John Allen, 22 Bond street.
384. Electro-magnetic Mallet. Dr. W. Myron Reynolds, 62 West Fourteenth street

Group 6.

Jewelry and Ornaments for the Person; Attachments used in out-door sports, Skates, Fishing Tackle, Hunting and Shooting Apparatus; Gymnastic Implements and Toys for Children; Meerschaum and other Smoking Pipes; Cases for Pipes and Cigars.

658. Charms, Microscopic. John H. Morrow, 661 Broadway.
664. Skates, New York Club. Phineas Smith, 116 Chambers street.
1313. Skates. Union Hardware Co., Wolcottville, Conn.
1315. "Le Cercle," an out-door game. L. B. Brooks, Boston, Mass.
1348. Equestrian Gymnasium Model. E. S. Scripture, Brooklyn, L. I.
806. Base Ball Players' Supplies, Skates, Gymnasium Goods, etc. Peck & Snyder 126 Nassau street.
88. Nettings, Seines and Fykes. American Net and Twine Company, 210 Fulton street.
620. Fish Lines and Twines. Willard Harvey, 42 Franklin street.
345. Toys, Tin. Charles Drake. 3 Hudson street.
258. India-rubber Goods. Joseph M. Ward, 905 Broadway.
737. Ivory, Compressed. William M. Welling, 207 Centre street.
292. Pipes, Meerschaum. F. Julius Kaldenberg, 6 John street.
256. Pipes, Brier and Carved Ivory. Harvey & Ford, 300 Canal street.

Group 7.

Portable Writing Desks, Portfolios, Pocket Pens and Pencils, Pocket Books; Trunks, Carpet Bags, Reticules, Traveling Cases, Umbrellas, Parasols, Canes; Hand Implements not elsewhere enumerated.

246. Pocket-books. C. Ramshon, 35 Maiden lane.
655. Pocket-books, etc. Edwin A. Austing, 44 Maiden lane.
76. Trunks. John W. Thorne, 53 Fulton street.
272. Trunk. Robert H. Hand, 182 and 184 Fulton street, Brooklyn, L. I.
692. Trunk, Patent Upright. Patent Upright Trunk Company, Barclay street.
803. Trunk Lock, Combination. Hamel, Gano & Co., 125 Worth street.
436. Canes, Walking. Fradley & Burr, 4 Maiden lane.
51. Umbrellas and Parasols. Byrd & Corwin, 414 Broadway.
221. Umbrellas and Parasols. George H. Clyde & Co., 911 Broadway.
486. Umbrellas, with Storm-defier and Ready Opener Frame and Burglar-proof Runner. Ellis Knapp & Co., 24 Walker street.
311. Collar, Travelers' Sleeping. Levi Dederick, Palisade avenue, near Hoboken avenue, Jersey City, N. J.
201. Fancy Leather Goods and Portable Writing Desk. Culbert & Co., 24 Maiden lane.
295. Razor, Comb and Hair-cutter. G. A. Harley, 6 City Hall place.
1505. Hat Brush. Handy Star Manufacturing Co., Albany, N. Y.

IV. DEPARTMENT OF CHEMISTRY AND MINERALOGY.

Under the direction of Charles Wager Hull, Thomas Rutter, Charles McK. Leoser.

GROUP 1.

Soaps, and all Compounds for Cleansing; Toilet Preparations, containing no Deleterious Ingredient. Candles, Oils, Wax, Resins, Hydro-carbon Compounds, and other Natural or Artificial Products used for Illuminating Purposes.

312. Soaps, Cold Water. James Bowman & Co., 22 Tenth avenue.
990. Toilet Soap and Pressing same. J. C. Hull's Son, 32 Park row.
147. Soap Powder. George F. Gantz & Company, 176 Duane street.
165. Soap and Sal Soda. E. Morgan's Sons, 211 Washington street.
1199. Soap, Swedish. J. L. Reed, 78 William street.
1306. Oil, Safety. Denslow & Bush, 130 Maiden lane.
783. Oil, Lubricating. Henry Solms, 13 Clinton street.
795. Oil, Wickes' Eclectic. J. H. Wickes, 120 Maiden lane.
387. Oil, Pratt's Astral. Charles Pratt, 108 Fulton street.
552. Petroleum, Products of. National Filtering Oil Company, 110 Front street.
763. Burnett's "Standard" Preparations. Joseph Burnett & Co., 27 Central street, Boston, Massachusets.
321. Lozenges, Tooth. W. H. Farnham & Co., 210 Broadway.

GROUP 2.

Acids, Alkalies, other Chemical Bases; Salts, Artificial Fertilizers; Soda Water, and Apparatus for Making it; Mineral Waters; Wines, Beverages, and Stimulants; Tobacco, Cigars, and Snuff. Drugs, Medicines, Tinctures, and Extracts of Officinal or known Composition; Disinfectants and Deodorizers; Chemicals not elsewhere provided for.

379. Oil of Myrbane. L. & J. Michaelis, 39 East Ninetieth street.
125. Oils, Essential. James B. Horner, 88 William street.
708. Tobacco. S. Rapp, 75 Fulton street.
196. Paste and Cement. J. S. Chase, 200 Mulberry street.
594. Bromo Chloralum (disinfectant). Tilden & Co., 176 William street.
961. Perfuming and Disinfecting Apparatus. Otto Boldemann, 148 West Sixteenth street.
323. Homœopathic Preparations. Henry M. Smith, 107 Fourth avenue.
329. Medicines, Officinal. Chemical and Pharmaceutical Preparations. Reed, Carnrick & Andrus, 198 Fulton street.
572. Officinal Fluid Extracts, Dragees, Chemicals, etc. James R. Mercein, Jersey City, N. J.
1116. Salts for Producing Mineral Waters. J. Matthews, First avenue, near Twenty-seventh street.
1168. Flavoring Extracts. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
566. Fly Paper. Curtis & Peck, Bridgeport, Conn.
152. Brimstone, refined. Brooklyn Sulphur Works, 163 Front street, N. Y.
151. Saltpetre, refined. Niagara Laboratory, 163 Front street.
998. Chemical Specimens. School of Mines, Columbia College.
131. Soda Water, Ginger Ale, and Syrups. Ryberg Brothers, 264 Division street.
1167. Soda Water and Mineral Waters. John Matthews, First avenue, near Twenty-seventh street.
1564. Wines, California. J. Landsberger & Co., San Francisco, California.

1705. Wines and Liquors, American. H. B. Kirk & Co., 58 Fulton street.
1166. Root Beer, "Otaki." John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
453. Soda Water Apparatus, Generators, Syphon Machines, etc. Wm. Gee, corner Elm and Franklin streets.
336. Syrup Fountain. James M. Whitfield & Son, 262 Water street.
1114. Soda and Mineral Water Apparatus, "Glacier." John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1119. Soda and Mineral Water Apparatus, "Frost King." John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1112. Soda and Mineral Water Apparatus, "Snow Queen." John Matthews, First avenue, between Twenty-sixth and twenty-seventh streets.
541. Ammoniated Superphosphate of Lime. George E. White, 160 Front street.
1112. Apparatus for Filling Syphons. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1113. Apparatus for Filling and Closing Bottles without Corks or Fastenings. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1117. Generator (Upright) for evolving Carbonic Acid Gas. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1118. Apparatus for Converting Still Wines into Sparkling Beverages. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1120. Syphon Bottles. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1121. Apparatus for Manufacturing Soda and Mineral Waters. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1162. Pump for Injecting Gas or Water into Soda Fountains. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1163. Section of Porcelain Lined Soda Fountain. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1165. Section of Seamless Lining of Pure Lead for Generator. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1164. Section of Seamless Lining of Pure Tin for Soda and Mineral Water Fountains. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1169. Stoppers, Gravitating Bottle. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1170. Fasteners, Cork. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.
1709. Soda Water Apparatus, Model. John Matthews, First avenue, between Twenty-sixth and Twenty-seventh streets.

GROUP 3.

Leather, Skins, Peltry, Furs, Parchment, Specimens of Taxidermy, Catgut, Goldbeaters' Skin, Membrane preparations; Preserved Wood, Fiber, Leaves, and other natural products used in the Arts.

1137. Sole Leather. George Hench & Son, Centre, Pa.
1187. Leather, Cropped or Sole. Keese & McCoy, 22 Ferry street.
1188. Leather, Cropped or Sole. Keese & McCoy, 22 Ferry street.
1189. Leather, Sole. Thorne & McFarland, Gold street.
1371. Leather, Sole, Oak Tanned. J. B. Hoyt & Co., 28 Spruce street.
1532 Leather, Hemlock Sole. G. B. Horton & Co., 28 Cliff street.

1533. Leather, Hemlock Sole. William Stout, 37 Spruce street.
1360. Leather, Sole. J. B. Hoyt & Co., 28 Spruce street.
1396. Leather. C. B. Williams' Sons, Philadelphia, Pa.
1571. Leather, Sole, Union Crop. Schultz's. Southwick & Co., 345 Pearl street.
1578. Leather, Sole Hemlock. Schultz's. Southwick & Co., 345 Pearl street.

GROUP 4.

India Rubber and Gutta Percha preparations, Papier Mache; Artificial Stone, Brick, specimens of Pottery, Earthen Ware, Porcelain, China and Glass; Crucibles, Cements, prepared Materials for Roofing.

670. Fire Brick. B. Kreischer & Son, 58 Goerck street.
573. Brick, Enameled. W. H. Paulding, 35 Dey street.
512. Artificial Stone, Frear's. New York Frear Stone Co., 346 and 348 Broadway, N. Y.
510. Cement and Iron Dyking. James S. Pierson, 119 Broadway.
999. Clay. George Such, South Amboy, N. J.
104. Plumbago, Manufactures of. Joseph Dixon Crucible Co., Jersey City, N. J.
571. Roofing, Roof Coating, Cement Roofing and Sheathing Felt. Henry W. Johns, 78 William street.
1757. Roofing Compound. Ebenezer Gordon, 621 West Forty-second street.

GROUP 5.

Paints, Dye-stuffs. Inks; Specimens of Dyed Yarns, Tissues, and other colored substances, and specimens of Bleaching; Preparations for Staining, Cleaning, and Polishing; Varnishes, Blueing, Blacking.

184. Paints, Varnishes, and Laundry Blueing. C. T. Raynolds & Co., 106 Fulton street.
183. Paint, Copper. John C. Giffing, 44 Water street.
316. Paint, Prince Metallic. A. K. Bass, Brooklyn.
331. Paint, Mineral. Daniel Bidwell, 254 Pearl street.
932. Paint, Lehigh Metallic. Lehigh Metallic Paint Works, 214 Pearl street.
914. White Lead. Brooklyn White Lead Co., 89 Maiden lane.
174. Varnishes and Wood Filling. Valentine & Co., 88 Chambers street.
1381. Wood Stain and Cottage Colors. Thomas G. Hoger, 936 Third avenue.
172. Glycerin Cake and Shellac. Marx & Rawolle, 179 William street.
439. Printing Ink, Improvement in. Francis & Loutrel, 45 Maiden lane.
167. Inks and Mucilage, "Carter's." J. P. Dinsmore, 36 Dey street.
1000. Inks, Colored. Thomas D. Leak, 378 Bleecker street.
1001. Glue, Comminuted. Milligan & Higgins Glue Company, 317 Pearl street.
761. Stove Polish, Liquid. R. W. Bailey & Co., 132 West Thirtieth street.
391. Stove Polish, "Gem." Phinney & Urquhart, 172 Forsyth street.
502. Stove Polish, Inks, Shoe Blacking, Laundry Blueing, etc. S. M. Bixby & Co., 173 Washington street.
1573. Polish, "Summit." John B. Knapp & Sons, Stamford, Conn.
1738. Puzzolana, for cleaning and polishing Silver Ware. Wm. C. Toone, 320 East One Hundred and Twenty-first street.
590. Blacking, "Rumford." Wilson, Lockwood, Everett & Co., 51 Murray street.
556. Emery, Flint, Pumice and Rotten Stone. T. Van Amringe, 360 Pearl street.
166. Sapolio. E. Morgan's Sons, 211 Washington steeet.
155. Electro-Silicon. Coffin, Redington & Co., 85 Liberty street.
782. Silver White for Polishing. S. M. Miller, 65 Liberty street.

1102. Polish, Piano and Furniture. Charles S. Ammel, Columbus, Ohio.
1504. Liquid Cement. Robert W. Patten, 1327 Broadway.

Group 6.

Flour, Meal and other prepared products used as food; Samples of Baking and Pastry Cooking, Sugars, Confectionery, Chocolate, Cocoa; prepared Condiments; Preserved Fruit, Vegetables and Meats; Condensed Fluids; Extracts used in preparing beverages.

583. Flour Mill in Operation; also Flour, Self-Raising Flour, Farina, etc. Hecker & Bro., 203 Cherry street.
190. Flour, Self-Leavening. Jewell Brothers, 2, 4 and 6 Fulton street, Brooklyn.
189. Flour, in minature papers. Jewell Brothers, 2, 4 and 6 Fulton street, Brooklyn.
153. Bride's Cake. W. W. Wall, 767 Sixth avenue.
338. Crackers and Pulverized Crackers. R. B. Garrison, 32 Desbrosses street.
309. Biscuits. James Morton, 474 Fulton avenue, Brooklyn, L. I.
528. Bread, Wheat. Silas B. Howe, 511 Third avenue.
901. Crackers, Cake, and Bread. John D. Gilmor, 205 Greenwich street.
357. Manioca. Mawbarn & Crane, 287 Washington street.
199. Hazard's Brazilian Cassava, Potted Meats, Hominy, Samp, Corn, etc. E. C. Hazard & Co., 192 Chambers street.
394. Imperial Granum—a Medicinal Food. Carle & Strong, 153 Water street.
148. Sea Foam Baking Powder, Carb. Soda, Cream Tartar, Saleratus, and Lemon Sugar. George F. Gantz & Co., 176 Duane street.
591. Cream Tartar, Hosford's. Wilson, Lockwood, Everett & Co., 51 Murray street.
592. Bread Preparation, Hosford's. Wilson, Lockwood, Everett & Co., 51 Murray street.
593. Yeast Powder, "Rumford." Wilson, Lockwood, Everett & Co., 51 Murray street.
1128. Yeast Cakes. Joyes & Stratton, Chicago, Ill.
144. Confectionery, "Fort and Ships." R. K. McCullough, 922 Broadway.
198. Chocolate Paste and Confectionery. Wallace & Co., 34 Maiden lane.
1551. Confectionery. American Confection Company, 159 Chambers street.
1103. Cough Drops. A. H. Brummell, 410 Grand street.
1157. Table Syrup. C. A. Demorest, 105 East One Hundred and Nineteenth street.
337. Pickles, Preserved Fruit, Jellies, etc. Wardell & Kennedy, 31 Jay street.
200. Sardines, American. American Sardine Company, 192 Chambers street.
149. Canned Roast Beef. George H. Monroe, 16 Cedar street.
977. Canned Soups. A. C. Blot, Jersey City, N. J.
1759. Mustard. Chas. L. Stickney, Jr., 209 Bowery.
1749. Fruits and Vegetables, Manhattan Preserving Co., 207 Duane street.

Group 7.

Specimens of natural Stones used in building; Minerals, Ores, Metals, Alloys; Models of apparatus and implements used in Chemical Works and the Laboratory; Apparatus for making Gas; Machines for expediting chemical changes.

350. Peat Fuel. T. H. Leavitt, Boston, Massachusetts.
997. Granite, Polished Column of American. Darius Wellington, Boston, Mass.
976. Steel Tools and articles cast or forged in iron and converted to Steel. Wihl Manufacturing Company, 279 N. Sixth street, Brooklyn, E. D., L. I.
931. Nickel, Nickel Alloy, etc. Joseph Wharton, Philadelphia, Pennsylvania.
395. Tinners' Waste, articles from. Thomas C. Lombard, 38 Broadway.

180. Specimens of Minerals. E. B. Benjamin, 10 Barclay street.
718. Air Treatment, apparatus for and products of. Rudolph d'Heureuse, 25 Old Slip.
161. Gas Carbonizer. Woodward Gas Carbonizing Company, 163 Broadway.
191. Gas Generator. Eugene C. Plumer, Columbia, South Carolina.
1346. Gas Machine, "Eagle." Howard Campbell, 9 Murray street.
1521. Carburetters, Gas. United States Gas Saving Co., New York city.
1514. Gas Machine, "Maxim." Maxim Gas Machine Co., 294 Broadway.
1544. Medallion Metal. New Jersey Medallion Metal Co., Jersey City, N. J.
1399. Spelter, refined. Leonce de Mets, Elizabethport, N. J.
1530. Iron Ore from Washington, N. J. Port Murray Mining Co., Washington, N. J.
1559. Nickel Ore. Rockland Nickel Mining Co., Stony Point, N. Y.
951. Concentrator. Robert C. Morton, 98 Cole street, Jersey City, N. J.
1544. Metal, Medallion. New Jersey Medallion Metal Co., Jersey City, N. Y.

V. DEPARTMENT OF ENGINES AND MACHINERY.

Under the direction of Walter Shriver, E. S. Dickinson, William Burdon.

GROUP 1.

Stationary Engines driven by Steam, Heated Air and other Gases; Water Engines and Water Wheels, and all other prime movers; Boilers, Steam-superheaters, Safety Valves, Steam Indicators and Governors, Dynamometers; Steam Gauges and other safety apparatus for Boilers, or to be attached to Engines.

339. Boiler, Tubular Steam. William Lowe, 93 Liberty street.
340. Boiler, Tubular Steam. Todd & Rafferty, Paterson, N. J.
539. Boiler, Sectional. Root Steam Engine Co., 500 to 510 Second avenue.
574. Boiler, Air Front. Handren & Ripley, corner Washington and Albany streets.
577. Boiler, "Allen." Allen Engine Works, One Hundred and Thirtieth street and Fourth avenue.
124. Boiler, "Phleger." John B. Lady, 3029 Chestnut street, Philadelphia, Pa.
929. Damper Regulator. D. P. Davis, 44 Cortlandt street.
509. Felting, Salamander. U. S. & Foreign Salamander Felting Co., Troy, N. Y
578. Safety Valve. J. D. Lynde, Philadelphia.
1555. Indicating Safety Valve. R. P. Staats, 53 E. Twentieth street.
579. Low Water Alarm. J. D. Lynde, Philadelphia.
581. Feed Water Regulator and Low Water Alarm, Combined. J. D. Lynde, Philadelphia.
589. High Pressure and Low Water Alarm. Massey Low Water Detector Co., 56 Broadway.
103. Feed Regulator and Low Water Alarm. Berryman Manufacturing Co., Hartford, Ct.
805. Pyrometer and Refractory Compound. Robert Spencer, 24 Cliff street.
488. Boiler Jackets. F. H. Snyder, 273 Cherry street.
368. Ferrule and Reducer for Boiler Tubes. R. A. Copeland, 93 Liberty street.
760. Grate Bar. R. A. Hutchinson, 89 Liberty street.
526. Grate Bar. Lorenzo B. Tupper, 120 West street.
278. Grate Bars. S. S. Bent, 304 Fourth street.
1731. Grate Bars. Corrugated Scofield Grate Bar Co., 95 Liberty street.
904. Steam Engine, Oscillating. William D. Andrews & Brother, 414 Water street.

123. Steam Engine, Upright. David G. Starkey, 337 East Eighty-third street.
496. Steam Engine and Surface Condenser. Wm. Wright & Co., Newburgh, N. Y.
587. Steam Engine, Baxter. Baxter Steam Engine Co., 18 Park place.
575. Engines, Vertical. Handren & Ripley, corner Washington and Albany streets.
544. Steam Engines, Portable. E. P. Hampson, 38 Cortlandt street.
543. Steam Engines, Vertical. E. P. Hampson, 38 Cortlandt street.
545. Engine, Hoisting. E. P. Hampson, 38 Cortlandt street.
317. Steam Engine, Rider Cut-off. A. K. Rider, foot West Thirteenth street.
308. Steam Engines. Wood & Mann, Utica Steam Engine Co., 42 Cortlandt street.
971. Steam Engine. Waring & Parke, 133 Centre street.
981. Steam Engine. George W. Hill, 45 Gold street.
689. Steam Engine and Boiler. Blanchard Steam Improvement Co., 71 Broadway.
1176. Steam Engines. New York Safety Steam Power Co., 44 Cortlandt street.
1182. Steam Boiler. B. F. Small & Co., 34 Dey street.
342. Caloric Engines. Thomas J. Rider, Thirteenth street and North river.
567. Steam Governors and Valves. Place Steam Governor Valve Co., 119 Broadway.
546. Compressible Globe Valves. J. Johnson & Co., 101 William street.
1558. Indicating Safety Valve. R. P. Staats, 53 East Twentieth street.
1752. Safety Valve. W. N. Buckley, 330 Gold street, Brooklyn, N. Y.
1688. Balance Slide Valve for Locomotive, Stationary and Marine Steam Engines. Esau D. Taylor, 211 Greene street, Jersey City, N. J.
1727. Patent Piston. Andrew McMullin, Paterson, N. J.
175. Gauge, Steam. A. Schmidt & Bros., 41 Centre street.
351. Gauges, Steam. Charles G. Willing, 88 John street.
1158. Gauges, Steam. W. Heuermann, 4 Cedar street.
1158. Gauges, Recording. Recording Steam Gauge Co., 91 Liberty street.
1554. Gauges, Recording. D. P. Davis, 44 Cortlandt street.
127. Packing, Steam. Manhattan Packing Manufacturing Co., Medford, Mass.
145. Governors, "Huntoon." Chase & Hewes, 93 Liberty street.
580. Governor. John D. Lynde, Philadelphia, Pa.
913. Governor and Regulator, Fly-Wheel. Dill & Moore, 149 Centre street.
126. Pyrometer. Henry W. Buckley, 98 Liberty street.
159. Steam Trap. P. W. Brewster & Co., Philadelphia, Pa.
927. Steam Jet. University of Pennsylvania, Philadelphia, Pa.
537. Lubricating Oils. Chard & Howe, 134 Maiden lane.
305. Lubricator. Hugh Pringle, 172 East Seventh street.
964. Lubricator for Shafting, etc. Hugh Thomas, 353 West Thirty-fifth street.
863. Lubricator for Metal Planing Machines. Hugh Thomas, 353 West Thirty-fifth street.
941. Lubricating Apparatus. P. W. Brewster, Philadelphia, Pa.
1133. Lubricators. Nathan & Dreyfus, 108 Liberty street.
1155. Automatic Lubricator. Holland & Cody, 8 Gold street.
956. Belt Clamp. Nathan S. Clement, Northampton, Mass.
530. Leather Belting. Reidy & Kiely, 23 Ferry street.
553. Leather Belting, Oak Tanned. Charles Schieren, 90 Gold street.
762. Belt Shifter and Holder. William D. Russell, Newark, N. J.
1178. Packing, Metallic. L. Katzenstein & Co., 370 Greene street.
1183. Leather Belting and Rubber Packing. B. F. Small & Co., 34 Dey street.

GROUP 2.

Pumping Machinery—Steam Fire Engines in operation, and other Engines and apparatus for moving fluids; Air Pumps, Fan Blowers, etc; Pipes for conveying water and other fluids; Valves, Cocks, Joints, and other appliances used in connection therewith.

128. Garden Pump, "Eureka." John R. Haines, 1459 Third avenue.
770. Pump, People's. American Pump Co., Petersboro, N. H.
532. Pumps, Fountain. J. A. Whitman, Providence, R. I.
540. Pump. Improved. J. D. West & Co., 40 Cortlandt street.
380. Pump, Compound Propellor. Thomas Shaw, Ridge avenue and Wood street, Philadelphia, Pa.
122. Pump, Centrifugal. D. G. Starkey, 337 East Eighty-third street.
605. Pump, Vacuum. A. S. Cameron & Co., 433 East Twenty-third street.
612. Pump, Vertical. A. S. Cameron & Co., 433 East Twenty-third street.
1101. Pumps, Steam. Woodward Steam Pump Manufacturing Co., 76 Centre street
906. Pump, Centrifugal. W. D. Andrews & Brother, 414 Water street.
789. Pump, Submerged. Bridgeport Manufacturing Co., 55 Chambers street.
613. Pump, Mining. A. S. Cameron, 433 East Twenty-third street.
611. Boiler Feeders. A. S. Cameron, 433 East Twenty-third street.
609. Pump, Wrecking. A. S. Cameron, 433 East Twenty-third street.
608. Pump Plunger. A. S. Cameron, 433 East Twenty-third street.
607. Pump, Crank and Fly-wheel. A. S. Cameron, 433 East Twenty-third street.
606. Pump and Engine, Combined. A. S. Cameron, 433 East Twenty-third street.
614. Pump, Special Steam. A. S. Cameron, 433 East Twenty-third street.
381. Pump, Automatic Steam. Automatic Steam Vacuum Pump Manufacturing Co., 85 Liberty street.
390. Pumps, Steam. Valley Machine Co., Northampton, Mass.
1184. Steam Pumps, "Earle's." Waring & Parke, 133 Centre street.
827. Pump, Submerged, Force. Forrester Manufacturing Co., 3 Park place.
135. Pump, Direct-acting Steam. C. B. Hardick, 23 Adams street, Brooklyn, L. I
975. Water-wheel. C. H. Hall, cor. Front and Pearl streets, Brooklyn, L. I.
1537. Water-wheel, Working Model of. C. F. H. Huff, 111 Bank street.
527. Water Elevating Apparatus. C. H. Hall, cor. Front and Pearl streets, Brooklyn, L. I.
1531. Hand Pump. Woodward Steam Pump Co., 76 and 78 Centre street.
1512. Condenser. Craig & Brevoort, 138 Broadway.
955. Hose Coupling. S. B. Hutchinson, Springfield, Mass.
1375. Hydrant, Stopcock. J. N. Smith, Jersey City, N. J..
1321. Eel Trap for Corporation Stop-cocks. G. W. Dutcher, New Haven, Ct.
610. Exhauster, Gas. A. S. Cameron, 433 East Twenty-third street.
905. Blower, Pressure. Charles Merrill & Sons, 556 Grand street.
115. Blowers, Root's Force Blast Rotary. S. S. Townsend, 31 Liberty street.
804. Compresser, Waring's Air. Waring & Parke, 133 Centre street.
1513. Ship Ventilator, Fog Alarm, and Bilge Pump. W. F. J. Theirs, Stevens House, Jersey City, N. J.
1750. Alarm Pump, for sailing vessels. Ezra Haskell, Dover, N. H.

GROUP 3.

Machinery for working Metals—Lathes, Planers, Screw-cutting machinery, Drills, Shaping and Slotting Machines, Emery Wheels, and all tools and apparatus used in working metals.

136. Saw Sets. George W. Dunn, Rondout, N. Y.
942. Saw Gummer and Sharpener. E. W. Phelps, Elizabeth, N. J.

320. Saw Set. E. Y. Clark, 387 South Fourth street, Jersey City.
576. Press, Lever. Reuben Brady, 631 Hudson street.
584. Press, Power. Bliss & Williams, 118 and 122 Plymouth street, Brooklyn, L. I.
193. Drill, Punching Press and Shear. W. Lyon, 796 Greenwich street.
359. Drilling Machine and Counter. J. Austin & Co., 168 Fulton street.
505. Power, Hand and Foot, for Running Emery Wheels, etc. W. S. Jarboe, 93 Liberty street.
709. Drilling Machine, Angular and Ratchet. Duryea & Kelly, 40 Dey street.
1751. Drilling Machine, Portable. Alex. McArthur, 504 West street.
1774. Rases Combined Fire Shrinker, Punch and Shears. Harry Sedgwick, Cromwell Hollow, Conn.
788. Drill, Helical Pawl. C. F. Mudge, 55 Chambers street.
1130. Drilling Machines. W. B. Bement & Sons, 93 Liberty street.
909. Drop Hammer. C. Merrill & Sons, 556 Grand street.
978. Drill, Hand. James Hunter, North Adams, Mass.
907. Forging Hammer. Charles Merrill & Sons, 556 Grand street.
947. Forging Machine, "Postlethwaite's." Henry Miller, 239 De Kalb avenue, Brooklyn.
1773. Nail Machine. D. Gugisperg, 64 Avenue B, N. Y.
585. Tuyere, Horizontal. John Bayliss, Fifty-fourth street and Lexington avenue.
586. Tuyere, Hot Blast and Water, and Forge. John Bayliss, Fifty-fourth street and Lexington avenue.
116. Forges, with Rotary Blowers. S. S. Townsend, 31 Liberty street.
398. Emery Wheels and Grinders. Post & Goddard, 109 Liberty street.
360. Emery Wheels and Hones. J. Austin & Co., 168 Fulton street.
185. Emery Wheels, Stone Center. W. S. Jarboe, 93 Liberty street.
358. Oil Stones. Chase & Sloper, 121 East Eighty-fourth street.
965. Oil Stones. G. O. Hall, 237 East Forty-first street.
361. Oil Stones. L. M. Jagger & Son, Long Island City.
503. Grindstone Frames. George L. Cummings, 140 Centre street.
911. Grinding Machines. Isaac R. Joslin, 91 Liberty street.
747. Slotter Gear Cutter Lathe and Drill. Hewes & Phillips, Newark, N. J.
983. Lathe, Geometrical, for Engine Turning. Anthony Schaefer, 82 Forsyth street.
1303. Steel and Steel Forgings, Richardson, Boynton & Co., "Atlantic Steel Works," 234 Water street.
731. Cast Steel, Castings to Patterns. Van Zandt Bros., 4 Dey street.
306. Vises, Parallel. A. P. & M. Stephens & Co., 91 Liberty street.
739. Vises and Tools. Backus Vise Co., Miller's Falls, Mass.
702. Vise Seat, Ball and Socket. Edward Maynard, Elizabeth, N. J.
513. Valve Refitting Machine. C. F. Hall & Son, 21 Murray street.
399. Taps, Dies, Reamers, etc. New York Tap and Die Company, Bridgeport, Ct. Post & Goddard, 109 Liberty street.
313. Files. Blake & Fessenden, 96 Chambers street.
400. Mandrels, Expanding. C. W. Le Count, South Norwalk, Ct. Post & Goddard, 199 Liberty street.
352. Metal Screws. C. Ducreux & Co., 93 Elizabeth street.
1301. Screw Wrench, "Lindsay." Bray & Rice, 20 Cortlandt street.

GROUP 4.

Machinery for working in Wood—Lathes, Saws, Planing Machines, Boring Machines, Machines for Mortising and Tetoning; Carpenters' Tools, and other Tools and Apparatus for working in wood.

1108. Saws. E. M. Boynton, 78 Beekman street.
168. Saws. Wheeler, Madden & Clemsen, Middletown, N. Y.
1161. Endless Chain Saw. De Lancey Kennedy, 121 W. Sixteenth street.
923. Saw, Scroll. Jerome S. Moseley, Syracuse, N. Y.
1309. Scroll Saw. Homer Belding, Rochester, N. Y.
1179. Saw Set, Circular. William H. Havens, Paterson, N. J.
1720. Saw, Scroll. T. L. Cornell, Derby, Conn.
1728. Saw, Movable Tooth Circular. Gottleib Manlick, Trenton, N. J.
1729. Saw, Improved Movable Tooth Circular. Gottleib Manlick, Trenton, N. J.
1739. Saws, Steel. R. Hoe & Co., 31 Gold street, N. Y.
523. Jig and Fret Saw. B. D. Wallace, Boston, Mass.
507. Scroll-Sawing Machines. Henry L. Beach, 90 Fulton street.
102. Circular Sawing, Rabbeting, and Tenoning Machine. J. A. Wood, Rockaway, N. Y.
1503. Steel Wood Saw Frame with Patent Graduated Tooth Saws. Emanuel Andrews, Williamsport, Pa.
118. Band and Jig Sawing Machines. First and Priabel, 452 Tenth avenue.
772. Band Sawing Machine. George Harvey, 23 Ferry street.
773. Band Sawing Machine. George Harvey, 23 Ferry street.
1572. Hand Sawing Machine. Hills & Hoag, 32 Cortlandt street.
922. Paneling Moulding, Carving and Dovetailing Machine. A. S. & J. Gear & Co., Boston, Mass.
568. Moulding Machine. S. C. Ellis, Jersey City, N. J.
910. Moulding Machine. Isaac R. Joslin, 91 Liberty street.
908. Solid Cutters for Tonguing and Grooving. William Thomson, 552 West Twenty-fourth street.
1540. Planer, Improved Surface. New England Machine Co., Fitchburg, Mass.
322. Planing and Matching Machine, Moulding Machine, Siding Saw, Vertical Resawing Machine, Side Tool Set, Knife-Grinding Machine, etc. J. B. Schenck's Sons, Matteawan, N. Y.
926. Dovetailing Machine. S. W. Shaw, San Francisco, Cal.
194. Dovetailing Machine. Harry H. Evarts, 93 Liberty street.
133. Knapp Dovetailing Machine. Knapp Dovetailing Machine Co., Northampton, Mass.
529. Band Sawing Machine. John T. Plass, 143 East Thirtieth street.
1714. Dovetailing Machine. Vergennes Machine Co., Vergennes, Vt.
1724. Scroll Sawing Machine, Revolving Blade. Charles D. Moore, Lawrence, Mass.
1732. Dovetailing Machine. Seymour & Whitlock, Newark, N. J.
1769. Saw Bench, Swiveling Miter. Jonathan P. Grosvenor, Lowell, Mass.
1786. Variety Moulding Machine. Jonathan P. Grosvenor, Lowell, Mass.
192. Blind-Stile Boring Machine. Colt's Patent Fire-Arms Manufacturing Co., Hartford, Conn.
570. Marking or Laying-Out Machine. S. C. Ellis, Jersey City, N. J.
1712. Measuring Rods. Olin Scott, Bennington, Vt.
569. Patent Journal Box for Wood or Iron-working Machines. S. C. Ellis, Jersey City, N. J.

1129. Tool Handles. Union Hardware Co., Wolcottville, Conn.
701. Tool Chests. Phineas Smith, 116 Chambers street.
143. Tool Chest. James T. Pratt & Co., 53 Fulton street.
555. Mechanics' Tools. Douglass Manufacturing Co., 45 Chambers street.
397. Auger Bits. Post & Goddard, 109 Liberty street.
542. Planes. Graham & Haines, 77 Chambers street.
565. Empire Wood Splitter. William S. Williams, 158 East Twenty-fifth street.

Group 5.

Machinery for preparing Fibers and Tissues; Carders, Pickers, etc.; Machinery and all Appliances used in the manufacture of Cloth, Carpeting, etc.; Spinning Frames, Spoolers, Looms; Machinery used in Printing.

1565. Printing Press. R. Hoe & Co., 31 Gold street.
689. Printing Press, "Chromatic." George F. Nesbitt & Co., corner Pearl and Pine streets.
478. Printing Press. Andrew Campbell, 233 Clement avenue, Brooklyn.
138. Labeling Machine. Edward Tyrrell, 139 Sands street, Brooklyn, L. I.
1314. Weather-Map Printing Press of the Signal Service of the United States Army. United States Government.
456. Loom, "Positive Motion." Atlantic Manufacturing Co., 82 Worth street.
389. Loom, "Positive Motion." The Positive Motion Loom Co., 35 and 37 Wooster street.
937. Cotton-Seed Hulling Machine. David Kahnweiler, 241 East Fifty-seventh street.
940. Wool Spinner. James Hunter & Son, North Adams, Mass.
1326. Cross Gig for Woolen Goods. D. F. Harris, 180 Fulton street.
1167. Burring Picker, "Domestic." Calvin L. Goddard, 3 Bowling Green.
132. Carpet-Cleaning Machine. Alexander Stevenson, 375 East Seventy-fifth street.
548. Corn Huskers. Hills & Hoag, 32 Cortlandt street.
778. Machine for Shrinking Hat Bodies. P. V. M. Bishop, Morristown, N. J.
157. Rope and Twine Machine. James Wood, 6 Cortlandt street.
1518. Double Burring Machine for First Breaker. C. L. Goddard, 3 Bowling Green.
1519. Steel Ring and Solid Packing Burring Machine for Second Breaker, Finisher and Condenser. C. L. Goddard, 3 Bowling Green.
1520. Steel Ring and Solid Packing Burring Machine for First Breaker. C. L. Goddard, 3 Bowling Green.
1515. One Pair Steel Ring Feeds, etc., for First Breaker. C. L. Goddard, 3 Bowling Green.
1516. Pair of Steel Ring Feed Rolls with Patent Stand and Box for Second Breaker, Finisher, and Condenser. C. L. Goddard, 3 Bowling Green.
1517. Pair Feed Rolls with Patent Stand and Box for First Breaker. C. L. Goddard, 3 Bowling Green.

Group 6.

Machinery and Tools used in the manufacture of Leather, India Rubber, Papier Mache, Paper, Porcelain, Pottery, Bricks, and materials used in the Arts, not elsewhere specified.

1107. Boot and Shoe Sewing Machine. Goodyear Boot and Shoe Sewing Machine Co., 59 and 61 Liberty street.
564. Leather-Dressing Machine. Hide and Leather Machine Co., Boston, Mass.
775. Brick Press. J. Nottingham Smith, Jersey City, N. J.
197. Re-Pressing Brick Machine. Anderson Brothers, Peekskill.

349. Flour Packer. J. Matteson, Brooklyn, L. I.
1370. Tanners' Hooks. James Hoffman, Belvidere, N. J.

GROUP 7.

Machinery for Grinding or Crushing Grain, Paint, Plumbago, and other natural products; Gearing, Millwork, Friction Pulleys, and Elements of Machinery for varying Speed or Power; all tools used by artisans or in factories not otherwise provided for.

949. Gold-rolling Mill. F. P. Kurtz & Co., 97 Cliff street.
948. Bracelet Machine. F. P. Kurtz & Co., 97 Cliff street.
506. Stone Crusher. A. Dietz, Plainfield, N. J.
515. Tunnel Drill, Diamond-pointed. American Diamond Drill Co., 61 Liberty street.
314. Paint and Grain Mill. Charles J. Ross, Williamsburgh, L. I.
787. Grist Mills. Leonard & Sullivan, Bridgeport, Conn.
139. Disintegrating Mill (model). George E. White, 160 Front street.
951. Concentrator, Ore. Robert C. Morton, 98 Cole street, Jersey City, N. J.
991. Soap Press. J. Atkiss, corner Flushing and Tompkins avenues, Brooklyn, L. I.
1581. Elastic Pulley. Heim & Zimmerman, 33 Ferry street.
1560. Diamond Gang Saw. H. & J. L. Young, East One Hundred and Sixteenth street.
1571. Machine for Making Paper Boxes. Root & Martin, New Haven, Conn.
1742. Rock Drill, Steam. Ingersol Rock Drill Co., 113 Broadway.
1781. Brush Making Machine. E. D. & E. C. Woodbury, 59 Lewis street.

VI. DEPARTMENT OF INTER-COMMUNICATION.

Under the direction of J. Trumbull Smith, William H. Butler, Stevenson Towle

GROUP 1.

Locomotive Engines, Cars, or Models of the same, and all apparatus used in constructing and operating Railways, Models of Bridges, etc.; all Fixtures, Furniture, and Appliances used on Passenger and Freight Railway Cars.

392. Locomotive Head Lights. L. G. Tillotson & Co., 8 Dey street.
710. Locomotive (model of). James Buchannan, Hudson River Railroad Shop. West Thirty-first street.
954. Brass and Copper Work for Locomotives and Steam Fire Engines. R. Harell Paterson, N. J.
792. Railway, Atmospheric Elevated. Rufus H. Gilbert, 254 Broadway.
1369. Rail Splices with Nut Locks. George P. Rose, Chicago, Ill.
917. Tubular Bridge. George H. White, 342 East One Hundred and Twenty-fourth street.
146. Car with Patent Brake (model). L. W. Tracey, corner Centre and White streets.
181. Railway Car Trimmings. L. G. Tillotson & Co., 8 Dey street.
919. Car Springs, "Convolute." Freeland & Ward, 313 West Twenty-seventh street.
1502. Car Springs, Torsion, Railroad, and Street. Richard Dudley, Erie, Pa.
1175. Safety Attachment for Street Railway Cars. Joseph Rice, Woodside, L. I.
385. Frogs, Elastic Railroad. Bray & Rice, 20 Cortlandt street.
918. Nut Lock and Washer. United States Nut Lock Co., 113 Broadway.
1149. Fish Joints. Pratt & Co., 87 Chambers street.

595. Fish Joint for Railroads. J. W. Quincy, 98 William street.
719. Bridge, Model of. Dudley Blanchard, Greenpoint, L. I.

Group 2.

Carriages, Wagons, Sleighs, and all vehicles drawn by animal power; Harness, Saddles, Bridles, and all apparatus used in connection with the horse and the stable; specimens of Improved Material for making Common Roads and Pavements, and all apparatus used in constructing the same and keeping them in repair.

378. Horse Collars, Wooden. Beekman Manufacturing Co., 20 and 22 Pell street.
325. Horse Collar, Machine-Made. William Guilfoyle, 271 Third avenue.
341. Horse Collars, "Climax." Isaac O. Hinsdale, 155 Bank street.
156. Harness Ornaments. J. V. Waldron & Bro., 46 Beekman street.
328. Harness and Saddlery Goods. C. M. Moseman & Bro., 114 Chambers street.
939. Check Rein Fastener. James S. Mott, Fairfield, Conn.
934. Curry Comb, Iron and Brass. William E. Lawrence, 822 Second avenue.
582. Curry Comb, Wooden Tooth. J. Austin & Co., 168 Fulton street.
504. Stocking, Perforated Elastic. William Lewis, Astoria, L. I.
119. Safety Attachment for Horses. Norman Fountain, 42 Carmine street.
508. Wheel, Patent. The Davis Hub and Wheel Co., 109 and 111 W. Broadway.
1194. Wheel, Patent. E. Hall & Co., Wallingford, Conn.
740. Carriage Trimmings, Ivory. Hackett & Bloodgood, 211 Centre street.
933. Axle, Carriage. Lomax Littlejohn, 245 Pearl street.
330. Axle Grease. Daniel Bidwell, Philmont, N. Y.
114. Wheel Jacks. Ames Plough Company, 53 Beekman street.
1708. Wagon Jacks, Race's Lifting. Geo. Race, Norwich, Conn.
332. Steering Apparatus, Model of. Joseph Walton, 96 Liberty street.
1556. Hand Carriage. Allen & Bond, St. Paul, Minn.
514. Child's Carriage, Velocipede, and Hobby Horses. Crandall & Co., 562 Third avenue.
714. Child's Carriage. Elder & Brown, 450 West street.
930. Mechanical Step, and Carriage Mountings. Ephraim Soper, 216 East Twenty-sixth street.
129. Child's Carriage. New Haven Folding Chair Company, New Haven, Conn.
101. Carriage, Phaeton (Children's), and Hobby Horse. L. P. Tibbals, 478 Broadway.
1556. Hand Carriage. Allen & Bond, St. Paul, Minn.
501. Pavement, Stone and Wood Combined. Charles G. Waterbury, 116 Wall street.
315. Pavement, Block Floor and Street. Tobias New, 32 John street.
140. Prism Block for Street Pavement. George F. Ziegler, 59 Nassau street.

Group 3.

Models of Vessels for navigating the Ocean, Rivers, Lakes, and Canals; all apparatus connected with building, propelling, and steering Vessels; models of Locks, Docks, Aqueducts; structures and implements used in Navigation.

1304. "Model of Engine, Boiler and Twin Screws" used in 1804 on the Hudson river in opposition to Fulton's steamboat. Stevens Institute Technology, Hoboken, N. J.
758. Model of Stevens Battery, Model of Marine Engine, and model of Armor-Plated Explosive Battery. Stevens Institute Technology, Hoboken, N. J.
959. Model of Double Screw Iron-Clad Casemented Ship of War. R. G. McDougall, 20 Cortlandt street.

388. Miniature Ship, "Western Ocean." George W. Beverly, 32 South street.
142. Model of Ship. Henry Lewis, 4 Van Brunt street, Brooklyn.
304. Row Boats. Stephen Roberts, One Hundred and Fourteenth street and East river.
1576. Canal Tug. James K. Miller, 448 East Houston street.
979. Scull Oars. E. W. Page, 69 West street.
346. Life Preserver. Thomas R. Scott, 586 Sixth avenue.
1343. Liquid Compass, "Ritchie's." T. S. Negus & Co., 149 Water street.
1713. Flag Staff with Patent Halyards. William Albert, 53 South street.

GROUP 4.

Electric Telegraphs, apparatus used in constructing Overland and Submarine Telegraph Lines; all Apparatus for giving Signals and Alarms; Bells, etc; Implements and Contrivances used in transporting and distributing Mails; Package Express, and implements connected therewith; Hand Machines, Materials, and Implements used in Printing, Engraving, and Advertising.

1305. "Remainder of Original Atlantic Ocean Telegraph Cable." Stevens Institute Technology, Hoboken, N. J.
1501. Burglar Alarms and Attachments. William B. Guernsey, 110 Wall street.
1550. Telegraphs, Alphabetical Dial. John Sidell, 24 Duane street.
597. Telegraph Instruments. L. G. Tilotson & Co., 8 Dey street.
516. Telegraph Instruments. Charles Williams, Jr., Boston, Mass.
1566. Telegraphic Instruments. William E. Davis, 319 Newark avenue, Jersey City, N. J.
986. Printing Telegraph. Commercial Printing Telegraph Company, 77 Spring street.
1174. Locomotive, Electric. Prevost & Barjon, 36 Amity street.
748. Electric Battery and Barjon's Electric Fluid. Prevost & Barjon, 36 Amity street.
179. Burglar and Fire Alarm. A. H. Brooks & Co., 524 Grand street.
173. Printing Press, Card. John Keller, 63 Duane street.
160. Printing Press, Autographic. Charles Maurice, 160 William street.
138. Printing Press, "Novelty." W. Y. Edwards, 543 Broadway.
169. Printing Press for the Blind. Reuben Vose, 67 Wall street.
733. Paging Machine, Double. John McAdams, 528 Kent avenue, Brooklyn, L. I.
732. Folding Machine "Guard." John McAdams, 528 Kent avenue, Brooklyn, L. I.
117. Decorated Tin Plate Signs. B. J. Hathaway, 44 Cliff street.
164. Vulcanized Rubber Stamp. Benjamin H. Marvin, 743 Broadway.
600. Stamps, Stereotype and Hand. Cooke, Smith & Co., 544 Broadway.
186. Stamp, Eureka Check. J. G. Moody, 111 Broadway.
307. Copying Presses. T. Shriver & Co., 333 East Fifty-sixth street.

GROUP 5.

Fire Engines and Apparatus used in extinguishing Fires; Fire Escapes; Apparatus used in making and conveying Illuminating Gas for towns and cities; Gas Meters; Apparatus for supplying towns and cities with Water; Water Meters.

1534. Steam Fire Engine. Harrell & Hayes, Paterson, N. J.
348. Fire Extinguisher. J. B. Stillson, 407 Broadway.
177. Water Meter. Tice Manufacturing Company, 491 First avenue.
757. Water Meter. James Cochrane, 64 West Tenth street.
774. Water Meter. William E. Desper, Worcester, Mass.
1105. Water Meter. S. B. Everett, Waterbury, Conn.
924 Water Tubing, Wooden. William F. Moulton, Johnson, Vt.

Group 6.

Implements for expediting Trade; Contrivances used in the Store and Warehouse; Scales; Locks for Stores and Banks; Safes; Hoisting Apparatus; Shutters; Vault Lights; Reflectors, and Iron Columns, etc; Specimens of Ledgers, Account Books, Blank Book, Tickets, Tags, Cards; Business Flags; Glass and other Ornamental Signs; Figure Signs.

1127. Letter-Box, Patent. Safety Letter-Box Company, 113 Broadway.
460. Mirror Show Cards and Glass Signs. Ornamental Mirror Company, 39 Dey street.
163. Powder Kegs and Canisters, Paint Pails, etc., of Tin. Metallic Keg Company, 418 West Twenty-seventh street.
176. Scales and Beams. Brandon Manufacturing Company, Brandon, Vt.
334. Paper Trimmer. Todd & Pond, Corning, N. Y.
105. Paper Trimmer, Wall and Border. Hy. A. Smith & Co., 112 Reade street, New York.
1115. Tumbler Washer, Somers'. John Matthews, First avenue and Twenty-seventh street.
1570. Tumbler Cleaners. John Matthews, First avenue and Twenty-seventh street.
1558. Mucilage and Marking Pot. J. Austin & Co., 168 Fulton street.
1160. Envelopes, Straw for bottles. Charles J. Murphy, 43 Broad street.
615. Bottling Apparatus, Automatic. P. M. Sherwood, 85 Liberty street.
171. Sign, Ornamental Pedestal. Strong & Sons, 564 Broadway.
367. Papier Mache Block Letters, Show Cards, etc. Reeves & Tregaskis, 57 Maiden lane.
393. Show Cards, Fancy. Andrew J. Smith, 5 Park place.
768. Coal Barrow, Iron Frame. Fletcher, Harrison & Co., 267 West street.
903. Hoisting Machine. W. D. Andrews & Bro., 414 Water street.
1764. Safety Platform for Warehouse. Wm. D. Andrews & Bro., 414 Water street.
1765. Hoisting Machine, Differential Geared. Wm. D. Andrews & Bro., 414 Water street.
902. Coal Hoisting and Carrying Apparatus. W. D. Andrews & Bro., 414 Water street.
1393. Coal Hoisting and Carrying Apparatus. Green & Stancliffe. Manhattan Gas Works, N. Y.
1177. Hod Elevator, Endless Ladder. Jesse Powers, Forty-ninth street and Broadway, N. Y.
935. Hod Hoisting Elevator. Lloyd & Earle, Sixty-fourth street near Second avenue.
16. Stamping Pads and Cushions. George J. Busteed, 343 Third avenue.
396. Linen Marker, "Acme." C. G. Mortimer, 33 Barclay street.
928. Punch, Safety Check. Joseph B. Parks, 57 Broadway.
187. Show Stand and Store Stools. J. J. Wilson, 89 White street.
43. Store Stool, Earl Lock, Am. Store Stool Co., 25 Howard street.
386. Show Case. W. H. Core, 153 Chatham street.
912. Show Case and Spring. Hoffman & Fersch, 148 Chatham street.
377. Sifting Machines. George Sidey, 170 Tillary street, Brooklyn.
349. Flour Packer, "Eagle." J. Mattison, Oswego, N. Y.
531. Safes, Kerosene Oil. Allen Bros., Fairhaven, Vt.
753. Milk Can, Cream Freezer, etc. Frazer, Bell & Loughran, 51 Cliff street.
950. Cans and Trimmings. Iron-Clad Can Company, 51 Dey street.
335. Ale Pump, Eight-Pull. James M. Whitfield & Son, 262 Water street.
195. Lasts. Lawrence Condon, 41 Murray street.

154. Cigar Moulds. George J. Prentice, 197 Pearl street.
158. Seal Locks, American. American Seal Lock Company, 744 Broadway.
141. Lock, Bank. Thomas B. Worrall, Frankford, Pa.
1180. Sectional Screw, Model of. J. L. Jackson & Bro., Twenty-eighth street, between First and Second avenues.
1746. Oil Cabinet, Safety. Safety Oil Cabinet Company, 93 to 97 Liberty street.

GROUP 7.

Army Apparatus used in Movements or in Camp; Flags, Guns, Pistols, Swords, Models of Fortifications; Apparatus used in the Navy; Articles and Devices for School Buildings and Grounds; Useful and Ornamental Work and Devices for Churches and Cemeteries; Articles and Implements used on Public Works, not elsewhere designated.

662. Guns and Pistols. Onion, Haigh & Cornwall, 18 Warren street.
596. Revolvers, Smith & Wesson. M. W. Robinson, 79 Chambers street.
1135. Fire-Arms, Breech-Loading. E. Remington & Son, 193 Broadway.
921. Rifles, Breech-Loading. Ward & Co., 54 Wall street.
1575. Breech-Loading Firearms. Whitney Arms Co., New Haven, Ct.
1575. Whitney's Patent Breech-Loading Gun. New Haven, Conn.

VII. DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

Under the direction of Nathan C. Ely, William Collins, Henry H. Rogers.

GROUP 1.

Plants and Flowers.

743. Single Specimen Plant. George Such, South Amboy, N. J.
1144. Single Specimen Plant. William Chorlton, Staten Island.
744. Six Varieties of Variegated Leaved Plants. George Such, South Amboy, N. J.
745. Collection of Variegated Leaved Plants. George Such, South Amboy, N. J.
741. Collection of Ferns and Lycopodiums. George Such, South Amboy, N. J.
742. Specimen of Coffee Plant. George Such, South Amboy, N J.
1557. Bark from California Big Tree. William Knowland, 317 Broadway.
746. Collection of Miscellaneous Plants of House Culture. George Such, South Amboy, N. J.
1146. Ereanthus Ravenna. Wm. Chorlton, W. New Brighton, S. I.
1131. Alpine Plants (Sedum), 45 Varieties; Alpine Plants (Semper Vivum), 31 Species; Alpine Plants (Echeviria Metallica), 1 Species. William Chorlton, West New Brighton, S. I.
1132. Alpine Plants, Ornamental Basket; Rustic Sand. William Chorlton, West New Brighton, S. I.
1145. Alpine Plants, Design. William Chorlton, West New Brighton, S. 1.
1134. Plants and Flowers, Assorted. M. Rattey, 1245 Broadway.
764. Basket of Flowers. C. L. Allen & Co., 76 Fulton street, Brooklyn.
1125. Hand Bouquets, Pair of. J. N. Hauser, Sixty-sixth street, near First avenue.
765. Bouquets, Pair of. C. L. Allen & Co., 76 Fulton street, Brooklyn.
723. Floral Design. C. L. Allen & Co., 76 Fulton street, Brooklyn.
996. Floral Design. J. N. Hauser, Sixty-sixth street, near Second avenue.
1140. Floral Design. Walter L. Read, 66 West Thirty-fourth street.
1362. Floral Design. John N. Hauser, Sixty-sixth street, near Second avenue.
1387. Floral Design. H. A. Siebrecht & Co., Fifth avenue and Forty-second street.
1382. Floral Design. Alexander Mead, Greenwich, Conn.
1378. Wardian Case. Walter Reid, 66 W. Thirty-fourth street.

1323. Wardian Case. R. E. Corcoran, Providence, R. I.
1385. Basket of Flowers and Table Bouquet. Walter Reid, 66 W. Thirty-fourth street.
1384. Floral Design. Walter Reid, 66 W. Thirty-fourth street.
1376. Collection of Ferns and Lycopodiums. Walter Reid, 66 W. Thirty-fourth street.
1328. Collection of Dahlias. C. S. Pell, New York Orphan Asylum.
1327. Collection of Pom Pom of Bouquet Dahlias. C. S. Pell, New York Orphan Asylum.
1197. Dahlias, 25 varieties. A. G. Burgess, East New York.
1198. Dahlias, 50 Varieties Seedling. A. G. Burgess, East New York.
1552. Dahlias, 100 varieties. Col. A. J. Johnson, Newark, N. J.
1524. Dahlias, 50 named varieties and 40 seedling. A. G. Burgess, East New York.
1329. Collection of Asters. C. S. Pell, New York Orphan Asylum.
1331. Collection of Cut Flowers. C. S. Pell, New York Orphan Asylum.
1330. Collection of Zinnias. C. S. Pell, New York Orphan Asylum.
1391. Collection of Cut Roses. H. A. Siebreeht & Co., Forty-second street and Fifth avenue.
1383. Display of Named Verbenas. Alexander Mead, Greenwich, Conn.
1377. Collection of Miscellaneous Plants, of house culture. Walter Reid, 66 West Thirty-fourth street.
1340. Collection of Miscellaneous Plants, of house culture. Wm. Baker, 236 East Forty-second street.
1389. Collection of Plants, of house culture. H. A. Siebrecht & Co., Forty-second street and Fifth avenue.
1392. Rustic Hanging Baskets. H. A. Siebrecht & Co., Forty-second street and Fifth avenue.
1335. Specimen of the Tea Plant. Wm. Baker, 236 East Forty-second street.
1386. Single Specimen Plant, "Variegated American Aloe." David Deans, Astoria, L. I.
1341. Single Specimen Plant. Wm. Baker, 236 East Forty-second street.
1339. Four Specimen Plants in bloom. Wm. Baker, 236 East Forty-second street.
1338. General Collection of Variegated Leaved Plants. Wm. Baker, 236 East Forty-second street.
1336. General Collection of Ferns and Lycopodiums. Wm. Baker, 236 East Forty-second street.
1337. Six Varieties of Variegated Leaved Plants. Wm. Baker, 236 East Forty-second street.
1390. Variegated Leaved Plants. H. A. Siebrecht & Co., Forty-second street and Fifth avenue.
1367. "Cycas Revoluta," or Sage Palm. H. A. Siebrecht, 502 Fifth avenue.
1366. Rustic Flower Stand. H. A. Siebrecht, 502 Fifth avenue.
1359. Bouquets of Natural Grasses. Mrs. Chorlton, West New Brighton, S. I.
1388. Table Bouquet. H. A. Siebrecht & Co., Forty-second street and Fifth avenue.
1380. Suammus Bushes. H. Taylor, 254 West Fifteenth street.
766. Table Bouquet. C. L. Allen & Co., 76 Fulton street, Brooklyn.
1141. Table Bouquet. Walter L. Reid, 66 West Thirty-fourth street.
995. Table Bouquet. John H. Hauser, Sixty-sixth street, between First and Second avenues.
973. Dahlias. C. S. Pell, New York Orphan Asylum.
974. Collection of Bouquet Dahlias. C. S. Pell, New York Orphan Asylum.

706. Collection of Dahlias. C. S. Pell, New York Orphan Asylum.
727. Named Lilies. C. L. Allen & Co., 76 Fulton street, Brooklyn.
726. Named Gladioli. C. L. Allen & Co., 76 Fulton street, Brooklyn.
725. Double Zinnias. C. L. Allen & Co., 76 Fulton street, Brooklyn.
724. Miscellaneous Named Flowers. C. L. Allen & Co., 76 Fulton street, Brooklyn.
1142. Flower Pots, Earthen. Rouse & Turner, Jersey City, N. J.
1584. Bulbs, Seeds, Flowers, Pots, etc. Richardson & Gould, 245 Broadway.
1590. Bulbs. B. K. Bliss & Sons, New York.
1557. Bark from California Tree. Wm. Knowland, 317 Broadway.
1508. Cox Comb. John Lundmark, Eighty-first street, between First and Second avenues.
1718. Collection of Seedling Dahlias. A. D. Burgess, East New York.
1719. Collection of Named Dahlias. East New York.
1722. Cox Comb. Nicholas Kassel, Sixty-seventh street, near Third avenue.

GROUP 2.

Fruits, Vegetables, Cereals, Roots, and Seeds.

622. Apples, 110 Named Varieties. Wm. H. Bailey, Plattsburgh, N. Y.
1592. Apples, 56 Varieties. Ellwanger & Barry, Rochester, N. Y.
621. Pears, 225 Named Varieties. Ellwanger & Barry, Rochester, N. Y.
738. Pears, 43 Named Varieties. William L. Ferris, Throgg's Neck, L. I.
734. Pears, 12 Named Varieties. S. Springstead, Unionport, N. Y.
1591. Pears, 50 Varieties. Ellwanger & Barry, Rochester, N. Y.
1109. Pears, "Stephenson Genesee." S. Springstead, Unionport, N. Y.
800. Pears, "Beurre Diel." Mrs. John W. Chambers, 296 Pearl street, Brooklyn, L. I.
946. Pears, 3 Varieties. G. G. Bergen, Brooklyn, L. I.
967. Pears, "Vicar." S. B. Kenyon, 307 East One Hundred and Eighteenth street.
969. Pears, "Duchesse." S. B. Kenyon, 307 East One Hundred and Eighteenth street.
1139. Pears, "Duchesse d'Angouleme." G. F. B. Leighton, Norfolk, Va.
1150. Pears, "Vicar of Wakefield." James Wiggins, Weehawken, N. J.
1172. Pear, Single Large. F. A. Gunz, Carlstadt, N. J.
982. Pears, "Duchesse d'Angouleme." B. K. Bliss & Son, 23 Park place.
1529. Pears, 5 Varieties. Garrett A. Lydecker, Englewood, N. J.
1535. Pears, Seckel. Henry Johnson, Gravesend, L. I.
1543. Pears, Seckel. Dr. C. Weeks, Bloomfield, N. J.
1355. Beurre Diel Pears. S. Springstead, Unionport, N. Y.
1356. Louise Bonne de Jersey Pear, Fulton Pear. S. Springstead, Unionport, N. Y.
1358. Calious Pear, Eurbenese Pear and Beurre Bosc Pear. S. Springstead, Unionport, N. Y.
1363. Duchesse d'Angouleme Pear. N. T. Romaine, Leonia, N. J.
1316. Peach, Seedling Cling. S. Springstead, Unionport, N. Y.
1200. Peach, Montrieux. H. E. Courvoisier, West Hoboken, N. J.
784. Peaches. S. P. Van Winkle, Paterson, N. J.
795. Peaches. Henry Peters, Brooklyn, L. I.
797. Peaches. Mrs. M. N. Shearman, 7. West Twenty-ninth street.
992. Peaches. D. Farr, 2331 Third avenue.
1110. Peaches. "Late Crawford." S. Springstead, Unionport, N. Y.
1111. Peaches, "Rare Ripe." S. Springstead, Unionport, N. Y.

1148. Peaches, "Seedling." J. W. Greene, 474 Warren street.
1143. Peaches, "Seedling." J. C. Watson, Brooklyn, L. I.
Peaches, "Seedling Cling." S. Springstead, Unionport, N. Y.
1549. Peaches, 3 Named Varieties. S. Springstead, Unionport, N. Y.
1589. Vegetables. B. K. Bliss & Sons, N. Y.
968. Quinces, "Apple." S. B. Kenyon, 307 E. One Hundred and Eighteenth street.
1541. Quinces, "Pear." William Callard, Bellville, N. J.
1325. Quince, Apple. Mrs. Elizabeth Sleight, Mount Vernon, N. Y.
1357. Cranberries. W. S. Easton, Mansfield Centre, Conn.
1190. Hickory Nut, "Paper Shell." H. Hales, Ridgewood, N. J.
1353. Potatoes, Early Rose. S. Springstead, Unionport, N. Y.
1352. Potatoes, 13 Varieties of Seedling. S. Springstead, Unionport, N. Y.
1351. Potatoes, King of the Early. S. Sprinstead, Unionport, N. Y.
1324. Potatoes, "Andes Seedling." Mrs. Elizabeth Sleight, Mount Vernon, N. Y.
1191. Potatoes, "Peerless." J. L. Conover & Crawford, Red Bank, N. J.
1308. Potatoes, "Breeze No. Six." G. D. Hopkins, West Rupert, Vt.
1349. Potatoes, White Sweet. S. Springstead, Unionport, N. Y.
1523. Potatoes, 74 Varieties. Gerard C. Brown, Croton Falls, N. Y.
1350. Potatoes, Yellow Sweet. S. Springstead, Unionport, N. Y.
1317. Corn, White Flint. S. Sprinstead, Unionport, N. Y.
1318. Corn, "90 Day." S. Springstead, Unionport, N. Y.
1354. Beets, Blood, and Cucumbers. S. Springstead, Unionport, N. Y.
1373. Beet. G. S. Chapin, 34 Ormond place, Brooklyn, L. I.
785. Tomato, "Beefsteak." Edward McFarlan, Brooklyn.
993. Tomato, "Archer's Beauty." W. H. Archer, Jerome, N. Y.
1374. Tomatoes. G. S. Chapin, 34 Ormond place, Brooklyn, L. I.
1525. Tomatoes, 5 Varieties. S. Springstead, Unionport, N. Y.
1567. Tomatoes. Miss Weiss, Tarrytown, N. Y.
1527. Peppers. S. Sprinstead, Unionport, N. Y.
1394. Beans, Bunch of. Levi Dodge, Lempster, N. H.
1546. Grapes. William Baker, 236 East Forty-second street.
1138. Grapes, "Walter Seedling." L. M. Ferris & Son, Poughkeepsie, N. Y.
1151. Grapes, 6 Named Varieties, grown under glass. John F. Seaman, Kingsbridge, N. Y.
1152. Grapes, 3 Named Varieties, grown under glass. John F. Seaman, Kingsbridge, N. Y.
1153. Grapes, Single Bunch, grown under glass. John F. Seaman, Kingsbridge, N. Y.
1173. Grapes. F. A. Gunz, Carlstadt, N. J.
1580. Concord Grapes. N. J. Burchell, New Rochelle, N. Y.
1585. Apples and Grapes. E. A. Coleman, Kansas.
1526. Strawberry Plants, 5 Varities. S. Springstead, Unionport, N. Y.
1124. Raspberries, "Welcome." C. B. Hornor, Mt. Holly, N. J.
162. Bone, Bone Meal and Flour, etc. Lister Bros., Newark, N. J.
1104. Seeds and Garden Requisites. Jas. Fleming, 67 Nassau street.
987. Potatoes. Henry A. Tilden, New Lebanon, N. Y.
1154. Cucumber, "Tolly Qua." J. F. Seaman, Kingsbridge, N. Y.
1538. Cucumbers, California. Adolph Hopstock, 152 East One Hundred and Tenth street.
1545. Onions, Red. J. A. Wagner, Holtsville, L. I.
1535. Onions, Red Globe. J. A. Wagener, Holtsville, L. I.

1528. Squashes and Pumpkins. S. Springstead, Unionport, N. Y.

GROUP 4.

Ploughs, Diggers, Cultivators, Harrows, Drain Pipe, and Implements used in preparing the Soil; Pruning Knives, and all Implements for cultivating Plants and Trees; Hot-house Apparatus.

791. Ploughs, Steel. Collins & Co., 212 Water street.
1511. Ploughs. John Moore, 193 Front street.
109. Plough, Hard Steel, No. 3. Ames Plough Co., 53 Beekman street.
106. Ploughs (Session & Knox Patent). Ames Plough Co., 53 Beekman street.
326. Plough, Gang. A. B. Wyckoff, Hightstown, N. J.
107. Plough, Telegraph Iron, with Wheel and Cutter. Ames Plough Co., 53 Beekman street.
786. Excavator. R. W. Davis, Bath, N. Y.
108. Cultivator. Ames Plough Co., 53 Beekman street.
110. Hand Cultivator and Seed Sewer, Single or Combined. Ames Plough Co., 53 Beekman street.
366. Harrow, Cultivator, and two Ploughs. Robert C. Reeves, 185 Water street.
703. Drain Pipe, and Terra-Cotta Ware. William Shute & Co., 417 W. Eighteenth street.
756. Drain Pipe, Carbon Cement, Concrete, etc. Thomas J. Barron, 145 Steuben street, Jersey City, N. J.
134. Drain Pipe. Norris & Miller, 229 E. Forty-first street.
707. Seed Drill and Planter. William F. West, Haverstraw, N. Y.
938. Garden Planter. William F. West, Haverstraw, N. Y.
767. Dirt Barrow, Tubular Frame. Fletcher, Harrison & Co., 266 West street.
980. Boilers for Heating Green-Houses, etc. John G. Wilson, 137 Centre street.
1562. Milk Cart or Van. John Harris, 237 East Twenty-fourth street.
364. Burdick's National Straw, Hay and Stalk Cutters. Robt. C. Reeves, 185 Water street.
1753. Plough, Combination Iron Corrosive. Decatur & Cox, 197 Water street.
1752. Corn Planter and Fertilizer Dropper. Edward P. Harnish, Felton, Del.
1754. Steamer for Cooking Food for Cattle and Warming Green-Houses, etc. Decatur & Cox, 197 Water street.
1788. Corn Planter. F. W. Wurster, 186 First street, Brooklyn, N. Y.
1779. Pulverizing Harrow. F. W. Wurster, 186 First street, Brooklyn, N. Y.

GROUP 5.

Mowers, Reapers, Scythes, and Implements used in gathering the products of the soil; Threshing Machines, Corn Shellers, Grain, and other Farm Mills.

343. Mower and Self-Raking Reaper, "Buckeye." Adriance Platt & Co., 165 Greenwich street.
953. Mowing Machines. Farmers' Mower and Reaper Co., 194 Broadway.
943. Mowing Machine. Higganum Manufacturing Co., Higganum, Conn.
711. Mowing Machine, "Advance." F. W. Wurster, 186 First street, Brooklyn.
362. Mowing Machine. Sprague Mowing Machine Co., Providence, R. I.
356. Mower, Direct-Draft "Eureka." Wilber's Eureka Mower and Reaper Manufacturing Co., Poughkeepsie, N. Y.
120. Reaper, Self-Rake, with Mowing Attachment. W. A. Wood, 40 Cortlandt street.
121. Mowing Machine, Iron Frame, Walter A. Wood, 44 Cortlandt street.

705. Mower and Reaper, "Columbian," Combined Self-Controllable Rake. R. F. Johnson, Twenty-fourth street and Tenth avenue.
1787. Harvester, "Young America." Frederick P. Markham, Buffalo, N. Y.
700. Lawn Mowers, "Excelsior" Hand, No. 0. Chadborn & Caldwell Manufacturing Co., Newburgh, N. Y.
801. Lawn Mowers, "Excelsior" Hand, No. 1. Chadborn & Caldwell Manufacturing Co., Newburgh, N. Y.
802. Lawn Mowers, "Elcelsior" Hand, No. 2. Chadborn & Caldwell Manufacturing Co., Newburgh, N. Y.
699. Lawn Mower, "'Excelsior" Hand, No. 3. Chadborn & Caldwell Manufacturing Co., Newburgh, N. Y.
752. Lawn Mowers. Griffing & Co., 60 Cortlandt street.
994. Rake, "Peerless" Horse. J. D. Brown, Boston, Mass.
111. Hay Tedder, "American." Ames Plough Co., 53 Beekman street.
327. Hay Tedder, "Bullard's." Nash & Brother, 110 Liberty street.
944. Hay Spreader. Higganum Manufacturing Co., Higganum, Conn.
1593. Hay Loading Machine. American Hay Loading Machine Co., Troy, N. Y.
113. Corn-shellers. Ames Plough Co., 53 Beekman street.
365. Cider Mill. Robert C. Reeves, 185 Water street.
952. Scoop Harvesting. John H. Porter, 415 Hudson street.
112. Mill, Corn, Coffee, and Drug. Ames Plough Co., 53 Beekman street.
364. Hay and Stalk Cutter. R. C. Reeves, 185 Water street.
1372. Mowing Machine. Universal Mower and Reaper Co., 91 Liberty street.
1185. Lawn Mower, Novelty. Phineas Smith, 116 Chambers street.
587. Lawn Mower, Victor. Arbeiter Lawn Mower Co., Hartford, Conn.
1397. Horse Rake, Peerless Self-operating. Peerless Horse Rake Co., P. O. Box 10 (19 Lindall street), Boston, Mass.
1721. Patato Digger. Pratt & Co., 87 Chambers street.
1756. Potato Harvester, Loader and Sorter. William Peacock, 28 Jefferson street.
1762. Potato Harvester. R. T. Trall, M. D., 1516 Chestnut street, Philadelphia, Pa.
1777. Corn and Coffee Mill. Decatur & Cox, 197 Water street.
1361. Railway Hay-pitching Apparatus, "Hinman's." Homer M. Fitch & Co., Lithgow, Dutchess county, N. Y.

Group 6.

Churns, Cheese Presses, and all articles used in Dairy, Farm House, and Farm Stable, not else where enumerated.

1364. Steamer and Caldron, Eagle. E. E. Sill, Rochester, N. Y.
1345. Water-Drawer, Excelsior. Chadborn & Caldwell Manufacturing Co., Newburgh, N. Y.
310. Churn, The Revolution. Levi Dederick, 77 Beach street.
1136. Churn, Atmospheric (tin). Iron-clad Can Co., 51 Dey street.
133. Hay Press, Eagle. Ingersoll & Dougherty, Greenpoint, L. I.
324. Hay and Straw Cutter. H. Baldwin, New Haven, Conn.
363. Bee Hives, Honey Extractor, Case of Bees and Glass of Honey. Homer A. King, 14 Murray street.
771. Hair-cutting and Sheep-shearing Machine, American. William Earl, Jr., Nashua, N. H.
958. Poultry Fountain, Flowing Spring. B. Van Gaasbeck, 12 First street.
137. Fence, Combination. Samuel Adger Darrach, 57 Liberty street.
1739. Kenyon's Corn Picking and Husking Machine. B. B. Vernam, Elizabeth, N. J.

GROUP 7.

Products of the Soil used in the Arts—Wood, Hemp, Flax, Cotton, etc.; Products of Animal Growth—Wool, Silk, Hair, Feathers, Down, Horn, Bone; Live Animals, whenever the Board of Managers shall decide to admit them.

150. Rustic Work, twenty-seven pieces. James King, New Haven, Conn.

178. Cut, Crushed and Winnowed Hay and Straw. Hay Cutting and Baling Co., Foot West Eleventh street.

1126. Talpacide or Mole Trap. Joseph Wilson, 25 Bond street.

363. Animal Trap, Self-adjusting. G. R. Harding, Manchester, Va.

REPORTS OF JUDGES.

Every article shown in the fortieth exhibition was examined and reported upon by competent judges appointed for that purpose. Each report, or so much thereof as was asked for by the exhibitor interested, has been engrossed and signed by the president and secretaries of the Institute, and presented to such exhibitor.

To give all these reports in full would occupy space in the volume of Transactions which must be reserved for a statement of the operations of other branches of the Institute. A few reports on machines and processes of unusual merit are hereto annexed, together with careful records of experimental tests and a summary of their results, made by order of the board of managers.

REPORT ON BENJAMIN CHEW TILGHMAN'S SAND-BLAST PROCESS.

To the Board of Managers:

Gentlemen.—After a full and impartial examination of the specimens of cutting hard substances by the sand-blast process, the undersigned judges report, that the process is designed to execute ornaments, inscriptions in intaglio or relief, or complete perforations, in any kind of stone, glass and other hard and brittle substance; or to cut deep grooves in natural rocks, in order to facilitate the process of quarrying; or to make circular incisions around the central mass of rock in the process of tunneling; or to remove slag, scale and sand from the surfaces of metal castings; or to clear the interior surfaces of boilers or boiler tubes of incrustations; or to cut ornaments or types from wood as well as from stone; or to depolish the surface of glass, producing, by the use of stencils or other partial protections, such as the bichromatized gelatine of photographic negatives, every variety of beautiful figures, including copies of the finest laces and the most delicate line engravings; or to prepare copper-plates in relief for printing, by making gelatine photographic pictures upon smooth surfaces of resin or pitch, cutting them out by the blast and afterward molding from them and electrotyping the molds.

This process is without precedent. The use of sand in sawing marble or in grinding glass by common methods hardly furnishes an analogy.

The apparatus consists of a tube of small diameter concentrically placed within a somewhat larger tube, and connected, the former with a reservoir of sand and the latter with a generator of high steam. The vessel of sand being placed higher than the mouth of the tube, its contents discharge themselves by their gravity; but on the admission of steam to the outer tube, the discharge is accelerated by aspiration or exhaustion, while the sand discharged is driven in a forcible current against the surface to be acted upon. The distance of this body from the jet is greater or less, according to the object to be effected. When mere surface cutting or depolishing of glass is desired, an air blast with a pressure not exceeding four inches of water is employed. A fan suffices to produce this; and the jet, instead of being cylindrical, is a broad and thin sheet. The fan, occupying the lower part of the apparatus, drives the sand through a circuit, in which, on the descending side, it encounters the object to be acted upon, and then, falling further, comes under the action of the fan again, and so continues to be used over and over again.

The utility of this invention is apparent in the statement above given, of the purposes to which it is applicable. It is regarded by the judges as being one of the most remarkable and valuable inventions which the age has produced.

Considering, therefore, the great originality, importance and value of this process, and the great variety and diversity of applications, both useful and ornamental, of which it is capable, the judges unanimously recommend that the great medal of honor of the Institute be conferred upon the ingenious inventor, as a well merited distinction.

F. A. P. BARNARD.
ALFRED H. MAYER.
HENRY MORTON.

Professor Egleston, of Columbia College, made experiments with the sand-blast, the results of which are given in the following letter:

NEW YORK, *November* 13*th*, 1871.

CHAS. WAGER HULL, Esq.:

DEAR SIR.—I inclose the results of the experiments which I made at the fair of the American Institute, on the effect of the sand-blast on substances of different hardness. I give below the loss in weight and the time required to effect it:

	Grains.		
Corundum from Delaware Co., Pa	1.49000	Black Diamond..	1.2607
	0.22021	Time, 3 minutes .	1.2235
Time, 30 seconds	1.16979	Loss	0.0372
Emery, Chester, Mass.....	16.65		1.2235
	11.6968	Time, 5 minutes .	1.1738
Time, 1 minute loss...	4.9532		0.0497
Topaz (Soute d'eau).......	2.0970		1.2607
	0.1263	Time, 8 minutes .	1.1738
Time, 1 minute loss...	1.9707		0.0869
Topaz pebble	9.774		
	7.6241		
Time, 1 minute loss...	2.1499		

The emery from Chester, Mass., is composed, to some extent, of magnetic iron ore. A hole was made through the specimen, leaving the corundum projecting, showing that the iron was affected much more rapidly than the harder material.

A conical hole was made in the topaz pittle, which in another minute would have penetrated it, had the blast been allowed to act longer. The surface of the black diamond was reduced from a very rough face to almost a plane one.

The examination of these specimens under the microscope, show exactly the same characteristics as those exhibited by the rolled specimens of the harder stones, and explain how, in nature, substances like diamond and topaz may be worn away by the action of other minerals, which are even three degrees, of the scale of hardness, softer.

These results are so remarkable as to lead me greatly to regret that I did not receive your communication in time to make more extended experiments, as I should like to have done, with substances softer than quartz sand. I wrote to the owner of the sand-blast machine, in the hope of being able to report to you an extended series of investigations with different materials and softer sand. It will, however, be so long before the machine will be ready to work again in New York, that I have decided to report now.

The action of this machine on the different rocks and minerals will undoubtedly go a great way in explaining many difficult problems in structural geology, and I have no hesitation in saying that I consider results of these experiments as being some of the most, if not the most, important of the fair.

With many thanks to you and the managers of the fair, for furnishing the diamond used in the experiments,

Yours very truly,

THOS. EGLESTON.

In conformity with the recommendation of the judges, the board of managers awarded to Benjamin Chew Tilghman, Esq., of Philadelphia, Pa., the great medal of honor, for his invention of the sand-blast process.

O. D. & E. C. WOODBURY'S MACHINE FOR MAKING BRUSHES.

To the Board of Managers:

GENTLEMEN.—After a full and impartial examination of the above named machine, the undersigned judges make report that this eminently novel, ingenious and useful invention embraces a new method of making brushes, and a machine admirably adapted to the manufacture of brushes according to that method.

Prior to this invention, brushes were either made by hand or by devices which assisted parts of the manufacture, but did not change the method of construction of the hand made brushes. The bunches of bristles were generally secured either by cement or by wires, which passed through the bunch on the back of the block or stock, the holes in the block being afterward covered by securing a covering to the back of the block.

This machine consists of an adjustable table having an overhanging arm which sustains most of the working parts, which are driven by steam or other power when in operation. The bristles are arranged in a metallic comb, which passes on guides through the machine. The bristles are arranged, are seized by teeth and forced through a spiral passage-way and so turned that they rest against a guide-way, and so turned that they rest against a guide; a point divides a sufficient quantity to form one bunch of bristles; below this point is a wedge which moves the bunch to a position directly over a tube and beneath a grooved and slotted plunger, which descends upon the center of the bunch and forces it into the tube, doubling the bristles so that they lie in the grooves of the plunger. At the lower part of this tube is a nut having spiral threads within it; this nut is pierced with holes, and when the double bunch of bristles reaches the nut, a wire, moved by automatic feed from a reel, is thrust through the nut and fold in the bristles, and then cut off to the required length. The plunger tube, nut and inclosed bristles now descend to the stock or block previously pierced with holes, to receive the bunches. The block is sustained by an adjustable plate and is brought to its proper position by a finder or guide. As soon as the nut reaches the block, the plunger turns and twists the cone around the bunch into the spiral grooves which screw the bunch of bristles through the nut into the holes in the stock. These movements are effected so rapidly that sixty bunches can be inserted in one minute; the movements are entirely automatic. The difference between this invention and the usual methods of making brushes, consists in the novel means by which the bristles are inserted and secured in the block. This consists in forming a double threaded screw of wire, which incloses the bunch and passes through the fold in the bristles; and also in the machine by which the wire is thus formed and by which the bunches are inserted.

These changes and modifications create a new system of making brushes; and affect the quality of the brushes thus made, the economy of labor, materials and the rapidity of manufacture so favorably, as to entitle the invention to the highest commendation of the Institute.

JOHN MATTHEWS.
EDWARD A. RAYMOND.
M. A. SUTHERLAND.

H. AND J. L. YOUNG'S DIAMOND GANG SAW.

To the Board of Managers:

GENTLEMEN.—After a full and careful examination of the above named machine, the undersigned judges report that the exceedingly useful, ingenious and novel system of sawing or dividing stone into slabs, as embodied in the construction and mode of operation of this machine, is believed to be the first practical application of the diamond to this purpose; such work being now done by plates of iron having a reciprocating motion, and supplied with sand and water. The machine consists essentially of a massive framework of timber, to sustain the working parts, and having a sash or framework, for sustaining the saw blades, which rests upon slides slightly inclined, and is driven to and fro by cranks. The block of stone is inclosed in a framework or cage, and is raised toward the saws by massive screws, driven by an automatic adjustable feed. The carbons or black diamonds, forming the cutters, are firmly set in steel blocks, two or more of which are inserted in the saw blades, so that at each stroke one block of diamonds is withdrawn from the end of the stone. An ingenious arrangement of guides keeps the saw blades in position. The diamonds are arranged to cut only in one direction, as the slides upon which the sash rests are automatically raised by cams on the return stroke of the saws, so that the diamonds are relieved from the to and fro thrust, which might tend to loosen them. Water is kept constantly supplied to the diamonds, so that they are kept cool, and the cuttings of stone are washed from the kerf. This machine cuts stone, marble, etc., about twelve times faster than the same work can be done by the system generally in use, and thus effects a great economy in this important branch of industry. We deem the changes and modifications embraced in this invention of such importance as to entitle it to the highest commendation of the Institute.

JOHN MATTHEWS.
EDWARD A. RAYMOND.
M. A. SUTHERLAND.

THE GOODYEAR BOOT AND SHOE SEWING MACHINE CO.'S BOOT AND SHOE SEWING MACHINE.

To the Board of Managers:

Gentlemen.—After a full and impartial examination of the above named machine, the undersigned judges make report that this novel, ingenious and eminently practical machine is designed particularly for sewing what are known as turned shoes; it is also adapted for sewing welts or inseams.

Prior to the invention and construction of this machine, work of this character was generally performed by hand. Machines are in use in which the upper is sewed to the sole by stitching directly through the sole of the shoe, in which case an insole is necessary, to which the upper is first secured by nails, and the shoe is then removed from the last before sewing it in the machine.

This machine consists essentially of a large upright column sustaining the working parts. A last-holder or jack, being a long lever so constructed as to sustain the shoe and to permit it to be turned as may be necessary during the operation of sewing, swings freely from a joint near the foot of the column. The needle, curved to a circle of less than two inches in diameter, is operated by a geared segment. Most of the movements are given by cams. The thread passes through a reservoir of wax, heated by a gas jet, and the passages through which the thread passes to the needle are also so heated. The shoe is lasted in the usual way with small tacks driven between the two channels, which are made by an auxiliary machine. The last is then mounted on the jack; the machine is put in motion by a treadle; the upper and sole are pressed firmly together, while being sewed, by steel fingers, which insures the tightness of the seam. The operator guides the shoe while the stitching is progressing, and can instantly stop the action of the needle by a movement of his foot. A pair of shoes can be completely stitched in from one to two minutes, and the character of the work is good.

The difference between this machine and others for like uses consists chiefly in the employment of a curved needle, working within a very small circle. Such a needle is required to do stitching required for this kind of work. Various other features necessary to operate this kind of needle, and possessing great novelty and ingenuity, are embraced in the machine.

These changes and modifications favorably affect the economy and quality of the work required in articles of almost universal use, and in so marked a degree as, in the opinion of your judges, to merit the highest commendation of the Institute.

JOHN MATTHEWS.
EDWARD A. RAYMOND.
M. A. SUTHERLAND.

THOMAS SHAW'S COMPOUND PROPELLER PUMP.

To the Board of Managers:

Gentlemen.—After a full and impartial examination of the above named pump, the undersigned judges make report that this pump is designed for elevating fluids, and is capable of adaptation to every form of raising or forcing water; the extent of the work done, that is, weight of fluid elevated and height at which delivered, being only a question of strength of material and power applied to accomplish the work.

The construction of this pump is as follows: In the center of a vertical cylinder or tube of any desired diameter and length is placed a shaft, upon which are secured, at proper distances apart, sections of propeller blades, upon the interior surface of the cylinder or tube; above these are oblique stationary segments of opposite pitch, to counteract the rotating motion imparted to the fluid raised by the centrifugal action of the screws in rapid revolution, and change it to an upward current. The thrust upon the vertical shaft, imparted to it by overcoming weight of load or work done, is arrested and received upon a comparatively frictionless water-bearing. This bearing consists of a cast iron beam which rests upon the top elbow of the pump, and upon which are secured pillars supporting a stationary disc, provided with an ordinary stuffing box, through which revolves the propeller shaft; under a dome, which rests on the stationary disc, is another disc, which is secured to the propeller shaft and revolves with it, and which is provided with an annular piston with ring packing.

Water is forced through an ordinary pipe between the stationary and revolving discs, under a pressure equal to the weight to be sustained per square inch, which is confined between them by the annular piston, and separating them by a film of water upon which the revolving disc floats, sustaining the weight of the column of water. Any surplus water forced between the discs, and lifting the revolving disc higher than a given point, the annular piston is thereby raised from off the stationary disc, and allowing the water to pass out under it, which is received into the dome and is returned through an ordinary pipe to the tank from which the supply is obtained. The action of the screws secured on the vertical shaft moves the water upward with more or less velocity, imparting to it a given momentum; the centrifugal action imparted to the fluid being counteracted and arrested by the oblique stationary segments of opposite inclination upon the interior of the cylinder, causing the water to move in its upward direction. The screws being placed at intervals above each other upon the rapidly revolving central shaft or axis, receive and impart to the moving ascending column of water, in regular succession, the requisite impetus or force required to keep it moving, without material change in its velocity, continuously to point of discharge.

This pump, as compared to all devices for the purposes intended, is more simple in its construction; involving no complication of parts, little liability to derangement, efficient in its action, and capable of performing an amount of work, limited only by strength of material and power requisite, and for these reasons, we consider it well deserving the very highest consideration of the honorable board of managers, in view of its great value and merit for the purposes intended, and as a proper recognition of this invention, we recommend your honorable board to award it the highest honor.

WM. W. W. WOOD.
A. H. SMITH.
JAMES HOW.

C. H. HALL'S WATER ELEVATING APPARATUS.

To the Board of Managers:

GENTLEMEN.—After a full and impartial examination of the above named apparatus, the undersigned judges make report that this is a machine for raising water (termed a Pulsometer), by the force of steam acting directly upon it, and belongs to a class heretofore known as steam or vacuum pumps; since the experiment of De Caus, in France, about the year 1615 in this direction, many eminent engineers and others have spent much time (both in this country and in Europe) in inventing and perfecting a vacuum pump to work continuously, raising its own water by vacuum, discharging it by direct steam pressure, so as to keep up a uniform motion or steady delivery.

This has never before been done successfully; the manner in which Mr. Hall applies the steam, the mode of condensing it and the method of operating the valves (automatic), we believe to be new. And we are of the opinion this pump will be of great value to the mining and manufacturing interests of the country, in view of its simplicity and adaptation to the many purposes for which it can be used.

We are requested by the inventor to restrict this report to the brief description above given referring to the construction and method of operation of this apparatus, in view of giving no further publicity to the points embracing the essential features of his invention, until his patents therefor are issued.

We recommend this invention to your honorable board as one of great merit, destined to supersede many of the machines and more expensive methods heretofore used for raising fluids within the limits to which the Pulsometer is especially adapted.

WM. W. W. WOOD.
A. H. SMITH.
JAMES HOW.

REPORT OF THE COMMITTEE

APPOINTED TO

TEST STEAM BOILERS

AT THE

AMERICAN INSTITUTE EXHIBITION, 1871.

To the Board of Managers, American Institute of the City of New York:

Gentlemen:—The undersigned, the Committee appointed by you as Judges in Department V, Group I, beg leave to report as follows, in reference to the steam boilers entered in competition at the industrial exhibition of the Institute, just closed:

The boilers thus entered were five in number. Taken in the order in which we tested them, they were the Root, the Allen, the Phleger, the Lowe, and the Blanchard boilers.

The Committee propose to compare these boilers, and to state what they consider their relative values in the following points, viz.: 1st. Safety. 2d. Durability. 3d. Ecomomy in fuel. 4th. Capacity for making steam. These four points are believed to cover all essential considerations in selecting a good steam boiler, with the single exception of first cost, which can be more satisfactorily investigated by the purchaser than by your committee.

1*st. Safety.*—The first three boilers named above, the Root, the Allen, and the Phleger, belong to a class which is rapidly and deservedly coming into favor, and which is known as the "sectional boiler."

In this class, of which there are many different kinds in the market, the water space, and frequently the steam space of the boiler, is contained in a large number of comparatively small compartments, each of which is very strong, and the explosion of any one of which is not likely to result in that widespread destruction of property, and that great loss of life which so frequently follows the explosion of the older and more common forms of steam boilers.

Your Committee feel confident that the introduction of this class of steam boilers will do much toward the removal of the cause of that universal feeling of distrust that renders the presence of a steam boiler so objectionable in every locality. The difficulties in thoroughly inspecting these boilers, in regulating their action, and other faults of the class, are gradually being overcome, and the committee look forward with confidence to the time when their use will become general, to the exclusion of the older and more dangerous forms of boilers.

Your Committee consider that the competing boilers should be placed in the following order, as respects safety, and they accord them marks on a scale of 10; *ten* representing a perfectly safe boiler, and *zero* a worthless one:

1st.	2d.	3d.	4th.	5th.
Root.	Allen.	Phleger.	Blanchard.	Lowe.
9.	8½.	7.	6.	5½.

2*d*. *Durability.*—On this point, as well as the preceding, the Committee can state only their opinion. To make a perfectly reliable determination by actual experiment and observation is, of course, beyond their power. In their judgment, however, these boilers would, if thoroughly tested, be found to stand in the following order, and to be deserving of the following marks for durability:

1st.	2d.	3d.	4th.	5th.
Root.	Allen.	Phleger.	Lowe.	Blanchard.
9.	8½.	6.	5½.	5.

3*d*. *Economy of fuel.*

4*th*. *Capacity for making steam.*

On these two points your Committee felt it their duty to make a careful report, based upon a thoughtfully devised and critically accurate series of experiments.

The usual test of the economy of a boiler and of its capacity for making steam consists simply in determining the quantity of water passing through it and the amount of fuel consumed in the same time, taking the weight of water used per pound of coal as a measure of the economy, and the total amount of water recorded in a given time as a measure of the steaming capacity.

But steam boilers usually—and invariably when unprovided with superheating apparatus—furnish "wet steam," and the weight of water passing off unevaporated is sometimes greater than the real weight of steam made. In order to make a reliable and valuable report upon these points, it becomes necessary to determine what is the *real* evaporation of each boiler and what weight of water passes over unevaporated.

Another extremely important fact, and one which should alone induce the Committee to propose and the Institute to permit them to adopt, an exact method of determining the true evaporative efficiency of the steam boilers presented for their judgment, is that ignorant or dishonest venders of peculiar forms of boilers have frequently deceived the public and have imposed upon purchasers by apparently well substantiated statements that their boilers have, by actual test, evaporated fourteen, fifteen, or even in some cases twenty pounds of water per pound of fuel consumed—the purchaser being unaware of the fact, so well known to scientific men and to engineers, that were it possible to obtain one pound of coal absolutely free from all impurities and composed of pure carbon, it would, if burned where no loss of heat could take place, and with the feed water at a temperature of 212 degrees Fahrenheit, evaporate but about fifteen pounds of water, and that under the usual circumstances of comparatively cold feed water and high pressure of steam, and with waste of heat by the chimney and in every direction by radiation, *very much less than fifteen pounds* must be evaporated by the very best boiler that man can build.

In order, therefore, to assist honest and skillful builders in preventing such injury of their business by those who would either knowingly or ignorantly take advantage of the lack of information possessed by the public, the Committee considered it a duty and a privilege to furnish, if possible, a weapon that might be made effective in protecting the public as well as manufacturers against such ignorance or dishonesty. This they proposed to do by determining accurately the performance of these five boilers, which they considered to include some that rate among the best boilers made, *and thus to furnish a standard* that should at all times be valuable for purposes of comparison.

The method adopted by the Committee of Judges is an extremely simple one in principle, and has often been before proposed by engineers. Its earliest conception, probably, dates many years back. The expense attending the building of the necessary apparatus and the preparations for, and the prosecution, of such an exact investigation, has prevented the earlier adoption of the plan, notwithstanding the fact that its importance has long been recognized. The intelligent liberality of the Board of Managers, who promptly acquiesced in the proposal of the Committee, and directed the committee of the board, to whom was assigned Department V, to assist in the prosecution of the work, has enabled the American Institute to practically inaugurate this method of testing steam boilers. The apparatus required in conducting the proposed tests was prepared by direction of the chairman of the committee, under the immediate supervision of Mr. J. W. Blake, the Superintendent of Machinery. To the competing manufacturers, as well as to the superintendent, the Committee are indebted for valuable suggestions.

A large wooden tank was prepared, in which was built a surface condenser having an area of about eleven hundred (1,100) square feet of cooling surface. This latter was made by connecting up the requisite number of tubes, obtained from the Root Steam Engine Company, the peculiar method of connection adopted in the Root boiler affording excellent facilities for so doing. The Committee are greatly indebted to Mr. J. B. Root for assistance kindly tendered in this matter. Water from the hydrants was led through Worthington meters into the lower part of the tank, and, rising among the tubes of the condenser, overflowed at the top.

The steam from the boiler on trial entered the tubes at the top of the condenser, and the water of condensation flowed out at the lowest point. The currents of steam and of condensing water thus moved in opposite directions and the steam was condensed completely with the least possible quantity of condensing water.

Thermometers were carefully made for the occasion by G. Tagliabue, and were placed as follows: One having a scale ranging from 30 degrees to 101 degrees Fahrenheit was placed at the inlet of the injection water, and its reading indicated the temperature of both feed and injection; one ranging from 100 degrees to 175 degrees Fahrenheit was placed at the mouth of the overflow pipe, and exhibited the temperature of the condensing water when discharged from the tank; one thermometer with a range of from 45 degrees to 175 degrees Fahrenheit was so placed as to indicate the temperature of the water of condensation when leaving the condenser.

Another thermometer was placed in the steam space of the boiler.

The pressure of the steam was indicated by two recording gauges, furnished by their respective patentees, M. B. Edson, and D. P. Davis, and both gave satisfactory evidence of efficiency. The indications of the former were so accurate that it was made the standard during the trial, and the latter, also remarkably accurate, by its record of time, as well as pressure, was a most valuable check upon the record of the log as obtained by observations at regular intervals.

The quantity of water passing through each boiler was determined by weighing it, 300 pounds at a time, on carefully adjusted scales.

The Superintendent of Machinery and his assistant, Messrs. J. W. Blake and J. B. Fitch, who, representing the Committee, had immediate charge of the trials, were aided, except in the test of the Blanchard boiler, by students Henderson, Hewitt, Poinier, and Post, of the *Stevens Institute of Technology*, who, under the instructions of the Chairman of the Committee, kept the log with commendable exactness, and rendered very valuable assistance.

The coal used during the whole series of trials was from the Buck Mountain Coal Company, Philadelphia, Nathan Hilles, President. It was found to be of excellent quality, and the results of the test are, therefore, the more valuable as a *standard representing the efficiency of good apparatus with good fuel.* The analysis of this coal, as determined by Professor Walter R. Johnson, is given as follows:

Water	0.390
Gaseous matter, including some agate, volatile at bright red heat	5.515
Carbon	91.016
Earthy matter and oxyd	3.079
	100.000

It would be interesting to learn the constituents of the "gaseous matter given at 5.15 *per centum*, but this the Committee were unable to ascertain. If there were, however, any combustible gases, it is exceedingly unlikely that they existed in sufficient amount to appreciably raise the evaporative efficiency of the coal, as the steam generating powers of the anthracites seem to be precisely proportional to the amounts of carbon they respectively contain. This fact was well proven by Professor Johnson, in the course of his very extended and valuable researches upon the constitution and value of American coals. (See Report on American Coals, p. 586.) The total heating value of this coal, therefore, provided all waste could be prevented, is readily calculated, and would be 13,197.32, "*British thermal units;*" *i. e.*, one pound of this coal, burned without waste, should be capable of raising the temperature of 13,197.32 pounds of water one degree Fahrenheit. This would be equivalent to evaporating 13.65 pounds of water at the temperature of 212 degrees Fahrenheit, and under atmospheric pressure. In comparing this result with the actual performance on the test, it should be remembered that a large amount of coal always falls through the grate unburned, and thus greatly reduces the practical efficiency of all coals. The amount of this loss can only be approximately estimated, and the Committee judge it to have averaged at least fifteen *per cent* during these trials.

The evaporative power of pure carbon, which has usually been found to be capable of developing 14,500 British thermal units, is fifteen pounds of water per pound of carbon, the water being evaporated under the pressure of the atmosphere at a temperature of 212 degrees Fahrenheit. All of the results obtained by the Committee are reduced to similar standard measures of thermal units developed per pound of *combustible*, and to the equivalent evaporation from 212 degrees Fahrenheit. It is by the comparison of these reduced observations, that the relative economic efficiencies of the competing steam boilers are to be determined.

The preparations for the trial having been completed, the following letters of instruction were written, and forwarded to the Superintendent of Machinery, by whom their contents were communicated to the exhibitors, and the agreement of each to the proposed terms, was a condition precedent to admission for competition.

Fair of the American Institute,
New York, *October* 31*st*, 1871.

To the Superintendent of Machinery:

Sir.—The Committee of Judges of Department V, Group I, having determined to make a thorough test of the economic values, and of the steaming capacities of the steam boilers entered for competition, you are hereby authorized and instructed to make the necessary preparations for such a test.

The steam from each boiler, when under test, will be conducted into a surface condenser of a capacity of at least eight hundred (800) square feet of condensing surface; the *water of condensation* will be collected in a tank placed beneath the condenser, and there measured; the *feed* water will be measured by a meter, and the *condensing water* will be measured in the same manner, the meters being previously tested.

The pressure of steam will be maintained constant (at seventy-five [75] pounds), by means of a safety valve placed between the boiler and the condenser, and the Committee desire that the safety valves entered by Messrs. Bulkley and Lynde be used, if possible, for this purpose, and that they thus be tested.

Each exhibitor will see that his boiler is ready for the test, his steam pipe well covered, and valves in good order. He will, before his boiler is connected for test, hand to the Committee, through the Superintendent of Machinery, a statement of the amount of heating and of grate surface in his boiler, and a further statement, that he has read this letter of instructions, taken a copy, and that he is ready to go on with the test as herein proposed.

Any exceptions taken to the proposed test, or any detail thereof, must be forwarded to the Committee in writing, previous to entering upon the test. Any exceptions taken to the action of one exhibitor by another, or to the decision of the Judges during the trial, will be presented promptly in writing.

It is to be understood that the proposed test is made for the purpose of enabling the Committee of Judges to make up their report to the Managers, as required by regulation, with intelligence and confidence.

In conducting the test, you and your assistant are authorized to superintend and to keep the log, with the aid of such other assistants as the Committee may appoint.

The trials will be of twelve hours each; and the boilers will be tested successively in an order that will be determined by lot.

Fires will be started at nine (9) o'clock in the morning with *dry wood*, of which you will see a good supply on hand; and at the moment when steam issues freely from the safety-valve of the boiler, the test will be considered as commenced, and the fuel will be taken from the coal pile. No more wood will be used.

The coal will be weighed in buckets, carefully counterweighted on the scale, and always filled to the same weight precisely. The scales are to be tested and officially sealed before the trial.

The ashes will be weighed *dry* in a similar manner.

The dampers will be fixed wide open, unless it should become evident that the boiler "primes" or "foams" seriously in consequence.

Each half hour there will be noted in the log the time, height of barometer, steam pressure (from the same gauge in all tests), weight of coal used, weight of ashes removed, temperature of external atmosphere, of the feed water, water of condensation, steam in boiler, steam pipe, condensing water before and after leaving condenser tank, gases in flues, four feet, as nearly as is possible, from nearest heating surface, the volume of water of condensation, and the reading of the meters.

The fires will be attended to by the exhibitors, and managed as they may think proper. The water level will be fixed at a proper height, and a thread tied around the gauge-glass at that point, its height above the bottom of the glass being recorded; and the water will be kept, as nearly as possible, at that point. At the termination of twelve hours from the commencement of the trial, the stop valve will be shut, and the fires hauled. The exhibitor may, at his discretion, allow his fires to burn down toward the close of the trial; and will be credited, in any case, with the fuel remaining on the grate.

A Davis recording gauge, and, if possible, an Edson gauge, will be attached, and their record handed to the Committee at the close of each test.

The Committee will, at their own discretion, decline to proceed in any test where all the prescribed preliminaries have not been complied with; and will, should they consider it proper, throw out any test which has evidently not been conducted as directed.

After the trials all apparatus will be again tested, and measurements of heating and grate surfaces revised.

Very respectfully,

R. H. THURSTON,

Chairman.

Supplementary Letter.

Fair of American Institute,
November 9*th*, 1871.

To the Superintendent of Machinery:

Sir.—It having been found necessary to change the position of the meter which is to measure the quantity of injection water used during the proposed test of steam-boilers, and as it is now arranged so as to measure the entering stream, the following method of operation with respect to the supply of injection, etc., will be adopted:

At the beginning of each trial the injection will remain shut off until the temperature of the surface-water in the tank has reached one hundred and fifty (150) degrees Fahrenheit, when the injection will be turned on.

At the close of the test, after the steam has ceased entering the condenser from the boiler on trial, the injection will remain open until it is found that the water entering and that leaving the tank have about the same temperature, and evidence is thus given that all of the heat received from the boiler has been taken away and measured.

During this latter interval, the temperatures of injection and of discharge will be measured at as frequent intervals as the judges or their representatives may consider necessary for accurate determination of the quantity of heat passing off.

The tank for measuring the water of condensation having been found to leak seriously, you will substitute for it a vessel in which the water may be caught and accurately weighed.

You will see the precaution taken to open the injection-cock as little as possible, in order to use the least quantity of water consistent with complete condensation of steam.

Very respectfully, yours,

R. H. THURSTON,
Chairman, for the Committee.

The Root boiler was first connected with the condenser, and its trial commenced, November 10th. But it was found that the boiler could furnish more steam than the safety-valve, through which the steam was intended to blow off into the condenser, could pass. It became necessary, therefore, to allow the steam to pass directly through a stop-valve into the condenser. This interrupted the trial for the day, and advantage was taken of the opportunity thus offered to remedy all of the minor defects that had been discovered.

On November 13th, the trial of the Root boiler was made without mishap, continuing through twelve hours, as proposed; on the 14th, the Allen boiler was tried; on the 15th, the Phleger; and on the 16th, the Lowe. After a series of mishaps, the Blanchard boiler was also finally tested successfully on November 21st.

We annex the record, given by the logs, in exhibits A, B, C, D, and E; and before proceeding to discuss these results, will give a brief description of the competing boilers.

DESCRIPTION OF THE ROOT BOILER.—(PLATE 1.)

This boiler consists essentially of eighty (80) wrought iron tubes, each four (4) inches in diameter, and nine (9) feet long. These tubes are set in brickwork, at an angle of about 30° from the horizontal. The tubes are connected together by the system of triangular plates and crowfeet represented in figures 1 and 2; the joints being formed by the aid of rubber grummets. The boiler has a steam drum, eighteen (18) inches in diameter, and six and three-quarters ($6\frac{3}{4}$) feet long. The superheating of the steam is effected in the upper portion of the boiler, where the tubes are, like those forming the water space, surrounded by the heated gases. The water was maintained, during the trial, just above the fourth row of tubes.

The inventor claims that by the contraction of the passages, caused by the method of connecting the tubes, the steam is disengaged from the water in a comparatively dry state.

The areas of heating and grate surfaces of this, and of all the boilers under consideration, are given in the table of results.*

Description of the Allen Boiler.—(Plate 2.)

This boiler possesses several novel features. There are nine (9) cast iron cylinders, A, A, A, etc., each seven (7) inches internal diameter, and eleven (11) feet long; and into each of these cylinders eighteen (18) wrought iron tubes, B, B, each three and a half ($3\frac{1}{2}$) inches in diameter, and closed at one end with plugs, are screwed. In each section of wrought iron tubes, nine (9) of the tubes have a length of three (3) feet and two (2) inches, and the remaining nine (9) have a length of four (4) feet and five (5) inches each. The sections are all connected by the cast iron cylinders to a steam drum, C, two (2) feet in diameter and eight (8) feet long; and this drum is connected with another, D, two and a half ($2\frac{1}{2}$) feet in diameter, and eight (8) feet long. (This drum has been omitted in the engraving.) From this latter drum the steam leaves the boiler by the pipe E. These drums are so arranged as to superheat the steam, being surrounded by the products of combustion; and in the bottom of each of the drums are pipes, F, G, connecting with H, the lowest point of the boiler, to allow the water carried over by the steam to drain back. The feed and the water gauge and gauge cocks are connected to the steam and water spaces by the pipes J, K, L, leading to the steam drum, C, and the cross connection, H, respectively. The wrought iron pipes are connected to the cast iron cylinders at an angle of 20° from the vertical, the inventor claiming that as the most effective position. The inventor also claims great facility for making repairs by merely unscrewing a defective tube and substituting a good one.

Description of the Phleger Boiler.—(Plate 3.)

This consists of a number of wrought iron tubes, connected to cast iron tube plates, and set in brick-work. There are seventeen (17) bent tubes, A, each two (2) inches in diameter, and fifteen (15) feet long, so arranged as to form the furnace and a "water-grate," being

* The total of all surfaces exposed to contact with the products of combustion is taken as heating surface.

secured at the ends to cast iron tube sheets, S, S^1. There are, also, sixty-eight (68) straight tubes, of the same dimensions, secured at the ends to tube sheets, S, S^2. These tubes are all connected with each other and the steam drum, D, by a series of cast iron caps or water-ways, C^1, C^2, C^3, and by the pipes, S P, S P^1, these latter being flanged, and secured to the tube sheets by bolts. The steam drum is of wrought iron, and has a diameter of two and a half ($2\frac{1}{2}$), and a length of twelve (12) feet, and contains shelves, L, L, for the purpose of preventing foaming.

DESCRIPTION OF THE LOWE BOILER.—(PLATE 4.)

This is a tubular boiler, set in brick-work. The principal claim of the patentee is an improved arrangement of the flues and setting, for the purpose of securing more perfect combustion. The products of combustion pass from the furnace through openings into the combustion chamber. Air is admitted to the chamber by a register the amount of opening being varied, until it is judged that the best effect is produced. The further course of the gases is plainly marked by the arrows, through the tubes and under the boiler, passing by a drop flue to the chimney.

By this arrangement of the combustion chamber, the inventor claims to effect a more perfect combustion of the gases of the fuel than can be produced in any other boiler of this class.

In the trial, two boilers, placed side by side, were tested. The larger boiler was four (4) feet in diameter, fifteen (15) feet and four (4) inches long, and contained forty-five (45) tubes, each three (3) inches in diameter and twelve (12) feet long. The other boiler was of the same length as the first, but only three and a half ($3\frac{1}{2}$) feet in diameter, and contained thirty-six (36) tubes, of the same dimensions as those in the first.

DESCRIPTION OF THE BLANCHARD BOILER.—(PLATE 5.)

In this boiler a mechanical draft is employed. The air, instead of being forced through the ash-pit, in the ordinary manner, is drawn, much more effectively, as the inventor claims, by the action of a fan-like screw, placed in the smoke-pipe above the heaters; this fan being driven by a belt from the fly-wheel of the feed-pump. By this arrangement the inventor claims that he can utilize the products of combustion in a most thorough manner, and also that he can employ a much larger ratio of heating to grate surface than is commonly possible. The boiler, as shown in the figures, is of a vertical fire tube variety. There are ninety-four (94) tubes, C, each two (2) inches in diameter, and four and a half ($4\frac{1}{2}$) feet long. In the smoke-pipe is placed an arrangement, S, for superheating the steam, composed of two hundred and sixty-nine (269) one and a quarter ($1\frac{1}{4}$) inch tubes, each one and a half ($1\frac{1}{2}$) feet long, and above this is a feed water heater, F, consisting of the same number of one and a quarter ($1\frac{1}{4}$) inch tubes, each two (2) feet long. In the competitive test of this boiler, the feed water heater was used, but the steam was not passed through the superheater, but was drawn directly from the steam drum, D. This drum is twenty-two (22) inches in diameter, and thirty (30) inches high.

Calculations.

All calculations are given in detail, in exhibits F, G, H, I, and J.

In calculating the results from the record of the logs, the committee first determined the amount of heat carried away by the condensing water, by deducting the temperature at which it entered from that at which it passed off.

To this quantity is added the heat which was carried away by evaporation from the surface of the tank as determined by placing a cup of water in the tank at the top of the condenser, at such height that the level of the water inside and outside the cup were the same, noting the difference of temperatures of the water in the cup and at the overflow, and the loss by evaporation from the cup. The amount of evaporation from the surface of the water in the cup and in the condenser, which latter was exposed to the air, was considered as approximately proportional to the tension of vapor due their temperatures, and was so taken in the estimate. The excess of heat in the water of condensation over that in the feed water, also evidently came from the fuel, and this quantity was also added to those already mentioned.

The total quantities were, in thermal units, as follows:

Root	34,072,058.09
Allen	48,241,833.60
Phleger	24,004,601.14
Lowe	38,737,217.57
Blanchard	11,951,002.10

These quantities being divided by the weight of combustible used in each boiler during the test, will give a measure of their relative economical efficiency; and divided by the number of square feet of heating surface, will indicate their relative capacity for making steam. But as it is the intention of the committee to endeavor to establish a practically correct measure that shall serve as a standard of comparison in subsequent trials, it is advisable to correct these amounts by ascertaining how and where errors have entered, and introducing the proper correction.

There were two sources of error that are considered to have affected the result as above obtained. The tank being of wood, a considerable quantity of water entering it, leaked out again at the bottom, without increase of temperature, instead of passing through the tank and carrying away heat, as it is assumed to have done in the above calculation. The meters also, have registered rather more water than actually passed through them, and this excess assists in making the above figures too high. The sum of these errors, the Committee, after a careful consideration of the several logs, and inspection of the apparatus, have estimated at four (4) *per centum* of the total quantity of heat carried away by the condensing water. The other two quantities are considered very nearly correct.

Making these deductions, we have the following as the total heat, in British thermal units, which was thrown into the condenser by each boiler:

Root	32,751,834.34
Allen	46,387,827.10
Phleger	23,066,685.39
Lowe	37,228,739.07
Blanchard	11,485,777.35

That the figures thus obtained are very accurate, is shown by calculating the heat transferred to the condenser by the Root and the Allen boilers (both of which superheated their steam), by basing the calculation on the temperature of the steam in the boiler as given by the thermometer, the results thus obtained being 32,723,681.76 and 46,483,322.5, respectively.

Dividing these totals by the pounds of combustible consumed by each boiler, we get, as the quantity of heat per pound, and as *a measure of the relative economic efficiency:*

Root	10,281.53
Allen	10,246.92
Phleger	10,143.66
Lowe	10,048.24
Blanchard	10,964.94

Determining the weight, in pounds, of water evaporated per square foot of heating surface per hour, we get, as *a measure of the steaming capacity:*

Root	2.65
Allen	3.59
Phleger	2.83
Lowe	3.10
Blanchard	1.92

It is but right to remark here that, as is indicated by the log, the fires in the Root boiler were allowed, at one time, to get much too low, and it is supposed that the standing of that boiler was thus seriously impaired. The fires of the Lowe boilers were undisturbed during the whole trial, its position, also, being thus lowered.

The quantity of heat per pound of combustible, as above determined, being divided by the latent heat of steam at 212° Fahr. (966°.6), gives, as *the equivalent evaporation of water at the pressure of the atmosphere, and with the feed at a temperature of* 212° *Fahr.:*

Root	10.64
Allen	10.60
Phleger	10.49
Lowe	10.40
Blanchard	11.34

For general purposes, this is the most useful method of comparison for economy.

The above figures afford a means of comparison of the boilers, irrespective of the condition (wet or dry) of the steam furnished by them. All other things being equal, however, the committee consider that boiler to excel which furnishes the dryest steam; provided that the superheating, if any, does not exceed about 100° Fahrenheit.

In this trial *the superheating*, was as follows:

Root	16°.08
Allen	13°.23
Phleger	0°.
Lowe	0°.
Blanchard	0°.

As the Blanchard, Phleger and the Lowe boilers did not superheat, it becomes an interesting and important problem to determine the quantity of water carried over by each with the steam. This we are able, by the method adopted, to determine with great facility and accuracy.

Each pound of saturated steam transferred to the condensing water the quantity of heat which had been required to raise it from the temperature of the water of condensation to that due to the pressure at which it left the boiler, *plus* the heat required to evaporate it at that temperature.

Each pound of water gives up only the quantity of heat required to raise it from the temperature of the water of condensation to that of the steam with which it is mingled.

The total amount of heat is made up of two quantities, therefore, and a very simple algebraic equation may be constructed, which shall express the conditions of the problem:

Let H=heat units transferred per pound of steam.
h =heat units transferred per pound of water.
U =total quantity of heat transferred to condenser.
W =total weight of steam and water, or of feed water.
x =total weight of steam.
$W-x$=total weight of water primed.

Then $Hx+h(W-x)=U$; or, $x=\dfrac{\frac{U}{h}-W}{\frac{H}{h}-1}$

Substituting the proper values in this equation, we determine *the absolute weights and per centages of steam and water* delivered by the several boilers to be as follows:

	Weight of steam.	Weight of water.	Per centage of water primed to water evaporated.
Root	27,896.	0.	0.
Allen	39,670.	0.	0.
Phleger	19,782.94	645.06	3.26
Lowe	31,663.35	2,336.65	6.9
Blanchard	9,855.6	296.9	3.

And *the amount of water, in pounds, actually evaporated per pound of combustible:*

Root	8.76
Allen	8.76
Phleger	8.70
Lowe	8.55
Blanchard	9.41

Comparing the above results, the committee are enabled to state the following order of capacity and of economy, in the boilers exhibited, and their relative per centage of useful effect, as compared with the economical value of a steam boiler that should utilize all of the heat contained in the fuel:

	Steaming capacity.	Economy of fuel.	Per centage of economical effect.
Root	No. 4	No. 2	0.709
Allen	" 1	" 3	0.707
Phleger	" 3	" 4	0.699
Lowe	" 2	" 5	0.693
Blanchard	" 5	" 1	0.756

The results obtained, as above, and other very useful determinations derived from this extremely interesting trial, are given in the following table, which the Committee hope and anticipate may be found, by all who are interested in the subject, to be of very great value as a reliable record of the trial of several excellent steam boilers, as a valuable *standard set of data* with which to compare the results of future trials, and as a useful aid in judging of the accuracy of statements made by boiler venders in the endeavor to effect sales by presenting extravagant claims of economy in fuel.

The Committee regret that the log of the trial of the Blanchard boiler was carelessly kept, but they believe that the method adopted afforded such a perfect system of checks that no appreciable error was introduced.

They desire to express their appreciation of the neatness and efficiency of the arrangement by which provision is made, in the Lowe boiler, for complete combustion of the furnace gases, and of the excellent general arrangement and proportions which gave to the Allen boiler its remarkably high steaming capacity.

As some authorities consider the evaporation of one cubic foot per hour to be the equivalent of one horse-power, column Z is introduced to give the area of heating surface required in each boiler, per horse-power, on this basis. *A good, modern steam engine* ought not to require more than one-half the specified amount.

Results of the competitive trial of steam boilers at the Fair of the American Institute, November, 1871.

NAME.	Square Feet.		Ratio of heating surface to grate surface.	Total Weights.					Ratio of water primed to water evaporated.	Mean Temperatures.						
	Grate surface.	Heating surface.		Coal.	Combustible.	Feed.	Steam.	Primed water.		Injection.	Feed.	Water of condensation.	Discharge.	Steam.	Super heat.	Flues.
	A.	B.	C.	D.	E.	F.	G.	H	I.	J.	K.	L.	M.	N.	O.	P.
Root	27	876½	32.5	3800	3185.5	27896	27896	0.	0.	45°.94	45°.94	58°.31	143°.1	334°.6	16°.08	416°.6
Allen	32¼	920	28.5	5375	4527	39670	39670	0.	0.	45°.5	45°.5	63°.48	154°.76	330°.63	13°.23	345°.87
Phleger	23	600	26.1	2800	2274	20428	19782.94	645.06	3.26	45°.65	45°.65	54°.38	120°.83	321°.06	0°.	503°.76
Lowe	37¾	913	24.2	4400	3705	34000	31663.35	2336.65	6.9	45°.0	45°.0	54°.8	131°.5	319°.48	0°.	389°.6
Blanchard	8½	440	51.8	1232	1047.5	10152.5	9855.6	296.9	3.	44° 4	44°.4	49°.49	106°.14	323°.75	0°.	221°.67

Results, etc.—(Continued).

NAME.	Total British thermal units.	Total units per pound of combustible.	Apparent Evaporation.				Actual Evaporation.		Equivalent evaporation of water at 212° Fahr. and atmospheric pressure.	Square feet of heating surface required to evaporate one cubic foot of water per hour.	Coal, lbs. per square foot, grate surface per hour.	Efficiency; actual evaporation of fuel divided by theoretical.
			Per pound of coal.	Per pound of combustible.	Per square foot of grate surface per hour.	Per square foot of heating surface per hour.	Per pound of coal.	Per pound of combustible.				
	Q.	R.	S.	T.	U.	V.	W.	X.	Y.	Z.	Z. 1	Z. 2
Root	32, 751, 834.34	10, 281.53	7.34	8.76	86.09	2.65	7.34	8.76	10.64	23.59	11.73	0.709
Allen	46, 387, 827.1	10, 246.92	7.38	8.76	102.51	3.59	7.38	8.76	10.60	17.41	13.88	0.707
Phleger	23, 066, 685.39	10, 143.66	7.26	8.95	73.70	2.83	7.07	8.70	10.49	22.74	10.13	0.699
Lowe	37, 228, 739.072	10, 048.24	7.68	9.12	75.06	3.10	7.20	8.55	10.40	21.63	9.71	0.693
Blanchard	11, 485, 777.35	10, 964.94	8.24	9.69	99.53	1.92	8.00	9.41	11.34	33.48	12.10	0.756

Conclusion.

The Committee would finally remark:

1st. That the results of this trial indicate that, in steam boilers as now built by the best manufacturers, the differences in most respects are exceedingly small, and a purchaser can hardly fail to be well served if he go to a really intelligent and reliable builder.

2d. That the introduction of boilers having exceptionally large proportion of heating surface, and with large feed water heaters, and depending upon a mechanical draft, will, when properly designed and constructed, be attended with a marked economy, which, the Committee judge, should more than compensate for the increased trouble and expense involved if large boiler power is required.

3d. That the steaming capacity of a boiler depends largely upon its form, as well as upon the method of working its fires.

4th. That they are very greatly pleased with the result of this first trial of the method adopted of determining the economical performance of steam boilers and their capacity for making steam.

They earnestly desire to impress upon the Board of Managers the importance to the country, and to manufacturers of boilers, of having a standard set of apparatus, such as your Committee have used, constantly available for such trials of steam boilers.

They would also urge a consideration of the advantage to the American Institute of such tests as are above described, whicn, being publicly conducted, with the best apparatus available, and witn all of the accuracy and reliability, which by this method is easily attainable, place the decisions of the Judges and the awards of the Board of Managers beyond dispute.

With the experience now obtained, the results of such tests can be readily worked up.

They would earnestly recommend to the Board of Managers that provision be made for the erection of a well built condenser, with meters carefully and specially constructed for the work, and with thermometers of the greatest possible accuracy and delicacy, every possible provision being made for obtaining the most reliable results, and steam boiler trials by this apparatus, when completed, be made one of the regular features of the annual exhibitions of the Institute.

The members of this Committee will gladly give all needful instructions for the building of such an apparatus, and have no doubt that, a moderate charge being made for the privilege of its use by unfortunate competitors of former occasions and by builders of new forms of boilers, a reasonable profit might be made to accrue to the Institute from such an investment. Even were there no direct income from it, the advantages in other respects to the Institute and to its friends, and to the people generally, would be far more than commensurate with the moderate expense involved.

Very respectfully,

ROBERT H. THURSTON.
THOS. J. SLOAN.
ROBT. WEIR.

January, 1872.

EXHIBIT A.

Log of trial of Root's steam boiler, November 13th, 1871.

TIME.	Barometer.	Steam.	WEIGHT.		TEMPERATURE.						READING OF METERS.			
			Coal.	Feed.	Injection and feed.	Steam.	Water of condensation.	Discharge.	Flues.	Atmosphere.	Feed.	Injection. 1.	Injection. 2.	Injection. 3.
A. M.														
10.00	30.24	70.	800	300	45°.5	318°.5	51°.	135°.	405°.	44°.	13804.2	26614	2709	
10.30	30.24	78.	200	1,200	45°.8	337°.	55°.	148°.	418°.	45°.	13821.0	26663	2877	
11.00	30.26	77.5	200	1,200	46°.	342°.5	59°.5	148°.	445°.	46°.	13838.5	26761	2903	
11.30	30.26	74.	0.	1,200	46°.	339°.	60°.	145°.5	421°.	47°.	13860.0	26875	3028	
12.00	30.26	75.5	200	1,200	46°.	337°.	60°.	150°.2	415°.	47°.	13884.8	26984	3154	
P. M.														
12.30	30.26	78.	200	1,200	46°.	340°.	61°.	150°.5	419°.	49°.	13905.6	27096	3279	
1.00	30.26	70.	0.	1,200	46°.	336°.	61°.5	151°.	416°.	50°.5	13926.7	27204	3402	
1.30	30.25	75.5	200	1,500	46°.	341°.	61°.	155°.	427°.	55°.	13948.5	27309	3526	
2.00	30.24	73.	200	1,200	46°.	337°.	58°.5	149°.5	400°.	54°.	13967.9	27421	3650	
2.30	30.23	78.	200	1,200	46°.	342°.	58°.	142°.	412°.	53°.	13985.5	27534	3774	
3.00	30.23	79.	0.	1,500	46°.	343°.	63°.5	150°.5	445°.	50°.	14006.2	27649	3911	
3.30	30.24	72.5	200	1,200	46°.	336°.	63°.	156°.5	430°.	46°.	14028.9	27754	4033	
4.00	30.23	75.	0.	1,500	46°.	336°.	61°.	155°.5	430°.	44°.5	14051.7	27854	4150	
4.30	30.22	68.	200	1,200	46°.	328°.	57°.5	149°.	407°.5	44°.	14071.7	27957	4273	
5.00	30.21	73.	200	1,200	46°.	334°.	60°.5	150°.	425°.	41°.	14092.2	28068	4415	
5.30	30.20	72.5	0.	900	46°.	335°.	56°.5	148°.5	430°.	41°.	14106.9	28172	4539	
6.00	30.19	67.5	200	900	46°.	331°.	57°.5	139°.5	411°.	41°.	14127.2	28255	4644	
6.30	30.19	73.	200	900	46°.	326°.	54°.	120°.5	388°.	41°.5	14140.7	28375	4778	
7.00	30.19	70.	200	1,500	46°.	330°.	54°.5	121°.5	380°.	41°.	14156.5	28483	4900	
7.30	30.19	75.	0.	1,200	46°.	330°.	56°.5	119°.	405°.	41°.	14170.5	28593	5035	
8.00	30.19	71.	200	900	46°.	335°.	55°.5	129°.25	410°.	39°.5	14185.8	28696	5155	
8.30	30.18	72.	200	900	46°.	334°.5	57°.5	141°.5	412°.	39°.	14205.3	28815	5298	
9.00	30.17	70.	0.	900	45°.6	332°.	59°.	139°.	413°.	38°.	14224.7	28926	5415	
9.30	30.16	69.	0.	900	45°.6	330°.	57°.5	139°.5	421°.	38°.	14242.2	29070	5585	

REMARKS.—Trial commenced at 9.43½ A. M. Pounds of wood, 400; pounds of ashes, 614.5; temperature of discharge, taken at frequent intervals, from 9.43½ P. M. up to 10.25 P. M., 122°, 110°, 94°, 68°, 60°, 57°, 53°, 52°. Final reading of meters, at 10.25 P. M., feed, 14253.2; injection, No. 1, 29220; injection, No. 2, 5758; pounds of feed, from 9.30 P. M. to 10.25 P. M., 896.

EXHIBIT B.

Log of trial of Allen's steam boiler, November 14th, 1871.

TIME.	Barometer.	Steam.	WEIGHT. Coal.	WEIGHT. Feed.	TEMPERATURES. Injection and feed.	TEMPERATURES. Steam.	TEMPERATURES. Water of condensation.	TEMPERATURES. Discharge.	TEMPERATURES. Flues.	TEMPERATURES. Atmosphere.	READING OF METERS. Feed.	READING OF METERS. Injection. 1.	READING OF METERS. Injection. 2.	READING OF METERS. Injection. 3.
A. M.														
10.30	30.05	......	400	....	45°.5	....	....	....	....	46°.	14308.	....	....	....
11.00	30.05	68.	400	300	45°.5	316°.	50°.5	....	220°.	46°.	14311.	29244	6290	....
11.30	30.02	73.	600	900	45°.5	325°.	58°.5	145°.5	245°.	48°.	14323.5	29293	6353	....
12.00	30.00	71.	0	1,500	45°.5	330°.	65°.	158°.	250°.	46°.	14347.2	29406	6486	....
P. M.														
12.30	29.98	72.	200	2,100	45°.5	330°.	71°.	169°.5	255°.	47°.	14377.7	29502	6600	....
1.00	29.95	70.	200	1,800	45°.5	328°.	74°.	178°.	260°.	47°.	14413.0	29622	6714	....
1.30	29.92	74.	0	1,800	45°.5	336°.	77°.5	180°.	265°.	48°.	14441.5	29730	6860	25
2.00	29.90	69.	200	1,800	45°.5	328°.	83°.	180°.	265°.	48°.	14470.0	29815	6981	80
2.30	29.90	72.	200	900	45°.5	334°.	65°.	172°.	....	48°.	14498.8	29910	7099	154
3.00	29.86	64.	200	1,800	45°.5	330°.	66°.5	164°.	405°.	48°.	14528.2	30028	7234	237
3.30	29.86	67.	400	1,500	45°.5	336°.	57°.	145°.	410°.	48°.	14550.1	30123	7352	313
4.00	29.85	65.	200	1,800	45°.5	328°.	61°.	153°.	400°.	48°.	14576.8	30225	7468	385
4.30	20.84	75.	200	1,800	45°.5	336°.	60°.	148°.	390°.	49°.	14604.4	30334	7601	466
5.00	29.82	71.	200	1,500	45°.5	330°.	60°.5	148°.5	380°.	49°.	14632.1	30421	7713	537
5.30	29.80	69.	200	1,800	45°.5	332°.	59°.	148°.	370°.	50°.	14659.0	30544	7851	622
6.00	29.77	67.	200	1,500	45°.5	330°.	59°.	147°.	375°.	50°.	14685.6	30641	7973	696
6.30	29.74	70.	400	1,500	45°.5	330°.	57°.5	141°.	370°.	50°.	14710.5	30756	8092	771
7.00	29.72	67.	0	2,100	45°.5	328°.	61°.	147°.	390°.	52°.	14736.2	30854	8215	854
7.30	29.72	70.	200	1,500	45°.5	330°.	59°.5	150°.	390°.	52°.	14764.3	30985	8342	927
8.00	29.70	75.	400	1,800	45°.5	336°.	60°.	143°.	375°.	51°.	14789.5	31067	8476	1010
8.30	29.70	75.	200	1,800	45°.5	338°.	62°.5	145°.	390°.	52°.	14816.5	31172	8597	1085
9.00	29.68	76.	200	2,100	45°.5	336°.	67°.	151°.	400°.	52°.	14844.8	31272	8722	1162
9.30	29.64	78.	175	1,200	45°.5	328°.	62°.5	150°.	380°.	52°.	14873.9	31379	8847	1240
10.00	29.64	70.	0	2,100	45°.5	332°.	66°.	149°.	400°.	52°.	14899.8	31486	8973	1319
10.30	29.62	75.	0	1,500	45°.5	328°.	60°.	147°.	370°.	52°.	14928.5	31596	9101	1398

Remarks.—Trial commenced at 10.46 A. M. Pounds of wood, 400; pounds of ashes, 848. Temperatures of discharge, taken at frequent intervals, from 10.46 P. M. up to 11.35 P. M., 146°. 144½°, 140°, 135°, 124°, 103°, 88°, 77°, 66°, 62°, 57°, 54°, 52°. Final reading of meters, at 11.35 P. M.: Feed, 14943.5; injection No. 1, 31767.5; injection No. 2, 9393.; injection No. 3, 1584.5; pounds of feed from 10.30 P. M. to 11.35 P. M., 1270.

EXHIBIT C.

Log of trial of Phleger's steam boiler, November 15th, 1871.

TIME.	Barometer.	Steam.	WEIGHT.		TEMPERATURES.						READING OF METERS.			
			Coal.	Feed.	Injection and feed.	Steam.	Water of condensation.	Discharge.	Flues.	Atmosphere.	Feed.	Injection. 1.	Injection. 2.	Injection. 3.
A. M.														
9.00	29.47	......	800	....	46°.	317°.	....	....	560°.	53°.	....	....	....	....
9.30	29.47	75.	0	300	46°.	322°.	51°.	124°.	575°.	52°.	14989.5	9191	33816	....
10.00	29.47	75.	0	1200	45°.5	321°.	56°.	180°.	535°.	53°.	15003.0	9292	....	....
10.30	29.47	75.	0	1200	45°.7	322°.	57°.	148°.	515°.	53°.	15025.7	9412	33915	....
11.00	29.47	74.	200	900	45°.6	322°.	55°.	135°.	485°.	54°.	15043.0	9540	34027	....
11.30	29.46	74.	0	900	45°.6	325°.	55°.	120°.	505°.	55°.	15056.5	9661	34133	....
12.00	29.47	75.5	0	900	45°.6	323°.	56°.5	118°.5	500°.	55°.	15069.6	9784	34235	....
P. M.														
12.30	29.46	75.5	200	900	45°.6	318°.	54°.5	121°.	440°.	53°.	15082.4	9919	34341	....
1.00	29.45	75.	0	600	45°.7	320°.	55°.	110°.5	490°.	52°.	15098.8	10040	34432	....
1.30	29.44	76.	200	900	45°.9	319°.	54°.	109°.	490°.	51°.	15108.9	10168	34538	....
2.00	29.45	75.	0	600	45°.8	320°.	54°.	118°.5	460°.	51°.	15118.5	10293	34635	....
2.30	29.45	75.	200	900	45°.9	319°.	54°.	103°.	475°.	50°.	15133.6	10416	34738	....
3.00	29.45	75.	0	600	45°.7	319°.	53°.	103°.5	475°.	49°.	15141.8	10536	34835	....
3.30	29.46	75.	200	900	45°.7	321°.	54°.	107°.5	500°.	47°.5	15152.4	10657	34930	....
4.00	29.48	75.	0	900	45°.7	320°.	54°.5	114°.5	505°.	46°.	15166.1	10785	35028	....
4.30	29.47	75.	200	600	45°.7	322°.	55°.	122°.	511°.	46°.	15181.9	10927	35118	....
5.00	29.48	75.	200	900	45°.5	319°.	55°.	121°.3	535°.	46°.	15194.0	11036	35207	....
5.30	29.48	75.	0	900	45°.5	321°.	54°.5	116°.25	519°.	45°.	15207.0	11167	35309	....
6.00	29.48	75.	200	900	45°.5	319°.	54°.	123°.5	540°.	45°.	15221.0	11289	35405	....
6.30	29.51	75.	0	600	45°.5	321°.	54°.5	121°.	527°.	44°.	15236.3	11412	35497	....
7.00	29.50	76.	200	900	45°.5	324°.	54°.	119°.	540°.	44°.	15253.3	11531	35588	....
7.30	29.52	75.	0	900	45°.5	322°.	54°.	121°.	510°.	44°.	15262.1	11671	35704	....
8.00	29.54	75.	200	900	45°.5	320°.	54°.	121°.5	520°.	44°.	15277.0	11790	35796	....
8.30	29.52	75.	0	900	45°.5	322°.	52°.5	113°.5	482°.	42°.	15291.5	11912	35892	....
9.00	29.53	77.5	0	900	45°.5	328°.	54°.	111°.	400°.	42°.	15304.5	12030	35987	....

REMARKS.—Trial commenced at 9.10 A. M. Pounds of wood, 400; pounds of ashes, 526. Temperatures of discharge, taken at frequent intervals, from 9.10 P. M. up to 9.45 P. M., 100°, 90°, 78°, 66°, 59°, 54°, 52°, 50°. Final reading of meters, at 9,45 P. M.: Feed, 15314; injection No. 1, 12236; injection No. 2, 36154; pounds of feed from 9.00 P. M. to 9.45 P. M., 328.

EXHIBIT D.

Log of trial of Lowe's steam boilers, November 16th, 1871

TIME.	Barometer.	Steam.	WEIGHT.		TEMPERATURES.						READING OF METERS.			
			Coal.	Feed.	Injection and feed.	Steam.	Water of condensation.	Discharge.	Flues.	Atmosphere.	Feed.	Injection. 1.	Injection. 2.	Injection. 3.
A. M.														
9.30	29.62	73.	800	....	45°.	322°.	....	....	410°.	37°.	15494.4	12277	36180	....
10.00	29.63	72.	200	900	45°.	319°.	54°.	159°.	375°.	36°.	15508.5	12295	....	....
10.30	29.64	72.5	0	1200	45°.	321°.	61°.	154°.	400°.	37°.	15582.5	12415	36265	....
11.00	29.64	70.	400	1800	45°.	318°.	65°.	165°.	405°.	38°.	15558.	12536	36360	1581
11.30	29.64	70.	0	900	45°.	317°.	68°.	168°.	405°.	39°.	15589.	12663	36451	1614
12.00	29.64	70.	800	1500	45°.	319°.	60°.5	146°.5	410°.	38°.	15612.5	12780	36541	1719
P. M.														
12.30	29.64	72.5	0	2100	45°.	321°.	61°.5	145°.	410°.	38°.	15631.	12910	36640	1834
1.00	29.64	72.5	0	1500	45°.	318°.	57°.	134°.	395°.	38°.	15657.3	13040	36736	1950
1.30	29.64	75.	0	1500	45°.	323°.	57°.	131°.	405°.	38°.	15680.8	13163	36830	2060
2.00	29.65	73.	0	1200	45°.	318°.	54°.	116°.	390°.	38°.	15710.	13290	36920	2172
2.30	29.66	74.	600	1500	45°.	318°.	53°.5	114°.	370°.	38°.	15735.2	13412	37010	2280
3.00	29.66	73.	0	2100	45°.	321°.	58°.5	120°.5	385°.	37°.	15758.	13556	37122	2410
3.30	29.67	74.	0	1200	45°.	318°.	58°.5	139°.	395°.	37°.	15770.5	13646	37195	2490
4.00	29.67	73.	600	1500	45°.	320°.	54°.	130°.	395°.	37°.	15805.8	13776	37301	2605
4.30	29.68	72.5	0	1500	45°.	320°.	55°.	127°.	400°.	37°.	15829.3	13900	37376	2716
5.00	29.69	72.5	0	1500	45°.	321°.	59°.	122°.	400°.	38°.	15847.5	14024	37470	2826
5.30	29.70	70.	0	1500	45°.	318°.	55°.	123°.	390°.	37°.	15872.1	14150	37565	2940
6.00	29.72	72.5	400	1200	45°.	318°.	55°.	118°.	380°.	38°.	15896.	14273	37656	3150
6.30	29.73	72.	0	1500	45°.	320°.	57°.5	117°.	380°.	38°.	15913.6	14397	37750	3161
7.00	29.73	72.5	400	1200	45°.	318°.	56°.	128°.	380°.	37°.	15942.5	14523	37842	3272
7.30	29.74	72.5	0	1500	45°.	320°.	57°.5	130°.	375°.	37°.	15961.7	14646	37940	3482
8.00	29.75	72.5	0	1200	45°.	322°.	57°.	113°.	380°.	36°.	15982.2	14772	38034	3495
8.30	29.75	69.	200	1200	45°.	319°.	57°.	120°.	375°.	37°.	16003.4	14901	38132	3611
9.00	29.76	73.	0	1500	45°.	318°.	53°.5	112°.	375°.	37°.	16028.5	15025	38226	3723
9.30	29.78	75.	0	1300	45°.	320°.	45°.	... .	355°.	37°.	16077.1	15148	38320	3832

REMARKS. — Trial commenced at 9.30 A. M. Pounds of wood, 969; pounds of ashes, 695. Temperatures of discharge, taken at frequent intervals, from 9.30 P. M. up to 9.45 P. M., 90°, 70°, 56°, 50°. Final reading of meters, at 9.45 P. M.: Injection No. 1, 15178; injection No. 2, 38350; injection No. 3, 3862.

EXHIBIT E.

Log of trial of Blanchard's steam boiler, November 22d, 1871.

TIME.	Barometer.	Steam.	Weight.		Temperatures.						Reading of Meters.			
			Coal.	Feed.	Injection and feed.	Steam.	Water of condensation.	Discharge.	Flues.	Atmosphere.	Feed.	Injection. 1.	Injection. 2.	Injection. 3.
A. M.														
9.00	29.9	75	200	....	45°.5	318°.	47°.5	....	240°.	48°.	16378.8	38451	16165	....
9.30	29.9	70	200	300	45°.	320°.	48°.	137°.	250°.	48°.	....	....	....	....
10.00	29.9	72	200	600	44°.5	324°.	48°.	121°.5	220°.	48°.	....	....	....	....
10.30	29.9	75	200	300	44°.	326°.	49°.5	91°.	205°.	48°.	....	38591	....	....
11.00	29.9	75	200	600	44°.	324°.	49°.5	108°.	200°.	48°.	....	....	....	....
11.30	29.9	72	200	300	44°.5	322°.	49°.5	109°.	210°.	48°.	....	....	....	....
12.00	29.9	72	32	300	44°.5	324°.	49°.5	115°.	215°.	49°.	....	....	....	....
P. M.														
12.30	29.9	72	....	300	44°.5	330°.	49°.5	112°.	230°.	49°.	....	....	....	....
1.00	29.9	70	....	600	44°.5	322°.	49°.5	114°.	225°.	49°.	....	....	....	....
1.30	29.9	72	....	300	44°.5	328°.	49°.	115°.	240°.	49°.5	....	....	....	....
2.00	29.9	74	....	300	44°.5	328°.	50°.	116°.	230°.	50°.	....	....	....	....
2.30	29.9	75	....	600	44°.5	324°.	50°.	110°.5	230°.	50°.	....	....	....	....
3.00	29.9	70	....	600	44°.5	326°.	50°.	114°.5	240°.	49°.	....	....	....	....
3.30	29.9	70	....	300	44°.5	325°.	50°.	112°.5	215°.	49°.	....	....	....	....
4.00	29.9	72	....	300	44°.5	322°.	49°.5	106°.	220°.	48°.	....	....	....	....
4.30	29.9	75	....	600	44°.5	319°.	49°.5	105°.	220°.	47°.	16512.	....	17865	....
5.00	29.9	70	....	300	44°.5	324°.	50°.	104°.	230°.	46°.	16518.5	....	18005	....
5.30	29.9	66	....	600	44°.5	322°.	50°.	106°.	210°.	46°.	16532.1	....	18130	....
6.00	29.9	71	....	300	44°.5	324°.	50°.	102°.	220°.	46°.	16535.4	....	18250	....
6.30	29.9	76	....	600	44°.5	325°.	50°.	111°.	230°.	46°.	16541.4	....	18383	....
7.00	29.8	72	....	300	44°.5	325°.	50°.	108°.5	220°.	45°.	16552.	....	18500	....
7.30	29.8	72	....	600	44°.5	320°.	50°.	101°.	210°.	45°.	16563.	....	18620	....
8.00	29.8	70	....	600	44°.	320°.	49°.5	90°.	210°.	44°.5	16568.	....	18750	....
8.30	29.8	65	....	300	44°.	328°.	49°.5	91°.	200°.	43°.	16575.	....	18882	....
9.00	29.8	75	....	252½	44°.	....	49°.5	86°.	....	43°.	16580.	....	18970	....

REMARKS. — Trial commenced at 8.56 A. M. Pounds of wood, 300; pounds of ashes, 184.5. Temperatures of discharge, taken at frequent intervals, from 8.56 P. M. up to 9.26 P. M., 82°, 79°, 75°, 62°, 57°, 50°. Final reading of meter No. 2, at 9.26 P. M., 19090. Meter No. 1 shut off at 10.30 A. M.

EXHIBIT F.

Calculation of the Log of the Root Boiler, exhibited at the Fair of the American Institute, November, 1871.

Determination of the heat carried away by the condensing water discharged from the tank during the twelve hours trial.

	Units.
To 9.30 p. m., 5332 cub. ft. @ $62\frac{1}{2}$ lbs. = 333,250 lbs. @ range of 97°.16 Fahr.	32,378,570.
To 10.25 p. m., 323 cub. ft. @ $62\frac{1}{2}$ lbs. = 20,187.5 lbs. @ range of 31°.06 Fahr.	627,023.75
(*a*) Total British thermal units	33,005,593.75

Determination of heat carried away by evaporation at the surface of the tank.

	Units.
710.94 lbs. × 1014°.7 (latent heat at 143°.1 Fahr.) = (*b*)	721,390.818

Determination of heat carried away by water of condensation.

	Units.
27896 lbs. @ 12°.37 (range = 58°.31 − 45°.94) = (*c*)	345,073.52

Total heat derived from fuel, as determined above.

	Thermal units.
33,005,593.75 + 721,390.818 + 345,073.52 =	34,072,058.09
Deduct four per cent of (*a*) for errors (leakage and meters)	1,508,478.500
Final and corrected result	32,751,834.34

British thermal units per lb. combustible, 32,751,834.34 ÷ 3185.5 = 10,281.53.

Equivalent evaporation of water, temperature 212° Fahr., atmospheric pressure = 10,281.53 ÷ 966.6 = 10.64 lbs.

	Apparent results.	Real results.
Water evaporated per lb. of coal	$\frac{27896}{3800} = 7.34$	$\frac{27896}{3800} = 7.34$
Water evaporated per lb. of combustible	$\frac{27896}{3185.5} = 8.76$	$\frac{27896}{3185.5} = 8.76$

EXHIBIT G.

Calculation of the Log of the Allen Boiler, exhibited at the Fair of the American Institute, November, 1871.

Determination of the heat carried away by the condensing water discharged from the tank during the twelve hours trial.

	Units.
To 1.30 P. M., 1056 cub. ft. @ $62\frac{1}{2}$ lbs.=66000 lbs. @ range of 120°.7 Fahr.	7,966,200.
To 10.30 P. M., 5480 cub. ft. @ $62\frac{1}{2}$ lbs=342,500 lbs. @ range of 106°.08 Fahr.	36,332,400.
To 11.35 P. M. 650 cub. ft. @ $62\frac{1}{2}$ lbs.=40,625 lbs. @ range of 50°.5 Fahr.	2,051,562.5
(*a*) Total British thermal units	46,350,162.5

Determination of heat carried off by evaporation at the surface of the tank.

	Units.
1168.12 lbs. × 1008°.8 (latent heat at 152°.7 Fahr.=(*b*)	1,178,404.5

Determination of heat carried away by water of condensation.

	Units.
39670 lbs. @ 17°.98 (range=63°.48—45°.5=(*c*)	713 266.6

Total heat derived from fuel, as determined above.

	Thermal units.
46,350,162.5+1,178,404.5+713,266.6=	48,241,833.6
Deduct four per cent of (*a*) for errors (leakage and meters)	1,854,006.5
Final and corrected results	46,387,827.1

British thermal units per lb. combustible, 46,387,827.1÷4527=10,246.92.

Equivalent evaporation of water, temperature 212° Fahr., atmospheric pressure=10,246.92÷966.6=10.60 lbs.

	Apparent results.	Real results.
Water evaporated per lb. of coal	$\frac{39670}{5375}=7.38$	$\frac{39670}{5375}=7.38$
Water evaporated per lb. of combustible	$\frac{39670}{4527}=8.76$	$\frac{39670}{4527}=8.76$

EXHIBIT H.

CALCULATION OF THE LOG OF THE PHLEGER BOILER, EXHIBITED AT THE FAIR OF THE AMERICAN INSTITUTE, NOVEMBER, 1871.

Determination of the heat carried away by the condensing water discharged from the tank during the twelve hours trial.

	Units.
To 10 A. M., 101 cub. ft. @ 62½ lbs.=6,312.50 lbs. @ range of 106°.35 Fahr.=	671,334.38
To 9.00 P. M., 4909 cub. ft. @ 62½ lbs.=306,812.50 lbs. @ range of 72°.49 Fahr.=	22,240,838.13
To 9.45 P. M., 373 cub. ft. @ 62½ lbs.=23,312.5 lbs. @ range of 22°.98 Fahr.=	535,721.25
(*a*) Total British thermal units	23,447,893.76

Determination of heat carried off by evaporation at the surface of the tank.

	Units.
367.19 lbs. × 1030°.45 (latent heat at 120°.122 Fahr.=(*b*)	378,370.94

Determination of heat carried away by water of condensation.

	Units.
20,428 lbs. @ 8°.73 (range=4°.38−45°.65)=(*c*)	178,336.44

Total heat derived from fuel, as determined above.

	Thermal units.
23,447,893.76+378,370.94+178,336.44=	24,004,601.14
Deduct four per cent of (*a*) for errors (leakage and meters)	960,184.05
Final and corrected result	23,066,685.39

British thermal units per lb. combustible, 23,066,685.39÷2274=10,143.66.

Equivalent evaporation of water, temperature 212° Fahr., atmospheric pressure=10,143.66÷966.6=10.49 lbs.

Total weight of water actually evaporated, by equation $Hx+h(W-x)=U$, where

H=heat transferred by each lb. of steam.
h =heat carried into tank by one lb. of water.
x =weight steam, in lbs.
W=total weight feed.
U=total quantity of heat.
$1157.31x+266.16(W-x)=23{,}066{,}685.39$.
$=19782.94$ lbs. steam.
$W-x=645.06$ lbs. water.

	Apparent results.	Real results.
Water evaporated per lb. of coal	$\frac{20428}{2800}=7.26$	$\frac{19782.94}{2800}=7.07$
Water evaporated per lb. of combustible	$\frac{20428}{2274}=8.95$	$\frac{19782.94}{2274}=8.70$

EXHIBIT I.

CALCULATION OF THE LOG OF THE LOWE BOILERS, EXHIBITED AT THE FAIR OF THE AMERICAN INSTITUTE, NOVEMBER, 1871.

Determination of the heat carried away by the condensing water discharged from the tank during the twelve hours trial.

	Units.
To 11.00 A. M., 439 cub. ft. @ $62\frac{1}{2}$ lbs.=27,437.5 lbs. @ range of 114°.3 Fahr.=	3,136,102.25
To 9.00 P. M., 6823 cub. ft. @ $62\frac{1}{2}$ lbs.=426,437.5 lbs. @ range of 80°.9 Fahr.=	34,498,793.75
To 9.45 P. M., 90 cub. ft. @ $62\frac{1}{2}$ lbs.=5,625 lbs. @ range of 13°.7 Fahr.=	77,062.5
(*a*) Total British thermal units	37,711,962.50

Determination of heat carried off by evaporation at the surface of the tank.

	Units.
676.8 lbs. × 1022°.54 (latent heat at 131°.5 Fahr.=(*b*)	692,055.072

Determination of heat carried away by water of condensation.

	Units.
34000 lbs. @ 9°.8 (range=54°.8−45°)=(*c*)	333,200

Total heat derived from fuel, as determined above.

	Thermal units.
37,711,962.5+692,055.072+333,200=	38,737,217.572
Deduct four per cent of (*a*) for errors (leakage and meters	1,508,478.5
Final and corrected result	37,228,739.072

British thermal units per lb. combustible, 37,228,739.072÷3705=10,048.24.

Equivalent evaporation of water, temperature 212° Fahr., atmospheric pressure=10,048.24÷966.6=10.40 lbs.

Total weight of water actually evaporated, by equation $Hx-h(W-x)=U$, where

H=heat transferred by each lb. of steam.
h =heat carried into tank by one lb. of water.
x =weight steam, in lbs.
W=total weight feed.
U=total quantity of heat.

$1156.3x+263.8\,(34000-x)=37{,}228{,}739.072.$

$x=31663.35$ lbs. steam.

$W-x=2336.65$ lbs water.

	Apparent results.	Real results.
Water evaporated per lb. of coal	$\frac{34000}{4400}=7.68$	$\frac{31663.35}{4400}=7.20$
Water evaporated per lb. of combustible	$\frac{34000}{3705}=9.12$	$\frac{31663.35}{3705}=8.55$

EXHIBIT J.

CALCULATION OF THE LOG OF THE BLANCHARD BOILER, EXHIBITED AT THE FAIR OF THE AMERICAN INSTITUTE, NOVEMBER, 1871.

Determination of the heat carried away by the condensing water discharged from the tank during the twelve hours trial.

	Units.
To 10.30 A. M., 140 cub. ft. @ $62\frac{1}{2}$ lbs.=8750 lbs. @ range of 72°.1 Fahr.=	630,875.
To 8.56 P. M., 2805 cub. ft. @ $62\frac{1}{2}$ lbs.=175,312.5 lbs. @ range of 61°.74 Fahr.=	10,823,793.75
To 9.26 P. M., 120 cub. ft. @ $62\frac{1}{2}$ lbs.=7500 lbs. @ range of 23°.46 Fahr.=	175,950.
(*a*) Total British thermal units	11,630,618.75

Determination of heat carried off by evaporation at the surface of the tank.

	Units.
258.33 lbs. × 1040°.17 (latent heat at 106°.14 Fahr.=(*b*)..	268,707.12

Determination of heat carried away by water of condensation.

	Units.
10,152.5 lbs. @ 5°.09 (range=49°.49—44°.4)=(*c*)	51,676.23

Total heat derived from fuel, as determined above.

	Thermal units.
11,630,618.75+268,707.12+51,676.23=	11,951,002.10
Deduct four per cent of (*a*) for errors (leakage and meters	465,224.75
Final and corrected result......................	11,485,777.35

British thermal units per lb. combustible, 11,485,777.35÷1047.5= 10,964.94.

Equivalent evaporation of water, temperature 212° Fahr., atmospheric pressure=10,964.94÷966.6=11.34 lbs.

Total weight of water actually evaporated by equation, $Hx-h(W-x)=U$, where

H=heat transferred by each lb. of steam.
h =heat carried into tank by each lb. of water.
x =weight of steam, in lbs.
W=weight of feed.
U=total quantity of heat.
$1157.69x+256.14\,(10152.5-x)=11,485,777.35.$
x =9855.60 lbs. steam.
$W-x$ =296.90 lbs. water.

	Apparent results.	Real results.
Water evaporated per lb. of coal..	$\frac{10152.5}{1232}=8.24$	$\frac{9855.6}{1232}=8.00$
Water evaporated per lb. of combustible	$\frac{10152.5}{1047.5}=9.69$	$\frac{9855.6}{1047.5}=9.41$

To the Board of Managers of the American Institute, New York:

Gentlemen.—As judges of the sole leather entered in competition for the Schultz medals at your fortieth annual fair, we have to express our regret that, from the very small number of samples presented, the competition cannot, at least in the line of hemlock leather, be said to fairly represent the tanning industry of the country, as was undoubtedly the object of the founder of the medals. With some four or five hundred tanneries sending sole leather to the markets of New York, Boston, Philadelphia and Baltimore, or so located that their managers might, with very little trouble, enter the lists as competitors for "the grand medal of honor," we find that, after the matter has been fully presented to the trade, the attention of tanners having been frequently called to the subject through the Shoe and Leather Reporter, and when ample time has been given for the consideration of the subject, this being the second exhibition since the offer of Mr. Schultz, only fifteen tanners are represented as hoping to obtain the gold medals as the "best tanners" of oak, union and hemlock leather.

Upon the samples presented, however, and under the conditions prescribed, we render this report, with some explanation of the grounds upon which we make our awards. This is, in our opinion, necessary to a better understanding, by the trade at large, of the basis upon which the competition rests, according to the broad and liberal proposition of Mr. Schultz in his offer to found the medals; we may thus also remove the prejudices of many in the trade, who have heretofore considered it impossible to make such comparison between different grades of leather as will be equally fair for all competitors, distinguishing between the different recognized classes of manufacture, and giving due weight to the merits of each tannage, to the end that more thorough workmanship and a higher grade of practical efficiency may be encouraged among our tanners.

In addition to the two medals at first offered, Mr. Schultz has since, in an informal way, expressed his willingness, in accordance with the recommendation of the judges of leather at the fair of last year, to cause to be presented to the best tanner of union (or mixed oak and hemlock) leather a medal similar to those at first proposed for the best tanner of pure oak and the best tanner of pure hemlock leather, the terms of competition remaining the same.

It will be remembered that Mr. Schultz, in proposing to present, through the American Institute, gold medals—"one to the best hemlock tanner and one to the best oak tanner"—stated that the awards were not to be made upon "a few exceptionally thick and thoroughly tanned sides," but that "the leather exhibited must be samples of the whole product of the tanner." It was also stated by Mr. Schultz that the design in establishing these premiums was "to encourage skill and merit," so "that we may at no distant period be able to say of the tanning interest of our country, while it is second only in importance, it is equal in skill to any mechanical trade in the land."

It is evident, therefore, from the above statement of the terms on which the competition rests, that our decision must go further than a simple judgment as to the best side, *per se*, out of some twenty or thirty sides of hemlock leather, or the best side of oak or union leather from an equally small number of specimens exhibited. We have to decide upon these specimens only as they are "samples of the whole product of the tanner," and, with the view of "encouraging skill and merit," we have to take into consideration, as far as possible, the end which the tanner sought in manufacturing the leather, provided his object was to make the best leather of either class.

In the present competition, however, from the small number of samples presented, we do not think any further detailed statement necessary, except so far as to say that our examination has been made and our judgment is based on the conditions prescribed in the offer of the medals. It will at once be seen that such conditions impose upon the judges a great responsibility, and that, where the competition might be very close, it would be necessary that they should be supplied with accurate data respecting the tanning operation, and the usual product of leather.

We have, therefore, in accordance with our views of the ground upon which the merits of the several samples are to be judged, decided to award the medals as follows:

The "Lorillard medal," for the best oak tannage, to Messrs. Conrad & Fabel of Louisville, Ky. (Sample No. 1,371.)

The "Lee medal," for the best hemlock tannage, to Messrs. Grant & Horton of the Ridgway tannery, Ridgway, Pa. (Sample No. 1,532.)

The medal for "Union" leather, for best mixed oak and hemlock tannage, to Adam Innis, Esq., of the Scotia tannery, Scotia, N. Y. (Sample No. 1,577.)

In conclusion, we must express our surprise that there has been, apparently, so little interest manifested by our tanners in the objects sought in founding these medals. The competition, it appears to us, is no greater now, with the offer of the gold medals of Mr. Schultz as an inducement for tanners to compare the respective merits of their productions, than it was at the fairs of the American Institute twenty years ago. This may be, and doubtless is, in a great measure owing to the fact that of late years, or from a period commencing shortly after the breaking out of the war until 1868 and 1869, there was a very active demand for all qualities of sole leather, and many of our tanners have not as yet recovered from the influence which the call for a lower grade of goods then exerted upon the general character of their productions. For the period to which we have referred, the principal object of tanners seemed to be to produce the greatest amount of leather in the shortest possible space of time, in order to obtain the advantages of the high prices generally ruling in the market, and the standard of quality was, consequently, materially lowered. While, therefore, such of the members of the trade as are open to criticism on these grounds have our earnest sympathies for their present disappointments as to the average quality of their leather, we feel that the evil is not altogether without its compensation, inasmuch as it will probably compel the trade in general to work more earnestly hereafter to produce a better grade of goods.

Possibly, also, another reason for the limited number of sides exhibited in competition this year may be found in the assumption that a few of our tanners, making leather which commands a good price, and for which there is a steady demand, are a little timid about risking their reputation in a competition the basis of which is "the encouragement of skill and merit," wherein there might be a possibility, on a critical examination, of their losing something of the prestige, apparent or real, they may have supposed themselves to hold in the market. It is unfortunate for the trade if, as we suppose, such considerations have been allowed to interfere so as to prevent a more free and full competition; for we cannot but think, looking at the past history of the trade, considering the present state of the sole leather business, and making a reasonable allowance for its probable advancement and the closer competition which the future will almost of necessity bring, that a full, careful and thorough comparison of the merits of the different tannages of the country, at least once in each year, must necessarily be of great advantage to the whole trade. The annual fairs of the American Institute, at New York, seem to us to present the most ready means for the accomplishment of such a purpose, and the offer of Mr. Schultz, by which the competition is made to rest upon the skill and merit of each tanner entering the lists, not in the tanning of one, or two, or a dozen sides, but in his whole production of leather, presents the case on its broadest grounds. We hope, therefore, that the exhibition of 1872 will find at least one hundred of our tanners competing for the "grand medal of honor" of the American Institute, each striving for the distinction, which we think will in the end be not less profitable than honorable, of having his name inscribed on the "Lee" the "Lorillard," or the "Union" gold medal, as the best tanner, in his class of leather, in the country.

WM. PALEN.
JOHN F. McCOY.
E. FAXON.

PREMIUMS AWARDED IN THE SEVENTH DEPARTMENT.

GROUP 1. FIRST SERIES.

Floral Designs and Bouquets.

723. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best floral design. Silver plate or $25.

764. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best basket of flowers. Silver plate or $10.

766. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best table bouquet. Silver plate or $10.

765. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best pair of hand bouquets. Silver plate or $10.

Plants and Flowers.

746. George Such, South Amboy, N. J., for the best collection of miscellaneous plants of house culture. Silver plate or $20.

745. George Such, South Amboy, N. J., for the best collection of variegated leaved plants. Silver plate or $12.

744. George Such, South Amboy, N. J., for the best six varieties of variegated leaved plants. Silver plate or $10.

743. George Such, South Amboy, N. J., for the best single specimen plant. Silver plate or $10.

741. George Such, South Amboy, N. J., for the best collection of ferns and lycopodiums. Silver plate or $10.

Cut Flowers.

724. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best display of miscellaneous named flowers. Silver plate or $10.

706. C. S. Pell, New York Orphan Asylum, for the best display of dahlias. Silver plate or $5.

725. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best display of double linnias. Silver plate or $5.

726. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best display of gladioli. Silver plate or $5.

727. C. L. Allen & Co., 74 Fulton street, Brooklyn, N. Y., for the best display of lilies. Silver plate or $5.

Second Series.

Floral Designs and Bouquets.

1140. Walter Reid, 66 West Thirty-fourth street, for the best floral design. Silver plate or $25.

996. J. N. Hanser, Sixty-sixth street, near Second avenue, for the second best floral design. Silver plate or $10.

1141. Walter Reid, 66 West Thirty-fourth street, for the best table bouquet. Silver plate or $10.

995. John N. Hauser, Sixty-sixth street, near Second avenue, for the second best table bouquet. Silver plate or $5.

1125. John L. Hauser, Sixty-sixth street, near Second avenue, for the best pair of hand bouquets. Silver plate or $10.

Plants.

1144. William Charlton, Staten Island, for the best specimen plant. Silver plate or $10.

Cut Flowers.

973. C. S. Pell, New York Orphan Asylum, for the best display of dahlias. Silver plate or $5.

974. C. S. Pell, New York Orphan Asylum, for the best display of bouquet dahlias. Silver plate or $5.

Discretionary.

1134. M. Rattey, 1245 Broadway, for plants and flowers, assorted. Silver plate or $5.

1145. Wm. Charlton, Staten Island, for design of Alpine plants. Silver plate or $5.

1131. William Charlton, Staten Island, for an assortment of Alpine plants (sedum, forty-five varieties; semper vivum, thirty-one species; echeviria metalica, one). Silver plate or $10.

1132. William Charlton, Staten Island, for an oanamental basket and rustic stand of Alpine plants. Silver plate or $5.

Third Series.

Floral Designs and Bouquets.

1387. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for the best floral design. Silver plate or $25.

1384. Walter Reid, 66 West Thirty-fourth street, for the second best floral design. Silver plate or $10.

1385. Walter Reid, 66 West Thirty-fourth street, for the best basket of flowers. Silver plate or $10.

1388. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for the best table bouquet. Silver plate or $10.

1385. Walter Reid, 66 West Thirty-fourth street, for the second best table bouquet. Silver plate or $5.

Plants and Flowers.

1378. Walter Reid, 66 West Thirty-fourth street, for the best Wardian case. Silver plate or $20.

1323. R. E. Corcoran, Providence, R. I., for the second best Wardian case. Silver plate or $10.

1377. Walter Reid, 66 West Thirty-fourth street, for the best collection of miscellaneous plants of house culture. Silver plate or $20.

1389. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for the second best collection of miscellaneous plants of house culture. Silver plate or $10.

1339. William Baker, 236 East Forty-second street, for the best four specimen plants in bloom. Silver plate or $10.

1338. William Baker, 236 East Forty-second street, for the best general collection of variegated leaved plants. Silver plate or $12.

1390. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for the best six varieties of variegated leaved plants. Silver plate or $10.

1337. William Baker, 236 East Forty-second street, for the second best six varieties of variegated leaved plants. Silver plate or $5.

1386. David Deans, Astoria, L. I., for the best single specimen plant. Silver plate or $10.

1367. H. A. Siebrecht, 502 Fifth avenue, for the most ornamental and beautiful plant exhibited. Silver plate or $15.

1336. William Baker, 236 East Forty-second street, for the best collection of ferns and lycopodiums. Silver plate or $10.

1376. Walter Reid, 66 West Thirty-fourth street, for the second best collection of ferns and lycopodiums. Silver plate or $5.

1335. William Baker, 236 East Forty-second street, for the best tea plant. Silver plate or $5.

1740. M. Martel, 205 West Twenty-first street, for rustic stand containing orchids. Silver plate or $10.

Cut Flowers.

1331. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for the best display of named roses. Silver plate or $10.

1328. C. S. Pell, New York Orphan Asylum, for the best display of named dahlias. Silver plate or $5.

1383. Alexander Mead, Greenwich, Conn., for the best display of named verbenas. Silver plate or $5.

1329. C. S. Pell, New York Orphan Asylum, for the best collection of asters. Silver plate or $2.

Discretionary.

1366. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for a rustic flower stand. Silver plate or $5.

1392. H. A. Siebrecht & Co., Fifth avenue and Forty-second street, for rustic baskets with flowers. Silver plate or $5.

1359. Mrs. Charlton, Staten Island, for bouquets of natural flowers. Silver plate or $5.

Group 2.

Pears.

621. Ellwanger & Barry, Rochester, N. Y., for the best collection of named varieties of pears. Silver plate or $50.

738. William L. Ferris, Throg's Neck, N. Y., for the best thirty named varieties of pears. Silver plate or $30.

734. Spencer Springstead, Unionport, N. Y., for the best twelve named varieties of pears. Silver plate or $15.

1139. G. F. B. Leighton, Norfolk, Va., for extra large specimens of Duchess d'Angouleme pears. Silver plate or $5.

1363. N. T. Romaine, Leonia, N. J., for Duchess d'Angouleme pears. Silver plate or $2.

969. S. B. Kenyon, 307 East One Hundred and Eighteenth street, for Duchess d'Angouleme pears. Silver plate or $2.

1150. James Wiggins, Weehawken, N. J., for Vicar of Winkfield. Silver plate or $2.

946. G. G. Bergen, Brooklyn, L. I., for three varieties of pears. Silver plate or $2.

1109. S. Springstead, Unionport, N. Y., for Stephenson's Genesee pears. Silver plate or $2.

800. Mrs. John W. Chambers, 269 Pearl street, Brooklyn, N. Y., for Beurre Diel pears. Honorable mention.

Apples.

622. William H. Bailey, Plattsburgh, N. Y., for the best collection of apples. Silver plate or $40.

622. William H. Bailey, Plattsburgh, N. Y., for a seedling crab, "Bailey's Crimson." Silver plate or $2.

Grapes.

1151. John F. Seaman, Kingsbridge, N. Y., for the best six named varieties of grapes, grown under glass. Silver plate or $20.

1152. John F. Seaman, Kingsbridge, N. Y., for the best three named varieties of grapes, grown under glass. Silver plate or $10.

1153. John F. Seaman, Kingsbridge, N. Y., for the best single bunch of grapes. grown under glass. Silver plate or $5.

1138. L. M. Ferris & Son, Poughkeepsie, N. Y., for grapes, "Walter Seedling." Silver plate or $5.

Peaches.

784. S. P. Van Winkle, Paterson, N. J., for peaches. Silver plate or $5.

797. Mrs. M. N. Sherman, 7 West Twenty-ninth street, for peaches. Silver plate or $2.

975. Henry Peters, Brooklyn, N. Y., for peaches. Silver plate or $2.

992. D. Farr, 2331 Third avenue, for peaches. Silver plate or $2.

1143. J. C. Watson, Brooklyn, N. Y., for seedling peaches. Silver plate or $2.

1111. Spencer Springstead, Unionport, N. Y., for peaches, "Rare Ripe." Silver plate or $2.

1110. Spencer Springstead, Unionport, N. Y., for peaches, "Late Crawford." Silver plate or $2.

1148. J. W. Greene, Warren street, Brooklyn, for seedling peaches. Silver plate or $2.

1200. H. E. Corvoisier, West Hoboken, N. J., for Montrieux peaches. Silver plate or $2.

1124. Charles B. Horner, Mount Holly, N. J., for raspberries, "Welcome." Silver plate or $2.

Potatoes.

1523. Gerard C. Brown, Croton Falls, N. Y., for seventy-four varieties of potatoes. Silver plate or $10.

1191. J. L. Conover & Crawford, Red Bank, N. J., for the "Peerless" potatoes. Silver plates.

1308. G. D. Hopkins, West Rupert, for "Breeze No. 6" potatoes. Silver plate or $2.

1352. S. Springstead, Unionport, N. Y., for seedling potatoes. Silver plate or $5.

1353. S. Springstead, Unionport, N. Y., for "Early Rose" potatoes. Silver plate or $2.

1324. Mrs. Elizabeth Sleight, Mt. Vernon, N. Y., for Andes seedling potatoes. Silver plate or $2.

1349. S. Springstead, Unionport, N. Y., for white sweet potatoes. Silver plate or $2.

1568. Miss Hoffman, Tarrytown, N. Y., for "Peerless" potatoes. Silver plate or $2.

993. W. H. Archer, Jerome, N. Y., for tomatoes, "Archer's Beauty." Silver plate or $2.

1154. J. F. Seaman, King's Bridge, N. Y., for cucumbers. Honorable mention.

1354. S. Springstead, Unionport, N. Y., for cucumbers. Honorable mention.

1357. W. S. Eaton, Mansfield Centre, Conn., for cucumbers. Honorable mention.

1317. S. Springstead, Unionport, N. Y., for white flint corn. Silver plate or $2.

Discretionary.

E. A. Coleman and daughter, Lawrence, Douglass Co., Kansas, for a magnificent display of apples. Diploma.

State Horticultural Society of Kansas, for a splendid exhibition of cereals and apples. Diploma.

E. Page Davis, 153 Broadway, for corn, oats, wheat, beans, pease and a full assortment of vegetables of enormous growth, from the State of Minnesota, received and merited the highest commendation. Diploma.

ADDRESSES AT THE EXHIBITION OF 1871.

The exhibition of 1871 was opened with an address by the Hon. E. G. Squier. A copy of the author's manuscript used on this occasion has not been received. The following poem was recited by its author, Walt Whitman, Esq.:

AFTER ALL, NOT TO CREATE ONLY.

I.

After all, not to create only, or found only,
But to bring, perhaps from afar, what is already founded,
To give it our own identity, average, limitless, free;
To fill the gross, the torpid bulk with vital religious fire;
Not to repel or destroy, so much as accept, fuse, rehabilitate;
To obey, as well as command — to follow, more than to lead;
These also are the lessons of our New World;
—While how little the New, after all — how much the Old, Old World!

Long, long, long, has the grass been growing,
Long and long has the rain been falling,
Long has the globe been rolling round.

II.

Come, Muse, migrate from Greece and Ionia;
Cross out, please, those immensely overpaid accounts,
That matter of Troy, and Achilles' wrath, and Eneas', Odysseus' wanderings;
Placard "*Removed*" and "*To Let*" on the rocks of your snowy Parnassus;
Repeat at Jerusalem — place the notice high on Jaffa's gate, and on Mount Moriah;
The same on the walls of your Gothic European Cathedrals, and German, French and Spanish Castles;
For know, a better, fresher, busier sphere — a wide, untried domain awaits, demands you.

III.

Responsive to our summons,
Or rather to her long-nurs'd inclination,
Join'd with an irresistible, natural gravitation,

She comes! this famous Female — as was indeed to be expected;
(For who, so ever-youthful, 'cute and handsome, would wish to stay in mansions such as those,
When offer'd quarters with all the modern improvements,
With all the fun that's going — and all the best society?)

She comes! I hear the rustling of her gown;
I scent the odor of her breath's delicious fragrance;
I mark her step divine — her curious eyes aturning, rolling,
Upon this very scene.
The Dame of Dames! can I believe, then,
Those ancient temples classic, and castles strong and feudalistic, could none of them restrain her?
Nor shades of Virgil and Dante — nor myriad memories, poems, old associations magnetize and hold on to her?
But that she's left them all — and *here?*

Yes, if you will allow me to say so,
I, my friends, if you do not, can plainly see Her,
The same Undying Soul of Earth's activity's, beauty's, heroism's Expression,
Out from her evolutions hither come — submerged the strata of her former themes,
Hidden and cover'd by to-day's — foundation of to-day's;
Ended, deceas'd, through time, her voice by Castaly's fountain;
Silent through time the broken-lipp'd Sphynx in Egypt — silent those century-baffling tombs;
Closed for aye the epics of Asia's, Europe's helmeted warriors;
Calliope's call for ever closed — Clio, Melpomene, Thalia closed and dead;
Seal'd the stately rhythmus of Una and Oriana — ended the quest of the Holy Graal;
Jerusalem a handful of ashes blown by the wind — extinct;
The Crusaders' streams of shadowy, midnight troops, sped with the sunrise;
Amadis, Tancred, utterly gone — Charlemagne, Roland, Oliver gone,
Palmerin, ogre, departed — vanish'd the turrets that Usk reflected,
Arthur vanish'd with all his knights — Merlin and Lancelot and Galahad — all gone — dissolv'd utterly, like an exhalation;
Pass'd! pass'd! for us, for ever pass'd! that once so mighty World — now void, inanimate, phantom World!
Embroider'd, dazzling World! with all its gorgeous legends, myths,
Its kings and barons proud — its priests, and warlike lords, and courtly dames;
Pass'd to its charnel vault — laid on the shelf — coffin'd, with Crown and Armor on,
Blazon'd with Shakspeare's purple page,
And dirged by Tennyson's sweet, sad rhyme.

I say I see, my friends, if you do not, the Animus of all that World,
Escaped, bequeath'd, vital, fugacious as ever, leaving those dead remains, and now this spot approaching, filling;
—And I can hear what may be you do not — a terrible æsthetical commotion,
With howling, desperate gulp of "flower" and "bower,"
With "Sonnet to Matilda's Eyebrow" quite, quite frantic;
With gushing, sentimental reading circles turn'd to ice or stone;
With many a squeak (in metre choice), from Boston, New York, Philadelphia, London;

As she, the illustrious Emigrê (having, it is true, in her day, although the same, changed, journey'd considerable),
Making directly for this rendezvous — vigorously clearing a path for herself — striding through the confusion,
By thud of machinery and shrill steam-whistle undismay'd,
Bluff'd not a bit by drain-pipe, gasometers, artificial fertilizers,
Smiling and pleased, with palpable intent to stay,
She's here, install'd amid the kitchen ware!

IV.

But hold — don't I forget my manners?
To introduce the Stranger (what else indeed have I come for?) to thee, Columbia:
In Liberty's name, welcome, Immortal! clasp hands,
And ever henceforth Sisters dear be both.

Fear not, O Muse! truly new ways and days receive, surround you
(I candidly confess, a queer, queer race, of novel fashion),
And yet the same old human race — the same within, without,
Faces and hearts the same — feelings the same — yearnings the same,
The same old love — beauty and use the same.

V.

We do not blame thee, Elder World — nor separate ourselves from thee:
(Would the Son separate himself from the Father?)
Looking back on thee — seeing thee to thy duties, grandeurs, through past ages bending, building,
We build to ours to-day.

Mightier than Egypt's tombs,
Fairer than Grecia's, Roma's temples,
Prouder than Milan's statued, spired Cathedral,
More picturesque than Rhenish castle-keeps,
We plan, even now, to raise, beyond them all,
Thy great Cathedral, sacred Industry — no tomb,
A Keep for life for practical Invention.

As in a waking vision,
E'en while I chant, I see it rise — I scan and prophesy outside and in,
Its manifold ensemble.

VI.

Around a Palace,
Loftier, fairer, ampler than any yet,
Earth's modern Wonder, History's Seven outstripping,
High rising tier on tier, with glass and iron façades.
Gladdening the sun and sky — enhued in cheerfulest hues,
Bronze, lilac, robin's egg, marine and crimson,
Over whose golden roof shall flaunt, beneath thy banner, Freedom,
The banners of The States, the flags of every land,
A brood of lofty, fair, but lesser Palaces shall cluster.

Somewhere within the walls of all,
Shall all that forwards perfect human life be started,
Tried, taught, advanced, visibly exhibited.

Here shall you trace in flowing operation,
In every state of practical, busy movement
The rills of civilization.

Materials here, under your eye, shall change their shape, as if by magic;
The cotton shall be pick'd almost in the very field,
Shall be dried, clean'd, ginn'd, baled, spun into thread and cloth, before you:
You shall see hands at work at all the old processes, and all the new ones;
You shall see the various grains, and how flour is made, and then bread baked by the bakers;
You shall see the crude ores of California and Nevada passing on and on till they become bullion;
You shall watch how the printer sets type, and learn what a composing stick is;
You shall mark, in amazement, the Hoe press whirling its cylinders, shedding the printed leaves steady and fast:
The photograph, model, watch, pin, nail, shall be created before you.

In large calm halls, a stately Museum shall teach you the infinite, solemn lessons of Minerals:
In another, woods, plants, Vegetation shall be illustrated—in another Animals, animal life and development.

One stately house shall be the Music House,
Others for other Arts—Learning, the Sciences shall all be here;
None shall be slighted—none but shall here be honor'd, help'd, exampled.

VII.

This, this and these, America, shall be *your* Pyramids and Obelisks,
Your Alexandrian Pharos, gardens of Babylon,
Your temple at Olympia.

The male and female many laboring not,
Shall ever here confront the laboring many,
With precious benefits to both—glory to all,
To thee, America—and thee, Eternal Muse.
And here shall ye inhabit, Powerful Matrons!
In your vast state, vaster than all the old;
Echoed through long, long centuries to come,
To sound of different, prouder songs, with stronger themes,
Practical, peaceful life—the people's life—the People themselves,
Lifted, illumin'd, bathed in peace—elate, secure in peace.

VIII.

Away with themes of war! away with War itself!
Hence from my shuddering sight, to never more return, that show of blacken'd, mutilated corpses!

That hell unpent, and raid of blood — fit for wild tigers, or for lop-tongued wolves — not reasoning men!
And in its stead speed Industry's campaigns!
With thy undaunted armies, Engineering!
Thy pennants, Labor, loosen'd to the breeze!
Thy bugles sounding loud and clear!

Away with old romance!
Away with novels, plots, and plays of foreign courts!
Away with love-verses, sugar'd in rhyme — the intrigues, amours of idlers,
Fitted for only banquets of the night, where dancers to late music slide;
The unhealthy pleasures, extravagant dissipations of the few,
With perfumes, heat and wine, beneath the dazzling chandeliers.

IX.

To you, ye Reverent, sane Sisters,
To this resplendent day, the present scene,
These eyes and ears that like some broad parterre bloom up around, before me,
I raise a voice for far superber themes for poets and for Art,
To exalt the present and the real,
To teach the average man the glory of his daily walk and trade,
To sing, in songs, how exercise and chemical life are never to be baffled;
Boldly to thee, America, to-day! and thee, Immortal Muse!
To practical, manual work, for each and all — to plow, hoe, dig,
To plant and tend the tree, the berry, vegetables, flowers,
For every man to see to it that he really do something — for every woman too;
To use the hammer, and the saw (rip or cross-cut),
To cultivate a turn for carpentering, plastering, painting,
To work as tailor, tailoress, nurse, hostler, porter,
To invent a little — something ingenious — to aid the washing, cooking, cleaning,
And hold it no disgrace to take a hand at them themselves.

I say I bring thee, Muse, to-day and here,
All occupations, duties broad and close,
Toil, healthy toil and sweat, endless, without cessation,
The old, old general burdens, interests, joys,
The family, parentage, childhood, husband and wife,
The house-comforts — the house itself, and all its belongings,
Food and its preservations — chemistry applied to it;
Whatever forms the average, strong, complete, sweet-blooded Man or Woman — the perfect, longeve Personality,
And helps its present life to health and happiness — and shapes its Soul,
For the eternal Real Life to come.

With latest materials, works,
Steam-power, the great Express lines, gas, petroleum,
These triumphs of our time, the Atlantic's delicate cable,
The Pacific railroad, the Suez canal, the Mont Cenis tunnel;
Science advanced, in grandeur and reality, analyzing every thing,
This world all spann'd with iron rails — with lines of steamships threading every sea,
Our own Rondure, the current globe I bring.

X.

And thou, high-towering One — America!
Thy swarm of offspring towering high — yet higher thee, above all towering,
With Victory on thy left, and at thy right hand Law;
Thou Union, holding all — fusing, absorbing, tolerating all,
Thee, ever thee, I bring.

Thou — also thou, a world!
With all thy wide geographies, manifold, different, distant,
Rounding by thee in One — one common orbic language,
One common indivisible destiny and Union.

XI.

And by the spells which ye vouchsafe
To those, your ministers in earnest,
I here personify and call my themes,
To make them pass before ye.

Behold, America! (And thou, ineffable Guest and Sister!)
For thee come trooping up thy waters and thy lands:
Behold! thy fields and farms, thy far-off woods and mountains,
As in procession coming.

Behold! the sea itself!
And on its limitless, heaving breast, thy ships:
See! where their white sails, bellying in the wind, speckle the green and blue!
See! thy steamers coming and going, steaming in or out of port!
See! dusky and undulating, their long pennants of smoke!

Behold, in Oregon, far in the north and west,
Or in Maine, far in the north and east, thy cheerful axmen,
Wielding all day their axes!

Behold, on the lakes, thy pilots at their wheels — thy oarsmen!
Behold how the ash writhes under those muscular arms!

There by the furnace, and there by the anvil,
Behold thy sturdy blacksmiths, swinging their sledges;
Overhand so steady — overhand they turn and fall, with joyous clank,
Like a tumult of laughter.

Behold! (for still the procession moves,)
Behold, Mother of All, thy countless sailors, boatmen, coasters!
The myriads of thy young and old mechanics!
Mark — mark the spirit of invention everywhere — thy rapid patents,
Thy continual workshops, foundries, risen or rising;
See, from their chimneys, how the tall flame-fires stream!

Mark, thy interminable farms, North, South,
Thy wealthy Daughter-States, Eastern and Western,
The varied products of Ohio, Pennsylvania, Missouri, Georgia, Texas, and the rest;

Thy limitless crops — grass, wheat, sugar, corn, rice, hemp, hops,
Thy barns all fill'd — thy endless freight-trains, and thy bulging store-houses,
The grapes that ripen on thy vines — the apples in thy orchards,
Thy incalculable lumber, beef, pork, potatoes — thy coal — thy gold and silver,
The inexhaustible iron in thy mines.

XII.

All thine, O sacred Union!
Ship, farm, shop, barns, factories, mines,
City and State — North, South, item and aggregate,
We dedicate, dread Mother, all to thee!

Protectress absolute, thou! Bulwark of all!
For well we know that while thou givest each and all (generous as God),
Without thee, neither all nor each, nor land, home,
Ship, nor mine — nor any here, this day, secure,
Nor aught, nor any day, secure.

XIII.

And thou, thy Emblem, waving over all!
Delicate beauty! a word to thee (it may be salutary);
Remember, thou hast not always been, as here to-day, so comfortably ensovereign'd;
In other scenes than these have I observ'd thee, flag;
Not quite so trim and whole, and freshly blooming, in folds of stainless silk;
But I have seen thee, bunting, to tatters torn, upon thy splinter'd staff,
Or clutch'd to some young color-bearer's breast, with desperate hands,
Savagely struggled for, for life or death — fought over long,
'Mid cannon's thunder-crash, and many a curse, and groan and yell — and rifle-volleys cracking sharp,
And moving masses, as wild demons surging — and lives as nothing risk'd,
For thy mere remnant, grimed with dirt and smoke, and sopp'd in blood;
For sake of that, my beauty — and that thou might'st dally, as now, secure up there,
Many a good man have I seen go under.

Now here, and these, and hence, in peace, all thine, O Flag!
And here, and hence, for thee, O universal Muse! and thou for them!
And here and hence, O Union, all the work and workmen thine!
The poets, women, sailors, soldiers, farmers, miners, students thine!
None separate from Thee — henceforth one only, we and Thou;
(For the blood of the children — what is it only the blood Maternal?
And lives and works — what are they all at last except the roads to Faith and Death?)

While we rehearse our measureless wealth, it is for thee, dear Mother!
We own it all and several to-day indissoluble in Thee;
— Think not our chant, our show, merely for products gross, or lucre — it is for Thee, the Soul, electric, spiritual!
Our farms, inventions, crops, we own in Thee! Cities and States in Thee!
Our freedom all in Thee! our very lives in Thee!

CLOSING ADDRESS.

By Dr. James Knight, Chairman of the Board of Managers.

Ladies and Gentlemen.—The fortieth industrial exhibition of the American Institute is now about to close, after a most successful career of fifty days, presenting to the public one of the largest and most valuable collections of products of American industry. To the great regret of the Board of Managers, the still too limited space for exhibition (no doubt to the astonishment of the casual observer, seeming impossible, since 93,220 square feet is the present dimension of the structures) compelled them most reluctantly to refuse many valuable articles presented for exhibition. So popular and desirable have these exhibitions become, they afford facilities for exposition exceeding any other that we know of. About 300,000 visitors have attended this exhibition; and, for their inspection, profit and information, 1,330 entries of goods were received, many of them of extraordinary merit and value. This suggests the existing necessity for their continuance, if possible without great pecuniary loss to the American Institute, and invites assistance from whatever source it is to be obtained. These exhibitions are held at a large outlay, requiring the most careful management and scrutiny of expenditure. This is an impressive consideration for the friends of the American Institute, for thus both exhibitors and visitors are benefited; the one in remuneration from publicity, tending directly to the sale of their commodities, and the other from the knowledge obtained as to the benefits they may derive from the great improvements in all that pertains to comfort and the lessening of physical labor, and as to where such improvements may be purchased.

Were it not for these expositions, useful products would, in many instances, be only known to a very limited extent, which is very dis-discouraging to their inventors; and, because of their limited means to manufacture, they having expended, in many instances, in experimenting, all their means; at the completion of their inventions, not being disposed to give them to capitalists, they would be abandoned, to the great loss of the public. And here is the secret of our great success in our exhibitions. It is the great incentive to labor, for the Board of Managers labor with greater zeal and prudence here, than even in their own business. It is only practical business men that can successfully organize these monster exhibitions, and conduct them through to a successful end. Their recompense in money is nothing, yet far more satisfactory is it to know that they have greatly benefited thousands by giving encouragement to inventive genius, and showing how wants and comforts may be supplied, thus contributing largely to the happiness of their fellow-men. By favorable awards to inventors, much is being accomplished from the status of the American Institute at home and abroad. Its award of the great medal of honor can only be obtained by the discoverer or inventor of a machine, product or process, which shall be adjudged so important in its use or application as to supplant every article previously used for accomplishing the same purpose, or at least to work a favorable revolution in some branch of the arts; this confers upon the talented producer an award of the highest appreciation known of in this country, assuring him of a just recompense for his talent and industry. This is giving encouragement to the progress of science, and its applications, by making slaves of the great insensible forces of nature, and securing to man the prerogative of all that work which men only, by their individual intelligence and skilled hands, can accomplish, thus associating human labor with the highest creative genius.

The tendency of our great National Exhibition of American industries is to establish a great school for emulation in those arts of production by which raw material assumes a form, a shape, a new existence, adapted for some necessity or some use in the many wants of life, whether of wood, stone, metal, or textile matter. And it must be admitted that there exists a greater necessity for encouragement, by furnishing means and opportunity for instruction than has yet been given in our periodical exhibitions of American industries. We now ask, will they not be given us in this land of wealth and acknowledged birth-place of talent and ingenuity? The American Institute will not despair of this, but will labor and hope for the future, acknowledging, with grateful consideration, the great appreciation of their labors by the numerous exhibitors and visitors who are annually increasing in number. The continued success of these fairs proves how much more could be done, and this, we hope, will be an inducement to some of our millionaires to aid us in building, and thus rear a monument of honorable mention by the present and future generation, for having contributed largely to progressive enterprises in the arts of production. We want an establishment of ample dimensions to admit of a union of the labors of artists, both in the arts of design and the arts of production, where adventurous genius may find a home, and be free from difficulties like those met by the celebrated Cellina of Rome in the fifteenth century. The historian informs us that he was a working goldsmith, and the beauty of his works consisted in this: That they had the impress of genius so marked upon them that they never could have been designed by one person and executed by another. There was as much art in the finish as in the design. He went from step to step until at length he produced the most magnificent works on the largest scale in marble and bronze. He describes how he constructed his celebrated statue of Perseus. He went to purchase his wood and saw it brought; and when he was casting that exquisite statue, which is one of the most admired wonders of art, he met with a most sad misfortune. His furnace blew up, the roof was torn off, and the rain came in torrents upon the fire just the moment the metal was going to be poured in. By his ingenuity and extraordinary contrivances he overcame the whole chain of accidents, and brought out, almost without a flaw, that most perfect piece of workmanship. And, continues the writer: You may imagine to what a state he was reduced when at the very moment the metal was ready for pouring out, the explosion took place. He had no other resource but to run to his kitchen, as he says, and take every piece of copper, consisting of a large number of porringers and different sorts of kettles, and throw them into the fire, and from this that splendid statue came forth. It is stated of this great artist that on one occasion a surgeon came into his shop to perform an operation on the hand of one of his pupils. Upon looking at his instruments, he found them, as they were in those days, so exceedingly rude and clumsy, that he said, "If you will wait half an hour I will make you a better instrument;" and he went into his workshop and made a most beautifully finished knife. This man was a common workman, yet modeled in the most exquisite manner; was truly an artist, and at the same time a laboring artisan.

We have many such in our country who are laboring under equally great disadvantages. It is to encourage this talent that we want a great structure, which will be a standing proof of our advancement in civilization, and of desire for the promotion of arts and science, now and hereafter. This is an exceedingly brief view of our labors and desires. We hope the subject may be so carefully considered as to hasten the accomplishment of the great work in prospect.

And as we are now about to separate, for the present, in behalf of the Board of Managers, I thank you all, both exhibitors and visitors, for the interest you have manifested in the fortieth exhibition of the American Institute, being well assured that you will join us in congratulations at its successful termination.

TEST OF MOWING MACHINES

SHOWN AT THE EXHIBITION OF 1870.

The committee appointed to conduct a practical test or trial of the mowing machines exhibited at the American Institute Fair in the fall of 1870, having attended to the duties of their office, report as follows:

The trial took place on the farm of Samuel Sinclair, publisher of the Tribune, at Croton, on the Hudson river, June 21st, 1871. The field selected was a meadow recently underdrained (the ground in consequence of recent rains being quite soft), in oats last year, and bearing a burden of badly lodged clover and herd grass, which would average at least two tons to the acre. Four machines were entered for competition, "Clipper," "Buckeye," "Sprague" and "Warrior," besides several for exhibition. Each was assigned a plat 350 by 69 feet, in round numbers sixth-tenths of an acre, which they were directed to cut in their own time and way

Lot number one was mowed by the Clipper in nineteen and one-half minutes. The grass, in common with that in the whole field, was heavy and wet, and the machine, from some unexplained cause, clogged, so that the driver was under the necessity of leaving his seat frequently to clear the center bar. During the trial the sudden striking of the bar against a solid stem, broke and, for many minutes, disabled the machine. The grass was well cut, the draft did not appear to be heavy, and for light work and on smooth lands it is a machine worthy of the highest recommendation; but for all work, with rough as well as careful handling, your committee do not deem it of more than average worthiness.

Lot number two was cut by the Buckeye. This plot had more obstructions than either, and perhaps all the others. It was cut in nineteen minntes, without any assistance from a second man and without clogging. Twice it came in violent contact with hidden rocks without damage. The work was well done and the whole operation eminently satisfactory.

Lot number three was cut by the Sprague, a new and successful aspirant for popular favor. The plot had fewer obstructions than that of either the Clipper or the Buckeye, and with a finger bar two and four inches shorter respectively (if we are correct), did the work in the same time as the machines already mentioned. There was no clogging; the work was done with apparent ease and well done; little, if any, perceptible side draft, and, as a whole, the working of the machine was not only easy but admirable.

Lot number four was cut by the Warrior in nineteen and one-quarter minutes. It did its work well, without clogging, without breaking, although heavily striking one or two obstructions, but it seemed to work harder than some, if not all the others. Although the committee, much to their regret, had no instrument for definitely ascertaining the draft of either, it gave evidence of great strength, ease in handling, and, on the whole, did exceedingly satisfactory and creditable work.

Your committee regard as the features essential to a successful machine:

1st. Durability; and this in connection with work in all lands and in grasses of whatever condition and weight.

2d. Simplicity; making it possible for farmers who are not mechanics, or who depend upon uneducated labor, to work and repair (if needed) the machine.

3d. Lightness of draft; considering that every pound of force expended, if unnecessary, is a waste of muscle, and therefore a waste of money.

Keeping these points in mind, without evidence with regard to the latter, except from observation, your committee are of unanimous opinion that the Buckeye comes nearest to the standard proposed; nearest to being *the* universal machine.

Next to this, in their opinion, comes the Sprague, with as compact make, ease of draft, ease of handling, and, if time demonstrates it, its durability.

And that, third, between the Clipper that badly clogged, and the Warrior with its heavy draft (apparently), both being machines worthy of American genius and worthy of the age, your committee, being divided, respectfully ask that each be accorded the mention which they individually merit.

With regard to *tedders*, Bullard's was the committee's unanimous choice as being the best, although it is believed that the universal tedder is not yet invented.

All of which is respectfully submitted.

(Signed) H. L. READ,
JOSIAH H. MACY,
FRANK D. CURTIS,
Committee

THE ORIGIN OF INDUSTRIAL EXHIBITIONS IN THE CITY OF NEW YORK.

AN ADDRESS BEFORE THE AMERICAN INSTITUTE ON THE 29TH OF APRIL, 1871.

By Mr. Joseph P. Simpson.

Gentlemen of the American Institute.—I now undertake to discharge an engagement, some years since contemplated, of presenting a statement concerning the origin of industrial exhibitions in this city, and I may say in the United States. I regret that physical infirmity prevented my doing so before this, and now it will be but feebly performed. The subject seemed to be of such a nature that the American Institute was thought to be the proper place for its delivery. The indulgence of my audience for its imperfection in matter and manner is craved.

Fairs are of great antiquity. The city of Tyre was a celebrated place for holding them, but these, as well as all others early held in Europe, were for the display and sale of merchandise. The idea of merchants and manufacturers exhibiting the products of their labor for competition was not thought of. It was then only a display of attractive articles to suit the taste of the visitors that attended them. It was left for the city of New York, by the organization of the New York Mechanic and Scientific Institution, to open to the industrial world a new mode to stimulate skill and workmanship in the fabrication of all those useful and elegant articles which greatly increase the convenience of comfort of every community.

In the month of October, 1821, nearly fifty years ago, a circular was sent by the late Professor John Griscom to the leading master mechanics of this city, inviting them to meet at his rooms in the then alms-house, situated on Chambers street, where the new court house is being erected. This invitation was responded to by a large number of the prominent mechanics, mostly members of the General

Society of Mechanics and Tradesmen. Mr. Griscom proceeded to give a detailed account of his visit to Europe, from whence he had just returned, and especially his interview with the principal working establishments of England and Scotland, with a view of ascertaining their proficiency and excellence, in order to impart to his countrymen what he thought would be of advantage to the mechanic and manufacturer. He suggested what he believed would greatly benefit them, not only in increased perfection of the workmen, but also stimulate a laudable rivalry in the market to excel. This was organizing an institution to impart Mechanical Science and Chemistry as applied to the arts, by means of public lectures, with experiments on such subjects, and by awarding premiums for the best productions of the workshops, especially to the apprentices, in order to stimulate them to greater perfection in their work; also to have public exhibitions of the productions of the workshops and manufactories, which would tend to encourage the domestic industry of the county. He also proposed to give a course of lectures on Medical Science and Chemistry, as applied to the arts; to commence at once. After listening to Mr. Griscom's statements a meeting was organized; Stephen Allen, then mayor, was called to the chair, and Lewis Wilcox appointed secretary; when on a free exchange of opinion, a committee of seven was appointed, consisting of Stephen Allen, John J. Labagh, Thos. R. Mercien, Thomas Richards, Jonas Humbert, Lewis Wilcox and Joseph P. Simpson, to consider and report on the subject at a future meeting. The meeting adjourned to meet at the call of the committee. This committee met in the hall of the General Society of Mechanics and Tradesmen, corner of Broadway and Park place. After considerable discussion, a majority of the committee was in favor of only forming a class to attend the course of lectures to be given by Dr. Griscom, as he proposed, but Mr. Joseph P. Simpson insisted on taking immediate measures to form an institution that should sustain lectures on Medical and Chemical Science; collect a library and have a reading room, to promote mechanical knowledge; also to have an annual public exhibition of the productions of the workshops and the manufactories, and award premiums for the best specimens of the different articles exhibited; in this he was seconded by Jonas Humbert, and this was finally acceded to by the committee.

At a meeting held the 15th of December, an association was formed under the name of The New York Mechanics' Association; but this was subsequently altered to that of the New York Mechanics' and

Scientific Institution, and a constitution was adopted. On the 9th January, 1822, the following were elected officers and managers of the same: Stephen Allen, president; Gideon Lee, first vice-president; Henry Ecford, second vice-president; John Slidell, third vice-president; Nicholas Haight, treasurer; Thomas R. Mercien, corresponding secretary; Joseph C. Hart, curator; and as managers, John McComb, Jacob Lorillard, Isaac Pierson, Alexander M. Muir, Clarkson Crolins, Thomas Richards, Mordecai M. Noah, Jonas Humbert, James S. Martin, James P. Allaire, Hugh McCormick, Joseph P. Simpson, Samuel Akerly, John Griscom, John Olmsted, Isaac Lucas and Joseph Smith. On the 22d of March, 1822, an act of incorporation was passed by the Legislature, incorporating Gideon Lee, Hugh McCormick, Alexander M. Muir, Clarkson Crolins, Joseph Smith, Thos. R. Mercein, John Slidell, Joseph P. Simpson, Jonas Humbert, James S. Martin, Lewis Wilcox, Thomas Richards and James P. Allaire, by the name of the New York Mechanic and Scientific Institution, with the officers and managers named therein, so elected January 9th, with the exception of M. M. Noah, whose name was erased, and that of Peter Sharpe substituted; this incident shows how party politics interfere with private enterprises for the general good.

The institution proceeded with its arrangement to have public lectures on mechanical and chemical science. To accomplish this, it proceeded to appoint a professor of mechanical and chemical science, and a professor of diseases incident to the manufactory and workshop. John Griscom was appointed to the first, and Samuel Akerly to the second. The lectures were well attended, and the institution began a career that argued well for the cause of domestic industry and development of the mechanic arts; and as one of its objects was to excite a feeling of improvement with apprentices, an arrangement was made to hold an exhibition for the award of premiums for the best specimens of their work, to be held on the 4th of July, 1822, at the Apprentices' Hall, then located in Chambers street, near Chatham. A private subscription was made for that purpose, as the Institute had no funds. A statement of the proceedings of that exhibition, as published at the time, is herewith presented, which demonstrates the interest that was awakened by the enterprise, and the great good to be anticipated in the result of the future progress of the institution.

On the same day the charter, constitution, by-laws and an appropriate address were put in circulation. This was the induction of the first society or institution of the kind and purpose in this country, and deserved more than a passing remark respecting its connections and doings. It had been contemplated to hold a grand industrial exhibition in the ensuing fall, but the yellow fever visiting our city, it was postponed until the next year. Accordingly, early in the summer of 1823, notice was given that an exhibition would take place in November. A list of articles for which premiums would be given was published, inviting the exhibition of every species of domestic manufacture. Public feeling was forcibly in the undertaking; the managers having secured the State arsenal, then located in Elm street, to hold the exhibition, an arrangement was made for the same to be held on the 12th day of November, at that place. Public approbation was so great on the subject that a meeting of many prominent citizens, with their families, was held at Washington Hall, corner of Broadway and Reed street, now a part of A. T. Stewart's marble store. An address was delivered by Charles H. Haines, Esq., on the importance of the institution to the country, as tending to develop the character of our mechanics and manufacturers. According to arrangements previously made, the exhibition was held, and the result was here fully set forth in the papers of that day.

Thus were the expectations of the Institute more than realized; and thus was inspired a just pride in the mechanics of our city, as well as in the industry of others; and the hope was expressed that our domestic manufactories would soon render our country independent of the world. So great was the feeling of the public in behalf of the objects of the institution that, at a dinner given at the close of the exhibition, some of the most prominent public men of the city, and others, gave it their countenance by joining with the members in the repast. The toasts given, and the sentiments expressed by them on that occasion, showed the interest they felt in the subject.

The second exhibition was held at the arsenal November 13th, 1824, at which there was a large display of the products of the shop and factory; about 100 premiums were awarded; broadcloth was sold for fourteen dollars and fifty cents and fifteen dollars and fifty cents per yard, being considered superior to any imported. Soon after this a meeting of merchants and others was held in Philadelphia to get up a grand exhibition of American manufactures in Washington in January, 1825. On October 18th, 1825, a third exhibition was held at the arsenal, it being earlier than usual in consequence of the proposed great celebration which was to take place in November to commemorate the completion of the grand canal connecting the waters of the North river with those of Lake Erie. The articles exhibited at this fair were of a superior quality, and an improvement on previous exhibitions. Four gold, twenty silver medals, and about fifty diplomas in gilt frames were awarded. John Quincy Adams, then President of the United States, on a visit to his homestead, stopped in New York and spent some time in inspecting this exhibition. He approved very much the object of the Institute, and thought it would be of great importance to the country. This exhibition did not pay its expenses. A difficulty between the two professors of medical science, which had existed for some time, had now become so personal that it produced a division of feeling and discord generally among the members. The Institute being in debt, no other exhibition was held, and its meetings ceased. Thus an institution conceived in wisdom, and calculated to be of great benefit to the mechanical interest of the country, was compelled to abandon its work. A former member, dying some years after, made a bequest to enable it to pay its debts, and to give a large sum to the apprentices' library.

In the month of January, 1828, a public meeting was held at Tammany Hall, then opposite the City Hall, to consider the industrial interests of the country. The late Thaddeus B. Wakeman, long secretary of the American Institute, was the means of said meeting being held. Having been one of the first merchants who took an interest in the first exhibition of the New York Mechanic and Scientific Institution, after its failure he conceived the idea of setting on foot a movement for the organization of another similar institution. At this meeting a committee of seven was appointed to consider the subject.

This committee met at Stonehall's Hotel, corner of Nassau and Fulton streets, and organized a society which was chartered by the State Legislature, May 2d, 1829, under the name of the American Institute of the City of New York.

Its fair was held the year before at Masonic Hall, then standing in Broadway, between Duane and Pearl streets. The beginning promised well. In 1829 a fair was held at the same place, also in 1830. Each of these three fairs were financially unsuccessful; the receipts not meeting the expenses. In 1831, a fair was held with better success. The display of goods was large, and their quality was improved. Having succeeded in procuring the Hon. Edward Everett, of Boston, to deliver the annual address, we drew a large audience to hear him in the church in Walker street. The result of this fair was the saving of about $1,000. From this small beginning the American Institute has steadily grown until it has attained a world-wide influence.

SCIENTIFIC LECTURES

BEFORE THE

AMERICAN INSTITUTE OF THE CITY OF NEW YORK,

AT THE

ACADEMY OF MUSIC, FOURTEENTH STREET AND IRVING PLACE.

I. THE NATURE AND SOURCES OF LIGHT.

Delivered November 23d, 1871.

By Henry Morton, Ph. D., President of the Stevens Institute of Technology.

I think I shall not surprise any one who now hears me by saying that light is not a substance, but a force — not a kind of matter, but a quality of motion affecting matter. That the sun is not a vast fortress forever bombarding us with an infinite rain of projectiles, but a huge bell-tower, eternally surging out grand symphonies of light and color in harmonious waves.

But one of the many evidences of this fact it may not be amiss to mention in this connection. By three totally distinct methods the velocity of light has been measured, and shown to be about 200,000 miles in a second, or about 6,000 times as great as the initial velocity of a cannon ball. Now, we know that the destructive action of a projectile varies with its mass or weight, and the square of its velocity; hence, if light were a substance as heavy as iron, its destructive effect on striking us or any object would be 36,000,000 times as great as that of a cannon ball, or, assuming that it was 1,000 times lighter than hydrogen gas, which is the lightest substance we know about, its blows would still do more than 2,000 times the damage of the fiercest cannonade which ever assailed a beleaguered fortress, or mowed down the advancing columns of an army.

And yet the leaf that trembles in the gentlest breeze spreads its surface boldly to the direct rays of a summer's sun, and is not deflected a hair's breadth by their brightest beam.

Clearly, then, light is not a substance hurled at us in particles (no matter how light and small) by the sun and other sources of light, but must be a force of such a nature that its forward transmission does not imply any projectile motion.

Such a force as this we find in that sort of vibratory motion which gives us the waves of the ocean, or of any other expanse of water, and the fact that such waves do not involve in the forward progress of their action, any forward motion or velocity of the particles concerned, I will now show you by means of a very ingenious little piece of apparatus contrived and used many years ago by Prof. O. N. Rood.*

You see upon the screen a number of little square blocks arranged in the form of a wave, and which now, at a signal, rise and fall in succession, so as to give to the wave, of which they form the profile, the appearance of advancing and receding; and yet, if you will fix your attention upon any one of these little blocks of light you will see that it has no back or forward motion whatever, but simply rises and falls.

Such a wave could, therefore, "travel forward," as we say (*i. e.*), have the successive up and down motion of particles, follow each other with any imaginable velocity, and yet involve no forward motion or impact of the particles whatever.

Such, then, is our idea of light and of the manner in which it travels about from place to place.

We believe luminous sources to be, in fact, only vibrating bodies like ringing bells, only with far quicker pulsations; and from these centers of motion we imagine waves, in successive rings, to run outward in continuous flow in a rare, gaseous body, which we suppose to pervade all space, and which we call the luminiferous ether.

Let me illustrate this point to you in yet another way. I have here in the vertical lantern, which I exhibited to some of you last win-

* A magic lantern slide is prepared as follows: A grating A B (Fig. 1) of parallel bars is first made, capable of covering the entire field. This may either be done by painting on glass, by taking a "negative," blackened all over by "exposure" and "development," and scratching clear lines through the "film;" or, as I have found more convenient, by pasting narrow strips of paper on one plate of glass and covering it with another.

This double plate is inclosed in the usual way in a wooden frame, which has also a groove in which can slide freely another long plate of glass on which is a *transparent* sinusoid. This also is best made by cutting out a piece of dark colored crayon paper and pasting it on the strip of glass.

When, as the figure shows, the sinusoid is over the grating, we see a number of separate parallelograms arranged in a wave line; but as the long strip of glass is moved over the grating the individual parallelograms move up and down in succession, as in the progress of a wave; and yet none of them, by any possibility, having any advancing or lateral motion.

PLATE I.

Fig. 1.

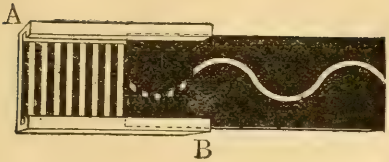


Fig. 2.

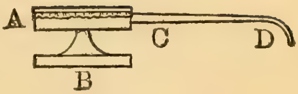


Fig. 3.

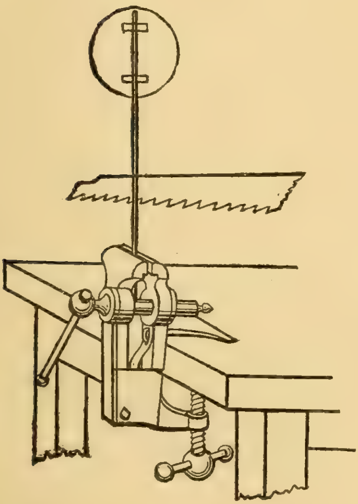


Fig. 4.

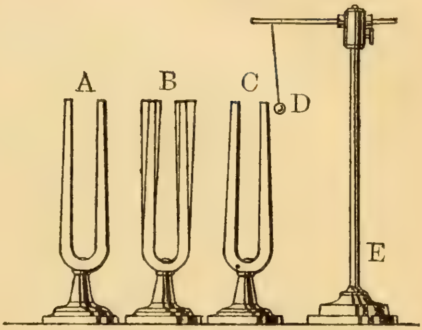


Fig. 6.

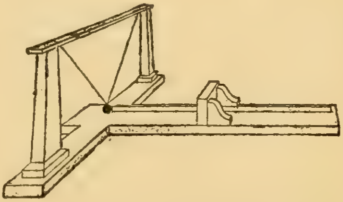


Fig 5.

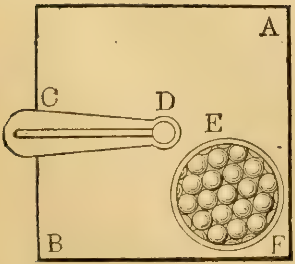
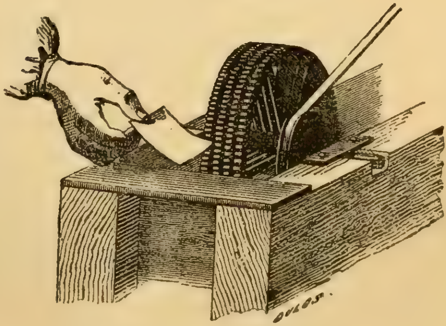


Fig. 7.



ter at the rooms of your Institute, a little circular tank or pond of water, in the center of which, by means of a very neat contrivance of Messrs. Hawkins & Wale, I can make, at will, single or successive vibrations fit to be the origin of outspreading waves.*

The image of all this you see upon the screen, and as I make a single motion you see a single wave-ring run out from the center, expanding until it strikes the sides of this tank, from which it is, in turn, reflected back to the center.

This, then, well represents the action of a light center and its radiations, but perhaps I can make this more clear by another illustration.

Some time since I stood in a large conservatory containing a great pond or basin of water for aquatic plants. In the middle of this played a fountain to freshen and renew the pool, and as the jet threw every moment splashes of water into the basin, circles of ripples from this center, ran widening outward over the smooth surface. Here and there they met the stem or flower of some flag or lotus, and then would make it tremble with like vibrations, and cause it to become a new center of minuter undulations. In other places, masses of rock-work rolled back the tiny waves and left quiet spaces in their rear, which the rippling waves failed to reach or to disturb.

At this moment, in this place, we have a parallel to the scene which I have just described. The light-conveying ether which pervades this building (as it does all other places) stands for the water of the green-house pool. Here in this lime light we have the fountain of fluid which is rippling the surrounding ether (at this moment a powerful lime light, which had been arranged under a screen upon a stand in the middle of the stage, was uncovered and emitted a blaze of light which filled the entire building), and sending wavelets of light outward in every direction. These waves strike on many objects and cause them to become centers from which emanate like luminous motions, which, passing to our eyes, convey to them the impressions of light and color. Here and there solid masses throw back the light-producing waves, and protect spaces in their rear from these disturbances, and give us thus the quiet of the shadows; and if one point more were needed to complete the parallel, I find it when, looking around, I see on all sides no unapt representatives of the flowers of the conservatory.

* The apparatus for producing the waves is as follows: A little brass box A (Fig 2), with a solid base B, is covered on top with sheet rubber, and has a small tube C D (a common mouth blow-pipe, in fact), running out from its side. If this is held so as to bring the point D over the spot where a wave is to be developed, and the rubber cover gently tapped with the finger, each tap causes a puff of air to escape from D, and this produces a well defined and single wave.

Such, then, is, in general, the character of the light-force; but fully to appreciate its nature we must look somewhat at its relations to the other natural forces.

The light-force belongs to a small group which may be defined as "modes of motion," and also, in a certain sense, as "the known forces." This group includes, beside *light*, *heat* and *sound*.

We know as well as we know anything in science, and this is not saying a little, that all these three forces are modes of motion, and indeed, more definitely still, vibratory modes of motion, and yet more precisely, modes of vibratory motion, one of whose marked distinctions is, that in the case of sound their recurrence is limited between the bounding terms of thirty-two vibrations, and some 10,000 in a second; in the case of heat, between 200,000,000,000,000 and 400,000,000,000,000 in a second, and in the case of light, between 400,000,000,000,000 and 800,000,000,000,000 in a second.

This is very much more than we can say of any of the other forces of nature, such as gravitation, adhesion, repulsion, electricity, etc., for we do not know the very first thing as to *their* nature, proximate or remote, and cannot so much as venture an opinion as to whether any of them are modes of motion or not.

We see, therefore, that there is some propriety in calling Sound, Heat and Light *known forces*, since our knowledge as to their nature reaches so far, as compared with its extent in other like directions.

But we must not be betrayed into regarding our knowledge even in this case as absolute. This vibratory motion depends for its maintenance and propagation upon certain properties of density, elasticity, etc., in the Luminiferous Ether, in the Atmosphere and in other materials, but these properties of density and elasticity are simply the expressions of Cohesion, Polarity, and other of the unknown forces, so that, if we push our study on to the extent of "final causes," we find ourselves here, as elsewhere, gazing over that vast ocean of infinite power and creative force, from which the billows of exhaustless energy are ever rolling in at our feet, but never bringing to us any evidence of the nature of their origin other than that of its omnipotence and divine beneficence.

Sound, heat and light, then, are all modes of vibratory motion, whose principal distinction we may regard as simply that of rapidity.

And here I may well mention a most suggestive idea thrown out

NOTE.—I considered it inexpedient to enter into the question of the distinctive character between sound and light, and heat vibrations, involved in the longitudinal character of the first, and the transverse nature of the others, especially as this was to be fully treated in a succeeding lecture by Prof. Rood.

by Professor Pierce, Superintendent of the United States Coast Survey. If we compare the range of our sound perceptions with those of heat and light, and the interval between the first and the others, we find that while the range of sound embraces some twelve octaves, that of heat and light includes between one and two octaves for each (by an octave I mean the range included between any given number of vibrations in a second, and double that number), while between the highest audible note and the lowest heat rate which we can estimate, comes a possible series of some thirty octaves of rates of vibrations inappreciable by any of the senses which we now possess, but capable of furnishing causes of perception to six or eight senses which might be fitted to respond to their excitations.

To return, however, to our assertion that sound, heat and light are all vibratory motions, increasing relatively in rate in the order in which we have named them. This I desire to prove to you by a series of experiments conducted before your eyes this evening.

First, then, to prove that sound is merely a vibratory motion, I have here a strip of metal, fastened upright in a vise, and carrying a large circle of card on its end, and I hold in my hand a carpenter's saw, with large teeth; if I draw the saw slowly over the strip of metal near where it is held in the vise, you will see the card wave back and forward as each tooth passes. (See Fig. 3.)

Here we have a vibratory motion, but one too slow to produce sound; for that purpose, we must have motions at least as rapid as sixteen full back-and-forth movements in a second. To accomplish this, we substitute for the elastic rod, which cannot move quickly, a stiff piece of wood, and for the saw, with its teeth far apart, a file, with close teeth; then we get just a similar motion to the former, but quicker; each tooth of the file catches the wood, pulls it a little way and lets go, as did the saw, and we then have, as you perceive, a very manifest, if disagreeable, production of sound.

Or, again, I take this piece of metal, called a tuning fork, and draw across it this violin bow (which is only a sort of musical file), made rough with rosin and the natural asperities of the hair, and from it proceeds a far more agreeable description of sound.

But, you may ask, how do we know that the fork is really moving? We cannot see its motion as we did that of the elastic rod. True, but you shall see it! I now place this tuning fork, as an object, in the lantern, and you see its enlarged image on the screen, the prongs being perfectly straight or of uniform thickness; I now sound it with the bow, as before, and while you hear its musical voice, I place it again in the lantern; now both its prongs have expanded, fan-like, into an outline somewhat hazy, which you will, no doubt, recognize as the result of their being in rapid motion; but to make this yet clearer, I will now bring a light pith ball in contact with one of them, when, as you see, it will be violently knocked away whenever it touches the moving fork. (See Fig. 4.)

Let us take now another example. I have here a glass plate, supported at its middle, and by drawing the bow across its edge I make it vibrate, and emit a bell-like sound. But you say again, perhaps, let us see that this plate really vibrates.

I reply, with great pleasure, and fix the plate in the vertical lantern, so that one corner of it may come into the field. On this corner I pour some water which is retained by a light rubber ring, and then by means of the bow I again make the plate emit its fundamental note. At once you see the screen covered with a beautiful pattern of ripples, which express, as in legible words, the vibratory motion. (See Fig. 5.) When, by a different management of the bow, the plate is caused to emit a higher note, the pattern of waves at once becomes finer, showing a quicker, and therefore shorter, wave motion.

I think one could hardly ask a clearer demonstration of the identity of sound and vibratory motion than this experiment affords. But yet further, to clinch our argument, let us resort to another experiment. We have here a brass rod firmly clamped at its middle, and with an ivory ball so suspended as to rest against one of its ends. (See Fig. 6.) Now, it seems hard to imagine that in order to sound, when the hand, covered with rosin, is drawn along it, this bar must so vibrate, its particles moving away from and toward each other, that it should actually grow longer and shorter, but yet such is in fact the case; for if I now draw my hand lightly along it, you soon hear a shrill, metallic ring, and at the same moment the ivory ball is violently driven away from the end of the bar. This shows us that, improbable as it may seem, the bar does in fact lengthen and shorten itself when in the act of emitting this sound.

And now we will take one more illustration for the sake of a connecting link, which it will furnish between one and another of the vibratory forces. We have seen how the teeth of a saw, the teeth of a file, or what may, by analogy, be called the teeth of the violin bow, cause a vibratory motion when they are drawn across a body capable of vibrating. It can, of course, make no difference if these teeth are arranged about the periphery of a wheel, and the wheel being in rotation, the body to be vibrated is brought in contact with the rotating teeth.

I have here such an arrangement in the form of a barrel, with various numbers of teeth at different parts, so that if a card is held against one part, it will be struck twenty-four times in each revolution of the barrel, at another part twenty-seven times, at another thirty times, and so on. By means of a system of band wheels, we can give this barrel a rapid and yet steady rotation. If, while it is thus rotating, I bring this card in contact with the part where the thirty-two teeth are placed, you hear a loud sound, and as I move it successively to the points where it is struck more and more frequently by the more closely arranged teeth, you perceive that the tone becomes more and more shrill, and in fact runs up through the notes of the natural scale or gamut.

This apparatus is named from its inventor, a renowned investigator in the subject of sound, Savart's Wheel. (See Fig. 7.)

We will now see if, by simply exalting the rate of the vibratory motions which in this case have developed sound, we can in exactly the same manner produce the other forces, heat and light.

We must not, however, forget that the gap between the rate of sound vibrations and of those constituting heat is a very great one, *i. e.*, from about 10,000 to 200,000,000,000,000 in a second, and that we must therefore take means greatly to exalt the rate of vibrations which we wish to produce. Remembering that the finer and smaller and closer the teeth, the higher the note or the more rapid the vibrations, we substitute for the toothed wheel a brass tube with a smooth surface, knowing that, under the microscope, a polished surface is like a file or a sheet of sand paper. By a more powerful combination of wheels and belts we give this tube as rapid a motion as we can, and then press against it pieces of wood. Moreover, that it may be evident to all of you that heat is developed, I pour some cold water into the tube and cork it tightly. In less than a minute, you see the cork is blown out with a loud report, and is followed by a puff of steam, showing that the water in the tube was actually made to boil by the heat vibrations developed by the impact of the asperities of the tube against the wooden pieces. The expulsion of the cork gives us, by the way, an illustration of the opposite conversion, *i. e.*, of the heat vibrations into sensible motion, or, as we call it, mechanical force.

We will now advance one step further and attempt the production of light in just such a method as that which we have already used for sound and heat.

We have here still larger driving wheels, and on a previous occasion, when I used this experiment in the opera house at Philadelphia, where there were conveniences for the purpose, I employed a ten horse-power steam engine as the driving force.

By thus rotating this thin disk at the rate of 6,000 times a minute, its surface moving only about ($3\frac{1}{2}$) three and a half times as fast as an express train, or some 216 miles an hour, and holding a file against its edge, a beautiful shower of sparks is projected upward, composed of fragments of the file torn off by the impact of the projecting particles of the wheel, and rendered luminous by the intensely rapid vibrations into which they are thus thrown.

We have thus seen, by many conclusive experiments, that sound is a vibration, and that heat and light may be produced by exactly the same means as sound, provided we exalt the rapidity of the action in the appropriate degree.

This may serve us as a legitimate ground for the assumption that light is one of the vibratory forces.

I would not have you suppose, however, that what I have already said includes the entire body of evidence on this subject; in fact, it hardly touches it, and not one lecture, but several, would be needed, even in the most general manner, to unfold the vast array of facts and arguments by which this doctrine is established.

Passing, then, from our brief consideration of the nature of light, we will next turn our attention to some of its sources.

Our late theoretical consideration of its nature teaches us that anything which would cause a very rapid vibratory movement in the particles of matter, might be a source of light. Such was the case in our last experiment of the rotating iron disk, where mechanical force expressed in sensible motion was the cause of light. Similar to this is the spark produced by the clash of flint and steel, the foot stroke of the iron-shod horse on the pavement, the flash produced by the cannon ball when it strikes the side of the iron-clad, and the flashing trail of the shooting star, and possibly we may go further still and look to a like conversion of mechanical force in the inrushing of condensing matter towards great centers of attraction and the impact of in-falling bodies for the origin of light in our glorious sun and in the infinite hosts of stars. But as the sun will be the special subject of a lecture

NOTE.—(See Fig. 8.) This experiment was first made by an American, Jacob Perkins, who achieved great reputation in England in connection with his steam gun, and steel-plate transfers, and who is now represented in London by the firm of A. M. Perkins & Son, who manufacture steam engines and boilers, running at very high pressures, 250 pounds and upward, and which are guaranteed to give a duty of one horse-power for each two pounds of coal consumed per hour.

PLATE II.

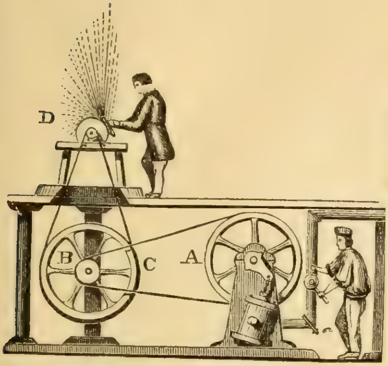


FIG. 8.

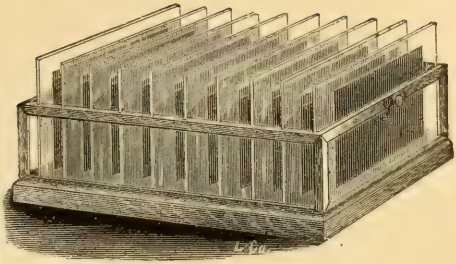


FIG. 9.

FIG. 10.

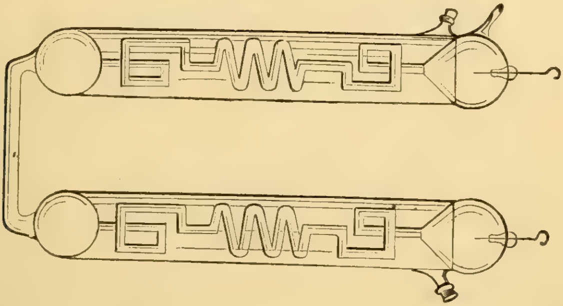
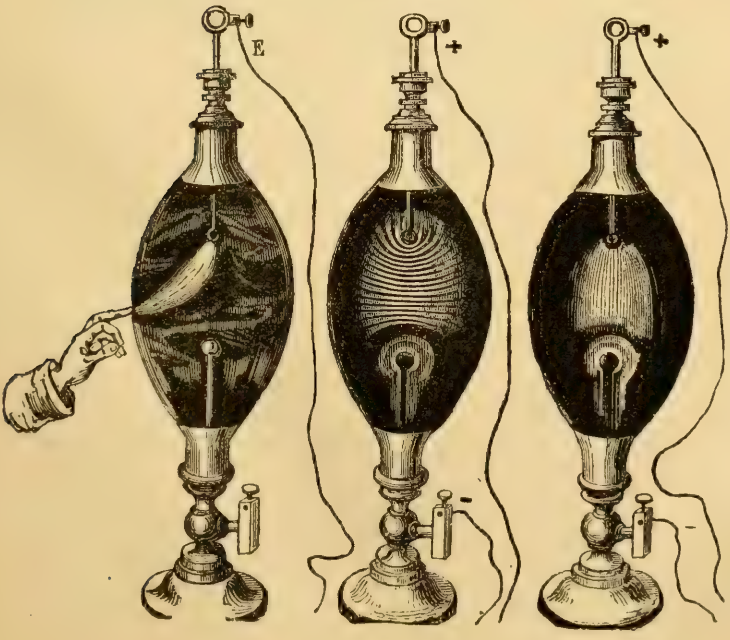


FIG. 11.



in this course by Prof. G. F. Barker, I will pass from this grand theme to lesser lights and mere mundane sources of illumination.

The first of these as regards its extent and importance is combustion, a very intense class of chemical combination.

When two substances enter into this sort of union, we may well conceive of their atoms as rushing violently together like contending armies in the clash of conflict, and then nothing is more natural than to suppose that the impact of the combining atoms should give rise to vibrations, whose intensity and violence should be in proportion to the energy of the actuating attraction. Passing by the ordinary illustrations with which we are every day and night made familiar in the light of fires, lamps, candles and gas flames, I will go at once to one of the most striking instances which is furnished us in the oxy-hydrogen blowpipe. Here we have a nozzle from which hydrogen, one of the most combustible of gases, issues in a large volume, burning, when ignited, with an immense flame.

Into the center of this is driven a stream of oxygen gas, which is a body with which hydrogen combines with the greatest energy. Its effect, as you see, is to diminish the size of the flame, but, as I will presently show you, vastly to increase its intensity.

(The apparatus, consisting of a large copper hydrogen generator, a cylinder of compressed oxygen, and the blowpipe, supported on a light stand, was standing on a platform built upon one of the stage traps and on a level with the floor. At this point the speaker, standing by his apparatus, made a signal, at which the trap was raised, so lifting all to a height of some ten feet above the floor. The height of the jet, being about four feet more, gave a considerable elevation. A bar of steel was first submitted to the action of the jet, and, being continuously fed forward as it was melted and dissipated, produced a cascade of sparks and scintillative globules, which, poured upon the stage, rebounded from metal plates placed to receive them and rolled in a torrent of minute sparks into the sunken footlights. Rods of cast-iron were then burned in like manner, with the production of large flower-like scintillation, but with less brilliant general effect; and, finally, the entire building was illuminated by the combustion of a bundle of magnesium wire similarly treated. The trap having been again lowered during this last experiment, the lecturer resumed.)

Some of you may, no doubt, be inclined to ask, If the source of the light was the vibration due to the combination of the oxygen and hydrogen, why was the brilliant light only seen when the solid metals were introduced? I will first answer by an illustration. I here hold in my hand a tuning-fork, which I make to vibrate violently by drawing this piece of wood between its prongs; but not a sound reaches you. I now rest its handle on this table, and at once it sings out until its voice can be heard in the most distant portion of this large building. Why is this? Largely because the prongs of the fork are too small to take much hold upon the air and set large masses of it in motion; but when its vibrations are communicated by contact to the entire table, then its whole surface begins, as we may say, to flap up and down, and to fan large areas at once into a responsive motion, which thus is readily brought to your ears.

So is it with the oxyhydrogen jet. The product of its combustion is too rare to take that hold upon the light-conveying æther which would give it a strong and far-reaching movement, and so we must give it a denser body, either solid, liquid or gaseous, to play the part of the table to the tuning-fork, or to be, as we may say, a *sounding-board to its light.*

Next to combustion, as a source of light, comes electricity. Here, again, we have to do with a force about whose nature, proximate or remote, we know nothing. Whether it is a fluid, or two fluids, which produce the various actions we call electric, or whether these are due to a certain motion or a polar arrangement of atoms of matter, we are profoundly ignorant. But we may well believe that, be it what it may, electricity, like other forces, when meeting with resistance, may excite vibratory motions in the resisting body, as the wind does when it whistles through the crack of a window or sounds the strings of an æolean harp; as the circular saw does when it sings its way through a plank; as the rain-drops when they patter on a metallic roof, the bullet whistling through the air, or a bar of tin, which "cries" when we bend it in the hand so as to disturb its polar relation of particles.

Certain it is that we find, in all cases where electric force is resisted in its motions, that heat, and, where the action is sufficiently strong, light, is developed. Thus, I have here a series of twelve large battery cells, each one of which exposes a zinc surface of about five square feet. I will pass what we call the electric current derived from these through a piece of very thick platinum wire, some eighteen inches long. At once you see it glows with dazzling whiteness, so as actually to light up all the stage.

Changing the connections, I now have a cup of mercury as one pole of the battery, and a steel file as the other. I dip the file in the mercury, and then, withdrawing it a very little, we have a beautiful boquet of fire-sparks, of burning steel and mercury, flying outward in dense clouds, all ignited by the intense vibrations produced by the electric force in traversing that little space of resisting air.

Yet again, substituting other terminals, I have here a thin rod of carbon connecting the polls, and, as you see, the vibrations caused by the flow of the force through its resisting substance causes it to glow with a dazzling whiteness.*

But these are not the only methods in which electricity resisted may become a cause of light-vibrations. Thus, for example, we have quite a different condition of the electric forces which we recognize as static, or "frictional electricity." In this case the force has the power of passing through considerable thicknesses of resisting material. Thus I have here an instrument for the development of electric force in this form. It is called an induction coil, and was constructed for me by Mr. E. S. Ritchie, of Boston. It throws, as you see, sparks in the air twenty-one inches in length, or in other words the electric force will pass through the air for that distance, producing vibrations in the matter along its path, which are recognized by your eyes as light. The same spark will also pass through three inches of solid glass, leaving a delicate line of fracture to mark its path, or by the use of this sheet of metallic paper, whose surface has been broken by crumpling, it will give us a lightning-like discharge of six or seven feet in length.†

By concentrating this flash, on the other hand, into a brief time and short space, we obtain, as you see, a more dazzling light, accompanied by a very sharp report, for by a secondary action, *i. e.*, that of heating and expanding the air, sound-vibrations, as well as those of light and heat, are in this case produced. ‡

When the resisting medium in the case of air or other gas or vapor is rarefied, the electric force, in its passage through, no longer confines

* These batteries of large surface and low resistance are of course unfit to produce an "electric light," in the ordinary sense. But the method described above serves as a very fair substitute for purposes of illustration; where, as in this case, the large batteries were needed for other experiments.

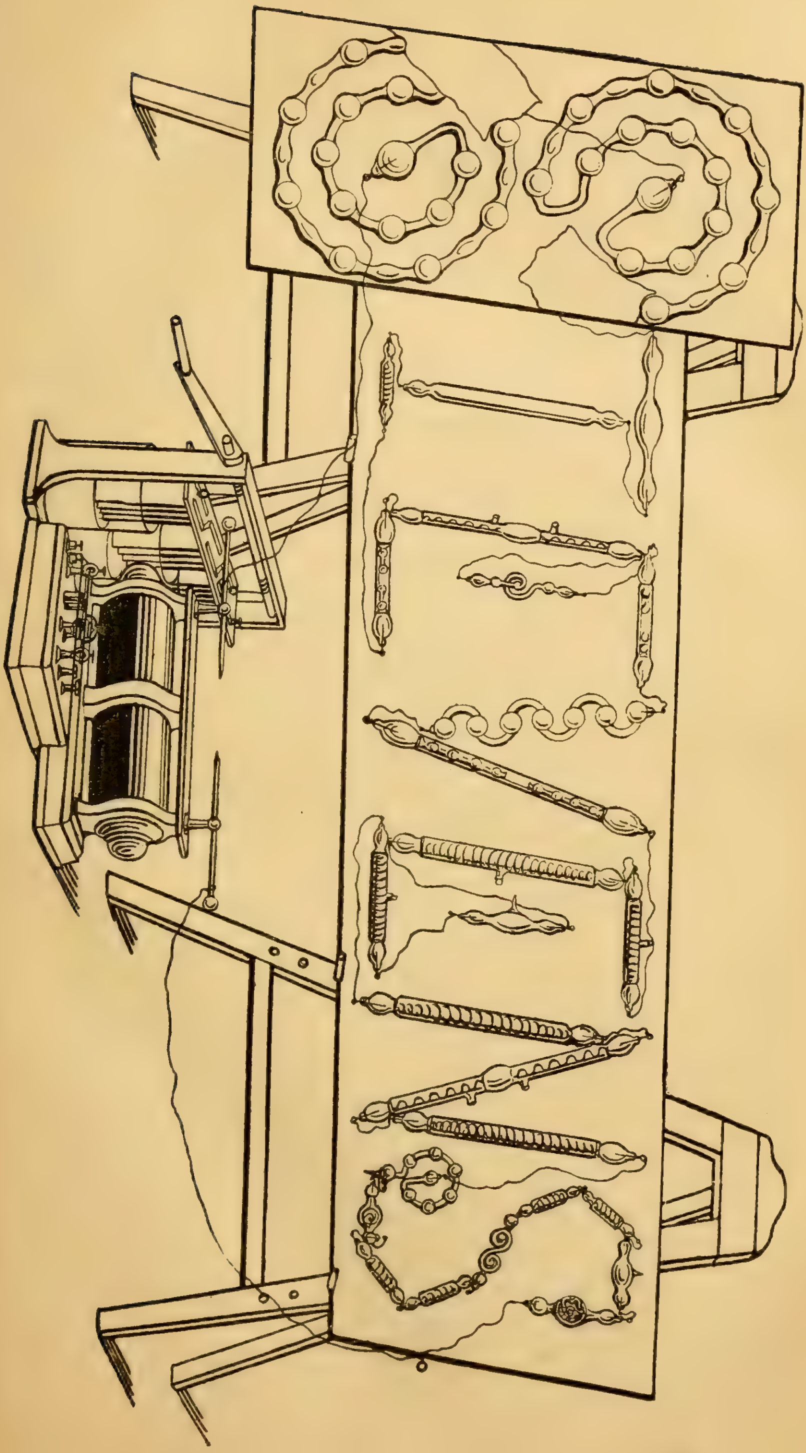
† This experiment is arranged as follows: One or more sheets of metallic paper, such as is used to wrap up coffee in packages by some dealers, are well crumpled so as to break up the metallic surface without tearing the paper. These are then stitched on a piece of cloth, such as a strip of "turkey red," so as to make a hanging banner, which is further completed by a cross-piece of wood suspended from a pole. One terminal of the coil is connected with the top of the metallic paper by a wire and the other with a long wire attached to a glass rod, by which it may be held and passed over various parts of the paper. My attention was first directed to the use of this paper for such a purpose by Mr. C. T. Chester, of New York.

‡ For these effects the Leyden jar and also the "secondary condenser," shown in the accompanying cut (see fig. 9), and fully described in the journal of the Franklin Institute, vol. 53, p. 256, with which dense white sparks fourteen inches long were shown, the condenser containing twenty coated panes.

itself to single lines, but diffuses in a cloud-like form through the space generally. It moreover seems preliminarily to induce a stratification of the residual gas, and then the areas of varying density are variously illuminated by the flash, so causing a very beautiful appearance. (See figs. 10 and 11.)

As you might naturally expect from analogy, with previous experiments in sound, a change in the nature of the gas, or even in the degree of its rarefaction, will make a great difference in the color of the light produced, just as a change in the weight or elasticity of a string, plate, or tuning-fork will produce a change in their note. To illustrate this fact, I have arranged here on this framework a number of glass tubes containing traces of various gases variously exhausted. By means of the two large induction coils which are placed in connection with them, these will be illuminated by the electric discharge; and when you read the name which they will there display, I think you will recognize one who, by his own labors and by his munificent patronage to science, well deserves to have his name recorded in letters of electric light. (See fig. 12.)

If now, in this very imperfect and brief sketch of a vast subject, I have at all succeeded in my object, I shall have shown you that light, like sound, is a vibratory force; that every little flame and glowing fire is sending out its voice in light rays, while our grand sun and every other star in the countless hosts of the heavens is part of a vast chorus which, in such tones of light and color as no words can adequately express, chants in inarticulate but most expressive harmonies the power and goodness of their Creator, and realize in a very true and real sense that poetical expression of Plato, "The music of the spheres."



SCIENTIFIC LECTURE—II.

THE CHEMISTRY OF THE SUN.

By Professor George F. Barker, of Yale College, Dec. 14, 1871.

Ladies and Gentlemen.—The sun has at all times been an object of interest to dwellers upon the earth. Not alone to the man of science, learning from Copernicus the sun's absolute autocracy, has this desire for more knowledge come; the common laborer in the field shares it with him, as he daily witnesses the glorious march of the day-god across the heavens, and beholds the wondrous metamorphoses effected by his beams; but at the utterly impassable distance at which he dwells, how shall this knowledge be attained? Who shall bridge the separating chasm and bring to us news of his composition and physical condition? The telescope offered the first partial solution of the question. No sooner was the first astronomical telescope constructed, than Galileo turned it upon the sun and accurately observed many of its phenomena; and, from 1611 to the present day, the telescopic method of investigation, perfected by the refinements of modern science, has been diligently applied to the problem and has collected a vast mass of facts of the greatest scientific value. The sun's distance, his size and weight, the curiously mottled appearance of his surface, with its faculæ and spots, and his time of rotation; these, with other and similar data, we owe to the telescope; but, notwithstanding all this, the problem of the sun's constitution remained unanswered. No one knew whether the sun was a hot or a cold body; whether it was liquid or gaseous, or whether it was uniform in character throughout, or made up of concentric layers. True, Sir William Herschel, resting mainly upon data collected by Wilson in 1769, from observations upon the spots, proposed in 1802 a plausible theory on the subject, a theory which admitted the previous notion that the spots were cavities in the solar surface, but which, reflecting the popular idea that the sun must be habitable, maintained that his true nucleus must be cold and dark, and was surrounded, at a distance of 4,000 miles, by a cloudy stratum from which the light emanated, and in which were the cavities through which the dark nucleus became visible. But this theory, based as it was on insufficient data, though accepted by astronomers as the best attainable by the telescope, was evidently inadequate to explain the facts, and a little more than fifty years later it gave way to newer and more probable theories, founded on facts gathered by a more wonderful instrument than the telescope. It is my purpose to spend the hour which you so kindly accord to me in an exposition of the principles upon which this new spectroscopic method is based, and a rapid review of the results which have been reached by it in solar physics.

The spectroscope was first brought into notice as an instrument of scientific research by Professors Bunsen and Kirchkoff, in 1860. As its name indicates, it is an instrument for viewing spectra. We can best elucidate its character by attempting to answer three questions: 1st. What is a spectrum? 2d. By what means may spectra be best produced and observed? and 3d. To the solution of what problem may the spectroscopic method be applied?

In the first place, then, what is a spectrum? The statement of a few elementary optical principles will enable us to answer the question. Light, from whatsoever source, which, so long as it traverses the same medium, passes in a straight line, is bent or diverted from its course, *i. e.*, is refracted, whenever the medium changes. But not only this; so long ago as 1672, Newton observed that an ordinary light-ray was not only bent from its course on entering a denser medium, but was also broken up into several other rays, all of them colored. Seven of these colors were distinguished by him, viz., red, orange, yellow, green, blue, indigo and violet; and he demonstrated that, since the refrangibility of each color was different—that of violet being greatest, and of red least—these colors must be separated from each other by refraction. If, therefore, a beam of light from a round opening be refracted by passing it through a prism, it will be not only bent out of its course, but will be decomposed, and will produce an elongated, rainbow-like image upon the opposite wall, made up of the seven colors above named, in the order indicated. This long and brilliantly-colored image is called *spectrum.* [The lecturer here illustrated these statements experimentally by means of an electric light from a Bunsen battery of 100 cells. The intensely heated carbon points were first projected on the screen. A lens placed in the path of the beam, brought to a focus the rays from the round opening in the lantern, through which the light came. On introducing a prism, the beam was bent out of its course, and was also decomposed into a brilliant rainbow band of color. An elongated opening or slit was then substituted for the round one, and the beam was dispersed by two carbon-disulphide prisms. A splendid spectrum, four feet broad and twenty feet long, appeared upon the screen.] We may, therefore, define a spectrum as the colored image obtained when light passes through a prism.

By what means, now, may spectra be best produced and examined; or, in other words, what are the essential parts of a spectroscope? We reply: there must be, first, the slit or narrow opening through which the light comes, and a lens to render the rays from it parallel; second, a prism for effecting the dispersion; and third, an observing telescope by which the spectrum is viewed. Every spectroscope must have these three parts; but having these, the details of arrangement may be widely different. The first spectroscope used by Bunsen consisted of a quadrangular box containing the prism, and carrying the telescopes in its sides. For purposes of solar research, spectroscopes with several prisms, like those of Kirchhoff, Lockyer and Young, are employed, in order to increase the length of the spectrum. [By means of the lime-light, pictures of Duboscq's single-prism spectroscope—one of the most convenient forms for chemical work—of Kirchhoff's four-prism spectroscope, and of Lockyer's and Young's telespectroscopes, were projected on the screen and described.]

To what problems, lastly, may the spectroscope be applied; and what may be learned from the study of spectra? It is evident at the outset that the spectrum of white light, in which all the colors are found, must differ from the spectrum of colored light, in which, by its very nature, some colors are or may be absent. White light gives what is called a continuous spectrum, because the seven colors shade inperceptibly into each other without any abrupt transition. Colored light, on the other hand, gives a discontinuous or interrupted spectrum, in which some of the colors are wholly or partially wanting. If, now, we remember that whenever a solid or liquid mass is raised to incandescence, the light emitted by it is always finally white, and that when a gáseous body is thus heated the light which it emits is colored, it is clear that we may determine by the spectroscope whether the source of light we are considering is in the solid or gaseous condition. Moreover, since all continuous spectra are alike, the spectroscope can tell us nothing about the character of an incandescent solid or liquid; but inasmuch as each gas or vapor, when heated to incandescence, gives a spectrum peculiar to itself, it is clear that the examination of its spectrum may be the means of its identification. [To show that the light emitted by incandescent vapors is colored, the lecturer heated salts of several metals in the flame of a Bunsen gas-burner. Potassium gave a lilac color, sodium a yellow, lithium a crimson, barium a green, and so on. Gases may be rendered incandescent by inclosing them in tubes under diminished pressure, and passing the electric spark through them. The word "Yale," in letters four feet long, made up of such tubes filled with different gases, was illuminated by the spark of the large Ruhmkorff coil of the Stevens Institute. The nitrogen emitted rose-colored light, chlorine a green, carbonic acid, greenish white, carbondisulphide vapor, white etc. Professor Barker then showed that the light emitted by the intensely heated solid carbon points gave a continuous spectrum on the screen; while by placing volatile substances on the lower carbon, they were converted into vapor by the heat, and this *vapor* being rendered incandescent gave a spectrum consisting of bright lines interrupted by dark spaces. The spectra of the metals lithium, magnesium, mercury, silver, copper, zinc and thalium, thus produced, were projected on the screen, and attention was called to the fact that each spectrum was peculiar and characteristic for the metal which gave it, however, it was shown that the incandescent vapor of brass gave the spectra of zinc and copper, of which it was composed, and that a mixture of the chlorides of several metals gave, in this way, spectra of all the constituents present; thus proving the identity of character possessed by an element, even when it is in combination.]

What, now, is the character of the spectrum afforded by sunlight, and what results may be obtained by its study concerning the composition and physical condition of the sun? If sunlight be received upon the prism from a narrow, elongated opening, the resulting spectrum will be found to be crossed by a multitude of dark lines, parallel to the axis of the prism. These lines were first observed by Wollaston in 1802, though they were not accurately mapped until 1814, when Fraunhofer fixed the position of 576 of them, and gave to the most prominent of them, beginning at the red end, the letters of the alphabet for names. Sir David Brewster subsequently mapped 2,000, and recently this number has been increased to above 3,000, by the researches of Angström and Kirchhoff. They probably number 10,000, at least. Various attempts have been made to account for these dark lines in the solar spectrum. In 1860–61, Professor

Kirchhoff was led to study a coincidence between the bright yellow line given by incandescent sodium vapor and the solar line D, which coincidence had already been noticed by Fraunhofer. Upon applying a greater dispersive power, he noticed that the line D was a double one; but so also was the sodium line under these conditions. Moreover, each line of the one coincided exactly with each line of the other. The suspicion became strong that it was sodium in the sun which caused the D lines. He then extended this comparison to other elements. He carefully measured sixty bright lines of the spectrum of iron; and found every one of these sixty lines to correspond with a dark line in the solar spectrum. The overwhelming probability of a common cause for both was forced upon him; and, by calculation, he ascertained that this probability was as one million-million-million to one in its favor. By a series of accurate comparisons of this sort, it has been ascertained that fourteen of the common elements known upon the earth exist in the sun, viz., sodium, iron, calcium, barium, magnesium, manganese, titanium, chromium, nickel, cobalt, hydrogen, aluminum, zinc and copper. One other question remains to be answered. Granting that these coincidences in the spectral lines prove a common cause for them, why are the lines in the solar spectrum dark? In one of Kirchhoff's experiments, he placed a yellow sodium light between the sun and the slit of his instrument, expecting thereby to neutralize, and perhaps to extinguish, the D lines. But what was his surprise to see these lines become darker. He repeated the experiment with the lime light and with a platinum wire heated by the electric current; the result was the same: two dark lines appeared in the yellow, corresponding to the D line. He had in fact succeeded in imitating this part of the solar spectrum; what wonder, then, that he should generalize upon it and conclude that the dark solar lines had a similar origin? His discovery was an important one in physics; it established for light what others had done for heat, and extended the law of exchange to another form of radiant energy. Kirchhoff's law is simply this: A glowing gas absorbs rays of the same refrangibility as those which it emits, *i. e.*, every colored flame is opaque to rays of its own color. The yellow sodium flame, in the experiment just mentioned, permits the red, the blue, and the green to pass, but retains the yellow; a dark line appears, therefore, in its place in the spectrum. It is now clear, says Kirchhoff, how the sun is constituted: there is within it a solid or liquid nucleus, intensely heated, which, were it seen alone, would give us white light and a continuous spectrum; but the intense heat there present converts the substances which compose it into vapor, and thus forms about the nucleus an enveloping layer of incandescent gas. Were this envelope seen alone, it would give a spectrum of bright lines. In fact, however, we see both together, and the white light of the nucleus, passing to our eyes through this surrounding layer, has absorbed from it the precise lines which would be given by the substances in this layer, and hence reaches us containing these breaks or dark lines. To put this wonderful theory to proof, an eclipse was necessary; for the intense light made it possible to see this envelope only when the moon came in as a screen. With what interest, then, did astronomers look forward to the total eclipse of 1868 to test the new hypothesis! All the governments of Europe vied with each other in sending fully equipped expeditions to the Indian Ocean; and as the moment of totality drew on, what wonder that the observers were agitated and that their nerves became tense. So soon as the last flash of sunlight disappeared, *bright lines* appeared in the field of the spectroscope! The proof was conclusive that there was a colored envelope about the sun, and Kirchhoff's theory was essentially established. [By means of colored photographs thrown on the screen, the lecturer illustrated his remarks from time to time. He showed the original spectrum of Fraunhofer; the remarkable spectrum obtained by photography by Rutherford; the coincidence of the sodium and D lines; those of the iron and solar lines; and the coincidence of the lines of several of the metals with lines in the solar spectrum. With the electric light, Professor Barker produced on the screen a continuous spectrum; and then, placing a piece of sodium on the lower carbon, the white-hot carbons were surrounded by a layer of incandescent sodium vapor, and a black band appeared on the screen in place of the yellow. The sodium line was thus reversed and the production of the line D imitated.]

Having now considered the spectroscope, and described the method by which it may be applied to solar investigation, we may pass to the sun itself, and consider briefly what has been revealed by spectrum-analysis concerning its constitution. So long ago as the eclipse of 1733, there were observed red, flame-like masses shooting out from the sun's edge. These were made the subject of special attention in 1860; but their character remained a mystery until 1868, when the spectroscope showed them to be masses of glowing hydrogen gas, shooting out to a vast height from the solar surface. The French astronomer Janssen, during the eclipse, conceived a method by which these "protuberances" could be seen without an eclipse; the next day he put his plan into execution, and enjoyed for nineteen days thereafter, as he says, a perpetual eclipse. Just after his description of the method reached the secretary of the French Academy, a communication was received from the English astronomer Lockyer, also announcing a similar method. Thanks to these gentlemen, we can now observe the protuberance daily. By such investigations it has been shown that they are merely local accumulations of a layer which entirely surrounds the sun, and which is called the "chromosphere." They mostly consist of hydrogen, though sodium and magnesium, and a new non-terrestrial element—called by Frankland "Helium," and by Young "D_3-stuff," from its characteristic line—have been observed in them. Their motion is oftentimes very rapid; Professor Young has just observed the explosion of one of these masses, and he saw the fragments rise 100,000 miles in ten minutes! Their forms are very variable; says Professor Lockyer: "Here, one is reminded by the fleecy, infinitely delicate cloud-forms, of an English hedge-row with luxuriant elms; here, of a densely intertwined tropical forest, the intimately interwoven branches threading in all directions, the prominences gradually expanding as they mount upward, and changing slowly, almost imperceptibly."

[The phenomena of an eclipse was illustrated on the screen by an ingenious slide devised by President Morton. The sun with its spots became gradually obscured as the moon slowly crept over it, until the last ray of light disappeared, and the glory of the eclipse, with its protuberances and corona, flashed into view. Photographs of the eclipses of 1868, 1869—so excellently observed in our own country—and of 1870 were exhibited, showing the arrangement of the protuberances. A series of these sun-flames, observed by Respighi, and a representation in miniature of the production of a sun-flame, were thrown on the screen. With the induction coil a series of tubes containing hydrogen were illuminated, to show the color of the rosy flames composed of this substance.]

Among solar phenomena none are of more interest than those of the spots. They are cavities in the luminous portion or "photosphere" of the sun. They are often of vast size, sometimes having a diameter of 147 seconds, or nearly nine times that of the earth. The surface of the sun is curiously mottled, resembling a mass of cumulous clouds. Some days before the appearance of a spot these photospheric granules become violently agitated, feculæ or bright spots and streaks are seen, and the umbra or nucleus of the spot appears. The penumbra, or half-shade, gradually becomes visible, and assumes a more regular form in proportion to the circular character of the spot. The umbra appears black, because of the intense light with which it is surrounded; but it is actually 4,000 times as bright as an equal area of the full moon, according to Zöllner. Not unfrequently the spots are crossed by bright streaks or bridges, and they are generally surrounded by feculæ, which are seen to become protuberances as they reach the edge of the sun. Upon applying the spectroscope to a spot, the same continuous spectrum is observed in all parts of it, dimmed, of course, in the umbra and penumbra, because there the light is diminished. None of the dark lines are wanting in the umbra spectrum, but many new groups of lines or absorption bands make their appearance. Moreover, certain lines, as those of calcium, barium, magnesium, iron, sodium and titanium, are markedly thickened in the umbra, showing an increase in the absorptive power of these vapors there present; and certain other lines, especially those of hydrogen, are completely reversed therein, becoming bright. The bridge gives the ordinary solar spectrum, except that the hydrogen lines are bright. The penumbral spectrum is similar, but in it the lines of hydrogen are absolutely wanting. From these results it appears clear that the umbra of a spot is a mass of matter similar in all respects to that of which the photosphere is made up, but which, being cooler, both radiates less light and exerts a greater elective absorptive action than the surrounding parts. In other words, it is a cloudy mass in the atmosphere of the sun, made up of the partially condensed vapors of calcium, iron, magnesium, barium, sodium and titanium, sinking gradually through the photosphere, and broken up occasionally by an up-rush through it of a mass of hydrogen, forming a bridge.

[The previous statements were illustrated by photographs thrown on the screen, showing the mottled or granular appearance of the sun's surface, the appearance of a facula, various sunspots as observed by Secchi, Chacornac, and others, the thickening of the D lines in the umbra, and finally the spectrum of a complete spot, bridge, umbra, penumbra and photosphere, as given by Secchi.]

The third and last solar phenomenon which we have to consider is the corona; that "ring of pearly, greenish light, dazzling within and fading away outwardly," contrasting so strongly with the solar prominences. It is a sort of radiant halo or aureole, surrounding the eclipsed sun and stretching away from it for a distance equal to from a quarter to a half of the moon's apparent diameter. It is irregularly quadrangular in shape, and is made up of rays, the raylets themselves being frequently curved. Many hypotheses have been put forth concerning its nature; the spectroscope, in the hands of Professor Young, shows that it is a self-luminous gas, since it gives at least one bright line which has become somewhat famous as the 1,474th line, the number referring to its position upon Kirchhoff's scale. The inner corona is unquestionably solar in its character; and the external corona is probably so, though the enormous distance to which it extends makes it difficult to account for it. Many have considered it a solar aurora; and some plausibility has been given to this theory by Winlock's observation, that a terrestrial aurora observed by him gave a spectrum in which were three lines nearly or quite identical in position with those observed in the solar corona by Young. The 1,474th line has been observed in the aurora but by one observer since that time, however. On the whole, the character of the corona must await further observations for its final determination. Much is hoped for in this direction from the eclipse observed day before yesterday in India, the first news from which Judge Daly has announced to us to-night. It informs us only that the observations were successful. [Photographs of the corona, as it appeared in the eclipses of 1868 and 1869, were exhibited on the screen.]

What now have we learned of the constitution of the sun by our spectroscopic investigation? In the first place, the theory of Sir Wm. Herschel has been disproved. The sun can no longer be regarded as having a cool, solid nucleus, inhabited by such beings as ourselves, and surrounded by a luminous envelope. The first stratum which is revealed to us is the photosphere. This Kirchhoff supposes to be liquid; but from the remarkable mobility it possesses, and the wonderful velocity with which changes take place in it, it is probably gaseous, or at least vaporous. This is reconcilable with the results of spectroscopic research, since Frankland has shown that a highly condensed gas when incandescent may give a continuous spectrum. This photosphere is in a state of intense activity, and glows with all the fierceness of its enormously high temperature. Surrounding this photosphere, and varying in thickness from one to twelve thousand miles, is the chromosphere, composed of more rare vapors, but which are yet incandescent. Here the absorption takes place which gives the Fraunhofer lines. Here are the projections of hydrogen, helium, sodium, magnesium, etc., which form the protuberances. Here the cooling vapors of iron, barium, calcium and titanium from the cloud, which, sinking down into the photosphere, forms a sunspot and is finally swallowed up therein. Outside still of all this is another atmosphere, constituting the inner and outer corona. The former is quadrangular in shape, the latter broken into rifts; both are made up of rays. The outer corona reaches out into space to a distance equal to once and a half the solar diameter, or nearly 1,400,000 miles! What its composition is, is entirely unknown. Its single spectrum line, though apparently coinciding with an iron line, cannot be due to that metal. It must belong apparently to an element as much lighter than hydrogen, as hydrogen is itself lighter than the heaviest terrestrial metal.

Such are some of the wonderful revelations which have been made by the spectroscope. Such are the results which sunlight gives us after traversing a prism. Such are the discoveries which show the marvelous power of the human mind, and which place it one in kind with that Omnipotence by which all these things were created. [The lecturer closed by illuminating the interior of the Academy of Music with monochromatic (yellow) light, alternating with the electric light, to show what the effect of sunlight would be were there no photosphere.]

SCIENTIFIC LECTURE—III.

MAGNETISM: THE EARTH A GREAT MAGNET.

By Professor A. M. Mayer,
Of the Stevens Institute of Technology. Dec. 21, 1871.

At the invitation of the Trustees of the American Institute, I have the honor to appear before you to deliver a lecture on Magnetism, a subject to which I have given several years of devoted study.

Confused by the multiplicity of the facts of this science, and embarrassed by the grandeur of its generalizations, I have resolved to do, what every public lecturer must do, who would confer on his hearers any greater benefit than mere temporary amusement, and that is, to select from this subject one prominent truth, and to present this to you in simple and striking experiments; but, so to describe and logically connect these experiments as clearly and forcibly to bring the truth before your minds and fix it there.

That this method of procedure is necessary, will be evident when you consider that over 100 men of the highest ability, as original investigators, have toiled, on an average of ten years each, at these problems of magnetism, thus making an aggregate of 1,000 years of successful search in the rich mine of natural truth.

From this vast accumulation of fact and of theory I select, as my text, words given to the world over 270 years ago, by Dr. William Gilbert, the physician to Queen Elizabeth. In the year 1600 Gilbert published a work entitled "De Magnete," or, "On the Magnet.* In

*Humboldt's Cosmos, volume 5, page 57: "About the close of the sixteenth century, William Gilbert, a man who excited the admiration of Galileo [who said of him, 'great to a degree that might be envied.' Cosmos, vol. 1, p, 170], although his merits were wholly unappreciated by Bacon, first laid down comprehensive views of the magnetic force of the earth. * * * Like other men of genius, he had made many happy results from feeble analogies, and the clear views which he had taken of terrestrial magnetism (*de magno magnete tellure*), led him to ascribe the magnetism of the vertical iron rods on the steeples of old church towers to the effect of this force. He, too, was the first in Europe who showed that iron might be rendered magnetic by being touched with a magnet, although the Chinese had been aware of the fact nearly 500 years before him. Even then Gilbert this book I found my text, and thus it reads: "*Magnus magnes ipse est globus terrestris*," which, being interpreted, is, "the earth itself is a great magnet."

Those who will examine this remarkable book of science cannot fail to observe how skillfully Gilbert handles the experimental or inductive method of research in arriving at the facts and the laws of magnetism; and if he cannot be styled "the Father of Inductive Philosophy," he can, at least, lay claim to our most hearty admiration for the brilliant manner in which he (with Galileo) first, by his discoveries, demonstrated the practical value of this injunction of Bacon — that by observation and experiment alone can the mind of man arrive at a knowledge of the laws which rule the universe.

That the earth itself is a great magnet, I propose as the problem to be solved before we separate, but the short duration of a single lecture will permit me to attack this problem only in the most general manner; and having proved that the earth is a magnet, it will not be allowed me the pleasure to examine with any minuteness the characteristics of this huge lodestone, such as the position of its poles, the path of its equator, and those mysterious variations on the directions and intensity of its force, which latter seem to be in subjection to emanations from the sun — changing with the apparent daily and yearly revolutions of that orb, and pulsating in sympathy with the huge waves of fire which sweep over its surface; for it seems probable that, on any sudden agitation of the sun's surface, the magnetism of the earth receives a profound disturbance in its equilibrium, causing fitful tremors in the magnets of our observatories and producing those grand outbursts of the polar lights, whose lambent flames dance in rhythm to the quivering needle.

The earth itself is a great magnet. Of the earth, you know; but what is a magnet? I hold one in my hand as given us by nature.

gave steel the preference over soft iron." Prof. John Robison—A System of Natural Philosophy. London, 1822: page 209: "It is not saying too much of this work of Dr. Gilbert's to affirm that it contains almost everything we know about magnetism. His unwearied diligence in searching every writing on the subject, and in getting information from navigators, and his incessant occupation in experiments, have left very few facts unknown to him. We meet with many things in the writings of posterior inquirers, some of them of high reputation, and of the present day, which are published and received as notable discoveries, but are contained in the rich collection of Dr. Gilbert. Dr. Gilbert's book, although one of those which does the highest honor to our country, is less known in Britain than on the continent. Indeed, we know of but two British editions of it, which are both in Latin; and we have seen five editions published in Germany and Holland before 1628. We earnestly recommend it to the perusal of the curious reader." Also, refer to Dr. Young's Lectures on Natural Philosophy, 1845: page 583; to Sir D. Brewster, Treatise on Magnetism, Edin., 1851: page 9; Whewell, History of the Inductive Sciences, volume iii, page 37, *et seq.*

This is the lodestone,* or leading stone (from the Saxon *læden*, to lead), so called because it causes iron to follow it. Our forefathers sometimes called it love-stone, just as the French now term it *l'aimant*, the affectionate, because it has a strong affection for iron, and draws it to itself. We call it magnet, from the province of Magnesia in Lydia, whence the ancient Greeks obtained it and thence gave it the name of the Magnesian stone.

So much for the name; but yet, what is a magnet? Define it. "A definition is the resolution of a complex idea into the simple elements which compose it;" but, in this case, the complexity of the idea conveyed by this name, magnet, so increases with our knowledge of its properties, and the simple elements of its characteristics are so far removed from ordinary observation, that I will be forced not to answer the question I have called up, but allow the magnet to speak for itself in its own "writing on the wall" [pointing to the screen], while I will stand by and be its interpreter.

Over the horizontal condensing lens (C) of this vertical lantern† I place this glass plate, and, on allowing the lime light to fall upon it, you observe on the screen a bright circle of over fifteen feet in diameter. I now place on the plate a few tacks, and there they are in the bright circle, each appearing over two feet long. That huge black mass which you see slowly entering the circle is the lodestone

* The lodestone is an oxide of iron ($FeO + Fe_2O_3$). We must not, however, infer that all specimens of magnetic oxide of iron are magnetic. The lodestone is black or deep brown; sometimes, however, it is of a lighter color. It is often crystallized in octahedra, more or less modified, or in rhomboidal dodecahedra. The best are homogeneous, with a fine-grained fracture, and susceptible of a beautiful polish. Their density varies, but is about 1.24. The magnetic ore generally occurs in primary mountains of gneiss, chlonti slate in primitive limestone, and sometimes in considerable masses in serpentine, and in trap. It is found in great quantity and purity at Roselay, in Sweden, in Corsica, on the island of Elba, in Norway, Saxony and Bohemia. A hill in Swedish Lapland, and Mount Pumacharache, in Chili, are said to consist almost entirely of magnetic ore. Extensive beds of magnetic ore occur in various places in the United States, and at some of them are found masses of the mineral possessing polarity; such as those at Marshall's Island, Maine; at Magnet's Cove, Arkansas; at Goshen, Chester County, Pennsylvania; and at Franklin, New Jersey. "The most powerful native magnets are found in Siberia, and in the Hartz; they are also obtained on the Island of Elba." [Dana.]

"Wolf mentions examples of natural magnets which could support, by means of an armature, from sixteen to forty times, and even 320 times their own weight. Duplex had in his possession a magnet of nine pounds in weight, which could hold seventy-six pounds. As a general rule, smaller magnets can support comparatively more than larger ones. Such, for example, as weigh twenty to thirty grains will sometimes support fifty times their weight, whilst magnets weighing two pounds scarcely ever sustain ten times their own weight. According to Dr. Martin, Sir Isaac Newton had a magnet which was set in a finger-ring, and which, though only of three grains in weight, could hold 746 grains. In the philosophical cabinet of the University of Dorpat there is a magnet weighing forty pounds, including the armature and the copper case, which is able to sustain eighty-seven pounds. A still larger one is found in Tyler's Museum, which weighs 307 pounds, the armature inclusive, and holds more than 320 pounds. Not less considerable was the magnet which John [V], King of Portugal, received as a present from the Emperor of China, which weighed a little over thirty-eight pounds, and was able [February, 1781], to support 202 pounds." Smith. Rept., 136, p. 288.

† See engraving in American Institute Transactions for 1870–1, p. 1019.

—see! as it progresses, how the tacks rush toward it, and observe also how they cling to one another until now they form a train and follow the stone, as it disappears from view. Surely it is "the affectionate."

The lodestone, however, attracts steel as well as iron, as you see, now that I have substituted these steel needles for the iron tacks. Apparently the lodestone acts alike on both, but let us examine into this. I have here a piece of copper wire, which I am wrapping around one end of this short piece of soft iron. I now have made a handle of wire, by which I can draw the other end of the iron through these iron-filings, which you observe as huge grains on the screen. The iron has ploughed a clear track through them. I again draw it through the same line, but you see that I have placed against its other end the lodestone, and you see the filings crowding in toward the iron from outside the bright track, and now the iron has actually taken off the plate a considerable breadth of them. I have placed aside the lodestone and again I draw the end of the iron across this plate in another direction. See, again it leaves behind it the bright, clean line, and not a particle of iron adheres to it in its progress. I now substitute for the soft iron a piece of stout darning needle. It also leaves behind it a clear line, and not a grain of iron attaches itself to it; and drawing it again through this line with the stone at the other end, you see that it, like the soft iron, draws to itself the filings. But now observe the difference when I lay aside the lodestone and draw alone the steel needle through the filings. See the iron brush which has formed on its end. I pull off the iron filaments. Again they form as I draw it across another diameter of the circle. Thus we find that iron is only temporarily, but steel is permanently magnetized by contact with the lodestone. Indeed, we find, on further examination, that the lodestone has endowed the steel with all of its magnetic properties, and therefore we can now set aside the stone and use in its stead these various steel bars and suspended needles, of more convenient forms, which we will suppose have derived their magnetism from contact with the lodestone.

Thus from the magnetism furnished us by nature in this stone I have permanently affected this piece of steel with extraordinary properties, but there are other means of obtaining them in a far more exalted degree. The most powerful yet reached has been accomplished by means of this instrument—the great electro-magnet of the Stevens Institute of Technology.

Here on each of these two strong tables rests four large brass spools, each wrapped with nine layers of stout copper wire. Thus we have eight spools, containing in all 2,000 feet of 2-10 inch insulated wire. Four of these hollow spools are placed in a line on each table, and into them is introduced a hollow cylinder of very soft iron three feet three inches long, of six inch outside diameter, and with an interior diameter of three and a half inches.* The two cylinders are terminated with these conical caps, and by rolling the tables they can be placed at various distances apart. On the shelves under these tables are twelve large battery-cells containing a solution of bi-chromate of potassa in dilute sulphuric acid. By turning these handles, those large plates (ten pairs to each cell) of zinc and carbon can be lowered into the solution and a powerful development of electricity instantly follows, and by means of these wire ropes it is led in one direction through all the wire on the eight spools. The electricity thus flows (as we say) around the two iron cores, and whenever this takes place they are instantly endowed with magnetic properties of the greatest intensity, as you will soon see.

The plates are out of the solution, and I place against the core these iron spikes. On ceasing to support them with my hands they fall to the ground, for the iron cores have no power to hold them up. Now I lower the plates into the solution, the electricity courses through the spools, and see, how the spikes are jerked out of my hand as I bring them near the magnet, and it takes all my strength to detach even one of them. I now throw a score of these spikes at the cores, which you will observe are about eighteen inches apart. How they clash against the iron! My assistants will now lift a whole keg of these eight-inch spikes above the maget, and turning it upside down they rush to the iron cores, and not one of them has fallen to the ground. Another keg of spikes is now thrown on the magnet,

* This most remarkable magnetizing power of an electric current was discovered by Arago in 1820, who found that as long as the current encircled an iron wire the latter remained magnetized, and that in similar circumstances a needle of steel received a permanent magnetic charge. The full development, however, of this discovery of Arago we owe to the genius of Professor Joseph Henry, who subsequently, in 1831, discovered the conditions necessary to obtain the greatest magnetic effect from any given bar of iron with any given battery; and, guided by these discoveries, he constructed a magnet which supported nearly three tons. Thus to our countryman belongs the honor of being the first to present freely to the world the knowledge of these fundamental facts, absolutely essential for the subsequent invention of the electro-magnetic telegraph; which invention, in all its essential principles, is also due to Henry, who, in 1832, at Albany, and during the following years at Princeton, exhibited his apparatus for transmitting electro-magnetic signals to a distance. Subsequently, Morse, backing his mechanical genius by an undaunted perseverance, succeeded in embodying the discoveries of Henry in his efficient invention, which has given to American ingenuity such world-wide renown. The powerful magnet which I used in this lecture is essentially Henry's magnet of 1832. It differs from it only in having had removed from its iron cores their inactive central portions, and in the trivial difference of these cores being placed, merely for convenience, in a horizontal position. See Rept. of Regents, Smith. Inst., 1857, p. 85, *et seq.*

and again another, and now we have an iron arch formed between the poles, on which my assistant, as you see, can stand with perfect security. He will now descend, and I will detach from the magnet one of these wire ropes leading from the battery—the iron bridge breaks and falls with a crash to the floor—an intensely brilliant flash occurs at the point where I detached the battery-wire. And now observe; the iron cores are as powerless to hold this spike as they were before the electric current enveloped them.

As yet we have only experimented with fixed magnets. Let us now see what will happen to a magnet when I support it, so that it can move freely around its center of figure; I have here two hard steel plates; one end of each is terminated in a spear, and in the middle of its length is a little agate cup. I place on the horizontal lens of the lattern this circular plate of glass, whose border, as you observe on the screen, is divided into degrees. In the center of this graduated circle I stand this little needle, and on it I rest one of these steel plates. See, it turns freely round on its agate cup when I tap it with my finger; and now I place its spear-end to any division of the circle, and you see it remains there, and you observe that it has no tendency, in itself, to point to one division in preference to any other. I now replace it with this other similar plate or needle; it behaves precisely like the former one. I am now going to make these needles magnets. What you see on the screen is the end of a steel magnet, which is slowly stroking the supported needle from heel to spear-end, and observe, I only pass the magnet over it in that direction. I now have made several passes, and I lay aside the magnet and allow the needle to take care of itself; see, how it is swinging forward and backward, and, at last, its spear end has come to rest at thirty-five degrees of the circle. I push it away from this position, but you see it persists in returning to it. It now evidently has a preference to remain in this diameter of the circle to any other, and we find on examination that this diameter lies nearly in the north and south line of the horizon. I now replace this by the other magnetized needle, and you observe that it also remains pointing to any division to which I direct it. I will also magnetize this needle by drawing over it in the same direction, from heel to spool-point, the same end of the magnet used in the previous experiment. I now remove my fingers from the needle, and observe, it, also, is swinging to and fro, and gradually it comes to rest, and now its spear-end is also pointing to thirty-five degrees of the dial, and it returns to this division as often as I deflect it from it. Thus, these experiments have clearly shown us that when any magnetized bar of steel can freely turn on its center, it will (here in New York) place its length in a northerly and southerly line.

We will now reverse our first experiments, and, instead of allowing a fixed magnet to act on movable masses of iron, we will see what takes place when a fixed mass of iron acts upon a movable magnet. I take this short piece of soft iron and point it toward the spear-end of the needle; you see that the spear moves toward it. I now bring it opposite the other end of the needle, and it also moves toward the iron. The iron pulls to itself, indifferently, either end of the needle. Hence, if a rod of iron be placed at right angles to the length of a magnetic needle, and point toward its center, the needle will not rotate. You see this deduction is correct, for there, in the bright circle, you see the iron rod pointing toward the center of the needle and the spear-end remains steady at thirty-five degrees.*

Let us now see what action this other magnetic needle will have on the similar one in the lantern. We have seen that the spear-end of each pointed in the same direction. I bring these two ends opposite each other. How remarkable! the spear-end of the lantern needle is repelled. Heretofore all of our phenomena were facts of attraction; here we first meet with repulsion. The swinging needle is now rapidly coming back to its thirty-five degree point, and I will again bring the same end of the needle close to it; see, although it was coming back to its position of preference with a rush, yet the repulsive action between the similar ends of these magnets is such that the swing of the needle was not only arrested, but its motion was reversed. See, again, how it shies away as I again bring the spears near each other. But attraction also exists between these magnets, as you perceive, as I bring the other end of this needle to point toward the spear-end of the lantern needle. Rapidly it swings toward it, and I had to be very quick in my movements or the unlike ends would have struck together. To bring forcibly before you the differences in the action of the iron and of the magnet on the same needle, I now, as I did with the iron, place the magnet at right angles to the length of the magnetic needle, and pointing toward its center. The needle now, however, does not remain steady at thirty-five degrees; it rotates; the spear-end of the stationary magnet draws to itself the other end of the needle. I reverse the position of the magnet, and the direction of rotation of the needle is also reversed.

* The pointing of the needle to this particular division means nothing, for the graduated plate was placed on the lantern without thought as to the direction of the zero point, and it merely happened that the needle pointed to thirty-five degrees when it came into the magnetic meridian.

We hence deduce a general rule of the mutual action of magnets, viz.: Like ends, or poles, repel; unlike poles attract.

In the course of the solution of our proposed problem, we will have frequent occasion to use the guidance of the following experimental tests:

Place the length of the bar you would test at right angles to the length of the needle, and pointing toward its center. If the needle remains at rest the bar is devoid of magnetism. If it rotates, the bar is a magnet; and if the north end of the needle approach the bar, then the south end of the latter is near the needle; if the south end of the needle approach the bar, then the north magnetic end of the bar is nearest the needle.

We have seen that both the lodestone and the great magnet conferred their magnetic properties on masses of iron which touched them; but contact with the magnet is not necessary for calling into existence attractive properties in iron, as you will clearly apprehend from the experiments I am about to make. I again bring over the lens of the lantern a glass plate strewn with iron filings, and I draw through them the end of this short iron rod, while near to the other extremity I hold this lodestone. You observe on the screen the considerable distance that separates them; yet you see the filings adhering to the iron, just as they did when the stone was in contact with it.

A similar experiment I will now perform with the great magnet. My assistants have unscrewed its conical caps, and have brought the two iron cores and the two sets of spools in close contact. Thus we have made out of the two cores one magnetic bar of seven feet in length. I now lower the battery plates, and the iron is powerfully magnetized. My assistant will stand against one of its ends, and I place against his chest this iron rod over four feet long; the bar is thus separated from the magnet by the thickness of his body, yet on bringing these rings to its free end they cling to it and to each other, and swing like a chain from its extremity; the bar is magnetized through the body of a man.

Again, another experiment I will make. I take this bar of soft iron, fourteen inches long and two inches in diameter, and ascending these steps I hold it aloft, a foot or more above the end of the great magnet. My assistant will now hand me those iron rings, each weighing three pounds; I bring one to the end of the bar nearest the magnet; the ring firmly adheres to it; to this ring I suspend another; and lifting the iron rod yet higher I have attached another, and another; and now I have six rings suspended from this stout iron rod, yet none of this mass of suspended iron touches the magnet. The battery wire is now detached and the rings fall to the floor.*

There is, however, another condition, besides mere proximity to the magnet, which is necessary for magnetization at a distance, and that is the part of the magnet toward which the iron bar points. Only with the great power of this huge magnet can I clearly show you this important truth, and without it a link in the chain of my reasoning toward the solution of our problem would be wanting. I hold in my hands a bar of soft iron four feet long; I bring this toward the center of the great magnet and point it at right angles to its length. Observe, it is powerless to hold up even a nail. Holding the bar at the same distance, I now point it toward one end of the magnet, and see the difference; how the spike and rings adhere to it; for as long as the bar points toward the end of the magnet it is magnetized; but observe, as I slowly rotate the bar around the end nearest the magnet—spike and ring are falling to the floor, and now that it points again toward the center of the magnet it is powerless. Therefore direction as well as proximity is necessary for the magnetization of a bar by induction.

With the knowledge of the method I have given you to distinguish between a mere magnetic substance which is attracted indifferently by either pole of a magnet, and a magnet, which is rotated in one direction by one pole and in the opposite direction by the other, we have the means of still further exploring this curious action of a magnet on a distant bar of iron or steel, and I ask your special attention while I make the following experiments, which give additional evidence of the power of this noble instrument, for it alone can accomplish what I now proceed to show you.

In my hands I hold a piece of gas-pipe, which I have carefully freed from any trace of magnetism, by a process which you will presently appreciate. You see that it is really devoid of magnetism, for you observe that when it is brought close to, and pointing toward, the center of the lantern needle it does not produce in it the slightest rotation. I now set in motion the great magnet, and carefully carry this pipe to a distance of about twelve feet from one of its ends, and I point the tube in an east and west line toward its pole; I now bring the tube again opposite the lantern needle, but, as before, no rotation takes place. I again place myself at the same distance, but, while the

* This experiment, which appears to have all the beauty of simplicity and completeness, is due to Mr. W. E. Geyer, of Hoboken.

tube is pointing toward the pole, and in the same direction as before, I strike it with this hammer; the tube rings at the blow, and all of its particles are powerfully agitated. I now present the tube to the lantern needle, and see! how it swings around. The large magnet really magnetized this tube when I previously pointed it toward its pole; but only temporarily, the magnetism disappearing as I removed from it. But, when the bar, in exactly the same position, was vibrated by the blow, it received a permanent charge. Thence we deduce another important fact, namely, that to produce at a distance from a magnet a permanent magnetic charge in a bar of iron (or steel) this must not only point toward its pole, but also its particles must be violently shaken.

By these conclusive experiments, we see that it is not necessary for an iron or steel bar to touch a magnet to derive from it either a temporary or a permanent magnetic charge, for, at a distance of twelve feet, we have shown that the magnet influences the iron, or induces it to become a magnet like itself; hence, this action of a magnet on a distant mass of iron or steel is called induction.

It now only remains to examine how the poles of these induced magnets are situate when referred to the positions of the poles of the inducing magnet. In the last experiment you observed that I pointed toward the great magnet the red end of this iron tube, and that on presenting this end to the center of the lantern needle you saw its spear or north end rotate toward it. I again repeat the experiment; you see it is as I say. Therefore this direction of rotation tells us that this red end of the bar is a south magnetic pole, and you observe that the other, or white end, is a north pole, because, as you see, it produces in the needle a rotation in the opposite direction. Now we will examine the magnetic condition of the end of the great magnet toward which the bar pointed, and then we can deduce another of those general rules, or laws, which are to serve us in our demonstration.

Here, on this wooden column, is a magnetic bar, over two feet long, which you observe turns freely on a hard steel point. It, therefore, has placed its length in the magnetic meridian, and on this end, which points toward the north, I have tied this ball of red cotton-wool. I will now carry this column near that end of the great magnet toward which we pointed the iron tube, and placing on the steel point the magnetic bar, you all observe that the cotton-wool moves away from the magnet; therefore, this end of the magnet is its north pole. From these facts we can deduce this general rule: When a bar of iron or of steel is magnetized by induction, the end of the bar nearest the inducing magnet is of the opposite polarity to that end of the magnet toward which it points. In the experiment just made, the end of the magnet was its north pole, and the red end of the bar nearest it has south polarity given it by induction.

With labor on my part, encouraged by patience on yours, I have at last put you in full possession of those tests which can determine for us whether any given bar has magnetic properties or is devoid of them; and I have also experimentally shown you those conditions necessary for a distant magnet to produce either temporary or permanent magnetism in bars of iron or steel. The process of the experimental establishment of these elementary principles, preparative to our actual work with the earth as a magnet, has been tedious to you and to me; some, thoughtlessly, may say *puerile;* yet as well say "every one knows that," and erase from your geometry its axioms, as omit from our demonstration those elementary facts and principles which constitute its very foundation, for

> *   *   "To tell by which of nature's laws,
> The stone called magnet by the Greeks—since first
> 'Mong the Magnesians found—can iron draw.
> *   *   *   *
> Here many principles we must first lay down,
> And slow approach by long preparative,
> Rightly to solve the rare phenomenon."
>
> *Lucretius, Book VI, Trans. of C. F. Johnson.*

"The earth itself is a great magnet;" if so, it also will confer on this iron bar temporary magnetism when its length points toward the earth's magnetic pole; and, if vibrated while in this position, it will also receive permanent magnetic properties. But here difficulties at once meet us. Are we not begging the question when we talk of drawing a line toward the earth's magnetic pole? That the earth has magnetic poles is just the problem to be solved. True, but we can do this; we know from experiment that *if* the earth be a magnet, then this point of concentration of the magnetic effect, called the pole, is situate somewhere in the depth of the earth, and this depth we can (as has, indeed, been done) approximately determine by experiments on a magnetic sphere of steel. Then, we can furthermore assume that these polar points exist somewhere on or near the earth's axis of rotation, for a freely suspended magnetic needle places itself, here in New York, approximately in a plane passing through this axis. Also, as the spear-end of the magnetic needle points toward the geographic north, then either that part of the earth is of magnetic polarity, or it is of north polarity south and the spear-end of the needle of south polarity. It matters not much which hypothesis you adopt, but we will call the spear-end of the needle its north pole, and the geographic north the south magnetic pole.

If, after assuming these circumstances, our experiments conform to such hypotheses, we have an honest reason for thinking that, in the main, their existence is highly probable; and, this much established, we can, from this knowledge, devise other and more searching observations and experiments, whose agreement or non-agreement with our hypothesis will carry more conclusive evidence as to the truth or falsity of our suppositions; and so, step by step, we ascend to the widest and surest generalizations of physical science. This, indeed, is the method of arriving at all the fundamental laws of natural philosophy, and, if not satisfactory to the strict scholastic logician, we only say that this is all that we can do, and show its value by pointing to the results obtained by such methods of inquiry. We start with imagining existences, and banish these dreams, one after another, until one is called up which conforms to the actual experiences of observation and experiment. The fault of the ancients was not that they wanted vivid imaginations—quite otherwise—but that they were satisfied that their imaginings should remain "of such stuff as dreams are made of," and never endeavored to find their realities in the material world, and give them embodiment in those entities which exist all around us. The search for these entities is the pursuit of science, and the finding of them is its object.

Thus we will proceed in our work. These parallel white cords, which you observe stretched above the floor, lead to the point in the earth where, in our imagination, we have placed its magnetic pole. We will soon see that there are other methods of very accurately determining the direction of these lines, and we will also find that our ideas have to be somewhat modified as to their paths, for we shall see that instead of being straight lines they really lead to the pole in curves. But remember that we are indulging in our first reverie, and this can but be a vague image of the truth. But all of the conditions necessary for the realization of our reverie are already clearly in your mental vision, and we can at once proceed to seek if any resemblance to it in nature really exists.

I take this bar of soft iron, and, holding it horizontally, I bring one end of it near the center of the lantern needle. You now see in the circle the end of the magnified rod, and you observe that the needle does not rotate. The bar is entirely devoid of magnetism. But those conditions necessary for the earth to act on it do not yet exist, for the bar must point toward the assumed position of its magnetic pole. I will, therefore, presently slowly raise this bar until its length is parallel to those stretched lines, and then, if the earth be a magnet, the needle should not only rotate, but the spear-end of it should go away from the lower end of the bar; and also if the rod, retaining its direction, should be lowered in the direction of its length, until the center of the bar has come opposite the needle, then the latter should return to the position it had when the bar was away; and, furthermore, on lowering yet more the bar until its upper end comes opposite the needle, we should see it again rotate, but this time its spear-end should approach the iron bar. I am now slowly elevating this white end of the bar, while the other, or red end, remains near the needle; see, it really is turning on its center, and the spear-end, as we imagined, is moving away from the rod. I have now brought the length of the rod parallel to the stretched cords, and observe how powerfully the needle is deflected, the spear-end turned away from the rod. I will now lower the rod along the line of its length; you observe the needle slowly moving to the position it had before the iron bar was brought near it, and now it is steady at that position, and the center of the rod is opposite the needle. I lower it yet further, and the needle is now turning in the other direction, the spear-end is approaching the bar, and now it has come quite close to it, and the upper, or white end of the bar, is opposite the center of the needle. I now reverse the position of the bar, and place the red end up; the white end is now close to the needle, and see, how the latter is swinging away from it. This white end has now north polarity, the same as the red end had when it was similarly placed. On lowering the bar in the line of its length, you see that its center is again devoid of action on the needle, and now that its upper or red end is opposite the needle, you observe the spear-end of the needle quite close to it, showing that again the upper end is of south magnetic polarity. I now remove the rod, and placing it in a horizontal position, I bring either end near the needle's center; you see that its magnetism has left it. From all of these experiments what are we to infer? That the magnetism of a bar of soft iron depends alone on its position, and is, therefore, due to some action outside of itself. When placed in a horizontal east and west line it is devoid of all magnetic properties; when placed parallel to these cords it is powerfully magnetic, and also, whichever end is downward that end has north magnetism. Thus have we found really existing in nature every one of those surmises which, before experiments were made, we only knew as the creatures of the imagination called up by logical inferences.

This first success flushes us with the consciousness of our power, and our vision involuntarily expands from this room out over the great earth itself, and we picture to our minds what would happen to this bar of soft iron if it were carried from here southward, across the equator into the southern hemisphere, and as we progressed on our voyage we should frequently hold the bar in a vertical line and test its magnetic condition. Here, in the northern hemisphere, we know from the experiments just made that the lower end of the bar is of north magnetism; but if, when we had reached the equatorial region of the earth, we should test the bar, should not the experiment show that it was devoid of magnetism? for did not our experiments on the great magnet teach us that when the bar was placed at right angles to the axis of the magnet and pointed toward its center, the bar remained unmagnetized? and those conditions would seem to be exactly repeated with the earth, supposing it a magnet, if we held the bar upright on or near the earth's equator. Pursuing our voyage yet more to the south, we enter the southern hemisphere and approach nearer the point where we supposed the earth's north magnetic pole to exist. Here this nearer pole should induce its opposite magnetism in the lower end of the bar, which should now be of south magnetism, which is opposite to that which it had when on the other side of the equator. We cannot travel so far together and test all this for ourselves, but I find that another man has also had this same vision, and actually sailed with a bar of iron into the South Atlantic, there to seek its reality; for, fortunately for the completeness of my argument, I made a note of a curious paper on this point, which I once found while studying the history of magnetic research, as contained in the Transactions of the Royal Society of London. This paper is entitled, "On the Tendency of the Needle to a piece of Iron, held perpendicular, in several climates; by a master of a ship, crossing the Equinoctial Line, Anno 1684." Let the mariner give his own evidence: "All the way from England to ten degrees north latitude the north end of the needle tended to the upper end of the iron and the south point to the lower end very strongly. * * * In latitude eight degrees seventeen seconds south and meridian distance from the Lizard seventeen degrees thirty-five seconds west, the north point of the needle would not respect the upper end of the iron; but the south point would still somewhat respect the lower end. * * * In latitude twenty-nine degrees twenty-five seconds south and thirteen degrees ten seconds west, from the meridian of the Lizard, the south point the needle respected the upper end of the iron and the north point of the lower end strongly." The sailor's evidence is completely in our favor, and especially will it so appear when you refer to any physical chart of the globe, where you will find that latitude eight degrees seventeen seconds south and longitude seventeen degrees thirty-five seconds west of the Lizard is almost exactly on that line laid down as the magnetic equator, on which the inductive actions of the north and south poles neutralized each other.

The first series of experiments we made on the distant action of the great electro-magnet suggested these, which we have so successfully repeated with the earth; but you will recall other experiments, in which a bar of rather hard iron pointing toward the pole of that magnet was permanently magnetized, when in that position I made it ring with the blow of a hammer; whereas when gently removed from that position, without having been agitated, it was found to be unmagnetized. Let us repeat these experiments, for all the conditions of their manifestation are known and can readily be obtained with the earth. Holding this bar horizontally with either end near the center of the lantern needle, you see that it is free of magnetism, for the needle does not move. I now place its length parallel to the direction of those stretched cords; this condition seems exactly to correspond to our previous experiment, when at a distance of twelve feet we pointed a bar toward the pole of the large magnet. I now bring it into a horizontal position, and again place its end near the center of the needle; you see it is still unmagnetized, exactly as when, after pointing a bar toward the magnet, we brought it near this needle. But we found that it was permanently magnetized when, in that position, its molecules were powerfully vibrated. This condition we can readily fulfill. Observe, I place the red end of the bar down, with its length parallel to those stretched cords, and now I strike down on its upper end with this hammer. We will hold it in the same position until its ring has died away. Now it has ceased to tremble; and placing it again in a horizontal position, I bring its red end near the needle. You all see how violently the needle swings around, its spear, or north end, rushing away from the bar, showing that the red or lower end has received a charge of north magnetism. The upper, or white end, is now opposite the center of the needle, and you see that it is as powerfully charged with south magnetism. The experiment is a beautiful one, but we have not yet seen all of its excellence. Let us again muse over our work and see if we cannot gain further mastery over these actions. You remember that the red or lower end of the bar is of north magnetism. Suppose, however, I place this end up and the white end down. Will this white end then have a north magnetism? Let us try. No, it is evidently weaker in its action on the needle, but is yet of south magnetism—but weaker. This weakening evidently comes from the action of the earth on the reversed bar. Therefore suppose, while holding the bar in this position, I strike it again with the hammer; what will happen? Will merely a blow be sufficient to take the south magnetism out of that end of the bar, and to leave the bar neutral, or, will it do even more and replace the south by north magnetism? In other words, will it reverse the magnetism of the bar? I will test it. Look steadily at the needle and observe its fixed position, while the end of the bar is near it, and keep your eye on the needle, and when you hear the blow of the hammer and ring of the bar, observe what takes place. I have struck the bar, and look, how the needle swings, and now its spear-end is away from the bar, thus showing that its magnetism has indeed been reversed. Thus can we cause the magnetism of the ends to change places as often as we wish; but can we not do something else? Can we not, by a properly regulated blow, shake (allowing such a crude expression) the magnetism entirely out of the bar? I think we can. You know that the lower or white end is of north polarity. I now reverse the position of the bar and the white end is up. I strike a blow. I now test the bar, but you see that I struck it with too much force, for the magnetism of the white end is now south; but feebly so, for the needle is only slightly deflected. Now I will show you a pretty experiment. I again reverse the bar, and the white or south magnetic end is down, and I strike the upper end with the palm of my hand. I place the bar in a horizontal position and I test it; it has evidently been weakened. I again bring my hand down on it. Its magnetism has, you see, almost disappeared. I again bring the bar into the upright position and tap it with my fingers. See, it is entirely freed of magnetism. I stated, when I began working on these bars, that they had all been demagnetized by a process which you would soon appreciate. I hope you now appreciate it.

How satisfactory is such work; we here repose on the decision of an upright judge. We bring our doubts and differences to the bar of nature, and the verdict is convincing to all. It is truth, which is the soul of science.

I think we can say that the experiments we have made with these magnets have well directed us in the progress of our experimental solution of the problem of the earth's magnetism; and this encourages me to examine more minutely the manner in which these curious attractive and repulsive effects, which we call magnetism, are distributed over the surface of these magnetic bars. We can only thus hope to secure more light to illumine our further progress, which seems here almost brought to a termination. But from experience we know that it is generally only by the most searching look into known phenomena that we can obtain that dim view of the path which leads to the hidden truths beyond, and thus, therefore, we will endeavor to find an opening into further research.

We have, as yet, only examined roughly the effects of the ends and of the central portions of a magnet on bars of iron; but we can, instead of using these large bars and needles, make use of quite minute and very short bars in the form of iron filings, and by this process give many points for the magnetic radiation to act on; and by distributing these points over the whole surface of the magnet we may arrive at some highly suggestive results. The idea is worth following up and we will proceed to test its value.

I strew this glass plate with finely sieved filings made from the softest Norway iron, which has been repeatedly annealed, and I place it over the horizontal lens of the vertical-lantern, and I lay this small bar magnet on the filings. You observe how they arrange themselves about its ends. I now roll the bar over and over, and you see more evidently than before that the attraction is localized. The middle of the bar has no filings adhering to it, but observe from the ends of the magnet these radiating iron filaments, and remark how their gradually declining contour actually shows the magnetic hold on the iron gradually diminishing from near the ends of the magnet toward its center.

I now modify this method of exploring the distribution of the magnetic force. I place this same bar magnet on the condensing lens of the lantern, and down on it I lower this glass plate on which has been sifted iron filings. They do not appear in the least affected by the magnet beneath them; but, observe when I let fall vertically on the plate this piece of light copper wire; see the curious lines that are growing around the magnet. These, proceeding outward from the ends appearing to radiate like rays of light from points within which we call the poles, while these, originating nearer its center, bend over the magnet, and in graceful curves embrace it.

Let me try if I can give you some insight into their significance. The plate sprinkled with iron dust was placed upon the magnet and nothing remarkable appeared. Why? Simply because all phenomena, without exception, are either motions or the results of motion; and no motions of the iron particles could take place until the plate was vibrated; then they sprang into the air, and the magnet, from its proximity, rendered every iron grain magnetic by induction, while the same directing principle joined their north and south poles. Thus, while in the air, or when gliding over the plate, they were deflected into those curious curves which is the figure of their dance. These lines thus show the directions in which act the combined magnetic radiations from the two poles. They are the lines of magnetic force. They indicate far more than this; but for the present what I have shown you will suffice. Now, if these curves are actually formed of iron filings whose greatest lengths lie in these lines, and whose contiguous ends are north and south poles, and if these lines truly mark out the resultants of the combined actions of the two poles, then this tiny magnetic needle which I have by a silk fiber suspended from this thin wire, will, if brought anywhere in this field of curves, always place its length in the direction of a line; moreover, when the center of the needle is moved along one of these lines, the length of the needle will always come into the line. I now bring all this to the test of experiment. You see all happens just as I predicted.

To lead the mind from the small to the great, from our puny experiments to the action of the great earth itself, I have magnetized this disc of steel; therefore, this metallic circle has magnetic poles, like the bar we have just experimented with. Hence, if "the earth is a great magnet," this disc gives an ideal section of its magnetism, and should produce on a small scale what the earth does on a grand one. Voyagers and philosophers have stated that the earth has two magnetic poles or points in its mass toward which the magnetic line converge.* When the little exploring needle was carried around one end of the bar magnet, you will remember that it always kept pointing toward one point, which we called the magnetic pole of the bar. So, in the case of this disc, will the exploring needle, when brought near the region of its poles, always point in lines which converge to these inner centers of force; hence it

* Gilbert, in his De Magnete, Lib. i, ch. 2, says: "This is that Robert Norman (a good seamen and an ingenious artificer) who first discovered the dip of magnetic iron." Norman made this very important observation in 1576.

necessarily follows that there must be two points on the circumference of this disc at which the needle points toward its center. Also, it is said that the earth has two such points, and when in June, 1831, the celebrated Sir James Ross reached the western coast of Boothia Felix, and found the magnetic needle pointing almost directly toward the center of the earth, he inferred that he stood on the termination of a line drawn from the earth's center through its magnetic pole to his feet. Thus rewarded for his hardihood, this bold mariner undertook another voyage of discovery in search of a similar point in the southern hemisphere, and in 1841 succeeded in reaching south latitude 76° 12′, on Victoria Land, where the needle made an angle of 88° 40′ with the horizon, and he concluded from this and other observations that the position where the needle would be vertical was about 160 nautical miles distant. From these and other discoveries made in the antarctic seas, it is supposed that the pole of the southern hemisphere must be somewhere about south latitude 70° and near the meridian of 125° E. of Greenwich, which would bring it somewhere on the territory dicovered by our countryman Wilkes. The exact position of this point, however, is not known, for no explorer has yet reached it. Now, if you will mark on a terrestrial globe the position of these two points, as I have here done, you will see that they are not exactly opposite each other, but are, however, nearer to that relation than is generally taught, and we might be led to infer from an examination of a physicial chart of the world. This is another example of the great importance of using the globe whenever it is possible to do so, and never being satisfied with the information and impression given by a distorted map of the world. Placing the pole of the northern hemisphere at latitude 70° and longitude, west 85° ; and the other pole at south latitude 70° and longitude 125° east, one of these points will be removed from the end of a diameter drawn from the other by only 30° in longitude ; which, on a parallel of 70°, only equals about 600 miles, so that if the southern pole should be moved by this quantity to the west, it would be exactly opposite the pole on the Isthmus of Boothia. But even this want of geographic symmetry has been reproduced on this disc, for I have made its poles distant from each other by the same arc of a sphere's circumference as separates the magnetic poles of the earth. This I accomplished in the following manner. Having calculated the angular distance of the terrestrial poles, I marked this opening by two points on the circumference of the disc, and at these points I placed the conical terminations of the cores of two very powerful electro-magnets. On passing the electric current around these cores, the disc was magnetized and its poles coincided with the points of contact of the cores. Thus this little disc of two and a quarter inches in diameter gives us an approximate representation of a section of the earth's magnestism, passing through the two magnetic poles.

We will now experiment with this disc as we did with the bar magnet, and in the same manner examine its magnetic curves; for if the earth be a magnet, they must give us an idea of the lines in which it also exerts on the needle its directing influence, and greatly aid in giving clear conceptions of the magnetic actions which have been observed by navigators and explorers. I now place the disc upon the horizontal condenser of this lantern, and down upon it I lower this plate on whose upper surface iron filings have been uniformly sifted. I now gently tap the plate. How beautifully these lines form around the disc! Here are its poles, for you observe the lines all leading to these points within the dark circle of the magnet, and directly over these points the lines tend directly to the center of the disc. Here, however, at positions on the circumference midway between the poles, you observe that the course of the lines for a short distance is parallel to the surface of the magnet, and places so situate determine points of its magnetic equator.

With this tiny magnetic needle, suspended by a delicate silk fiber, I will explore the magnetic condition of this bright space covered with lines, which you observe surrounding the black circle of the magnet. Wherever I place it you see that it always stands with its length in the direction of a curve, and now that I move its point of suspension over one of these lines you see it swinging round with the bend of the curve, just as a car curves on a railroad track; and you will remark that this takes place when it is moved over any line, whether near to or far from the disc. Now follow me as I move the needle around the circumference of the magnet, while at the same time I describe what takes place to a needle freely moving on its center when placed over the earth at points corresponding in latitude to those marked on this disc. The needle is now over the magnetic pole of the disc, for you see it points toward its center; thus stood the needle of Sir James Ross on the west coast of Boothia. I now progress southward, and observe how the end near the disc is gradually moving away from it; thus acts the needle on the earth when carried south from its position of verticality. Now the little needle is at a point of the disc marked with the latitude of New York, and you see it making an angle of about seventy-three degrees with the periphery of the circle. In like manner behaves the needle in this room, as I will presently show you. Here we have progressed so far south that the needle sets its length parallel to the circumference of the circle; thus the needle rests when moved about 90° from the magnetic pole of the earth. We are now traveling over the other side of the magnetic equator, and you observe that the end of the needle, which, in the former semi-circumference, pointed toward the disc, now points away from it; this also represents exactly what occurs when the needle is carried to the south of the terrestrial magnetic equator. As I proceed over the circle, this end points more and more toward it; now it stands at right angles to its surface, and is directly over the other magnetic pole; likewise points the needle when carried toward the magnetic pole of the southern hemisphere.

It is only possible for us to examine together the dip here at New York; all the rest we have to take on faith from the trustworthy travelers and voyagers who have reported in a minute manner on what I have given in a very general way. But, desirous that my work before you this evening should leave a permanent impress of that repose which always follows a thorough demonstration, I will, at least, show you the earth's directive action in this room in a very satisfactory manner. I have in my hand a disc of glass on whose margin is photographed a graduated circle, and at its center is a freely moving axis which passes through the center of gravity of this unmagnetized needle; thus supported, the needle will remain indifferently at any division of the circle to which I may direct it. I now place it in front of the condensing lens of this ordinary lantern, and the axis of the needle is horizontal, and the latter can move in the same vertical plane in which it would place itself if suspended by a fiber. I now place the needle at various angles of the circle, and you observe it remains immovable at all of them. Now its ends point to the zeros of the circle, which shows that its length is in a horizontal line. I will now magnetize it, and you will observe immediately that it is then endowed with a decided preference for a certain angular division of the circle. You now see on the screen end of the magnetic bar passing over the needle from heel to point. Now I have drawn it over several times, and I will take away my fingers which have held it in a horizontal position; see how it is swinging; no longer indifferent to its position in reference to the horizon, its spear or north end shows a decided preference for the lower part of the circle, and now, after several oscillations, it has finally come to rest with its spear-end 73° below the horizontal line. This deflection of the needle below the horizontal plane is called its "dip."

We have now in our possession a most valuable instrument for exploring the magnetic condition of the earth, and, with similar needles, explorers have traveled over all the accessible regions of the earth, and have carefully noted how its inclination to the horizon changed with various stations. At New York the north end of the needle dips 73°. Carrying it up the Hudson, we find that at Catskill it has increased to 74°; and at Saratoga it is 75°. Proceeding north and west we find the needle dipping more and more, until we reach latitude 70°, and a longitude that brings us in the center of the North American continent, where the needle points in the direction of the plumb line. Retracing our path to the south, we see the needle continuously lifting its north end, until we again have it at New York dipping seventy-three degrees. At Philadelphia it points a little below seventy-two degrees, and when we reach Washington it is at seventy-one degrees. Its north end gradually rising, we pass over the end of Florida, where it dips about fifty-five degrees. At the mouth of the Amazon, directly on the equator, it is yet twenty-five degrees below the horizontal line; but when we have reached latitude 17° south of the equator, and are about 12° in longitude west of the coast of Brazil, we see the dipping needle with its length parallel to the horizon. Here we have reached a point of the earth's magnetic equator corresponding to the point midway between the poles on the magnetic disc. But does the position we have reached correspond to such a position in reference to the earth's magnetic poles? I again take the terrestrial globe, and on it I draw a circumference of the sphere, which I pass from this point west of Brazil through the North American magnetic pole, and extending this circle beyond, I pass it round on the other side, until it has girdled the sphere. It very nearly cuts through the other pole, whose position we marked on Wilkes' Land. I now take a string and stretch it along the line from the Boothia pole to the point off the coast of Brazil where the dipping needle is horizontal. I then apply this same length from the southern pole towards the same point of Brazil, and I find that this point is only one degree too far south to be exactly midway between the two terrestrial magnetic poles. The coincidence is as near as we can expect with a sphere composed, like our earth, of such varying materials. We will now transport ourselves to the other side of the earth, on the line which we drew around the globe, and we find that the needle takes a horizontal position about latitude 6° north. Again stretching the string from northern and southern magnetic poles to this point, we find that it is six degrees too far south to be exactly midway between these poles. Here is a discrepancy, but yet a sufficient approximation to serve in the broad argument we are making.

Standing on the east coast of Brazil, at Porto Seguro, in south latitude 16°, the dipping needle is horizontal. Let us town travel eastward from this point around the world, and in our progress keep such a direction that the needle always remains horizontal. The line of our course will have marked out what is called the earth's magnetic equator. This line, starting from the coast of Brazil, tends north towards the coast of Africa, cutting the geographic equator about east longitude two degrees, and then enters the African continent at the Bight of Bennen; hence, leading slightly north, it strikes the parallel of ten degrees north, and keeps this line directly east to Cochin, on the western coast of Hindostan; now gradually bending south, it again cuts the equator in west longitude 170°, and thence treads southerly to South America, and meets that continent at about south latitude 7°, on the west coast of Peru, and from this point it bends southerly to reach the place of our departure at Porto Seguro. Such is the sinuous path of the earth's magnetic equator.

We have only roughly tracked this one line, and have approximately given the position of its poles, but the necessities of navigation require a minute knowledge of the magnetic condition of the earth, and charts have been prepared from the observations of magnetic observatories, and from the results of voyages and travels of discovery that, by means of similar lines, exhibit at a glance its action on a magnetic needle placed anywhere on its surface. This action manifests itself in giving to the needle (1) a direction in a horizontal plane (2) a direction in a vertical plane; and (3) by causing the needle to persist in these planes with intensities increasing from the magnetic equator towards its poles.

These charts, however, show only the earth's superficial magnetic action. But did not the experiments with our magnetic disc show that wherever in that bright circle we brought our tiny needle, it there placed its length in the line of a curve emanating from the magnet? and does not this fact show us where to "let the imagination go, guarding it by judgment and principle, but holding it in and directing it by experiment?" [Faraday.] You see the disc on the screen with a diameter of about six feet; imagine this the 8,000 miles of the earth's diameter. Observe that the illuminated circle, containing the disc, has a diameter of eighteen feet; let this suggest to us a portion of celestial space which will extend everywhere 8,000 miles from the earth's surface. Now contemplate those curves surrounding the magnet, and then lift up your minds and behold the lines of terrestrial magnetic force. Only imagine this circle, 24,000 miles in diameter, instead of eighteen feet, and then these curves, stretching thousands, yea tens of thousands of miles from the earth, plot out for you, in celestial space, the earth's magnetic influence. Thus, by a legitimate effort of the imagination, we will prove the visible and tangible to the invisible and inapproachable; yet, in this case not altogether invisible, for these very curves you have all seen traced in space by the light of the aurora's beautiful beams. That these luminous columns of the aurora polaris lie in the curves of the earth's magnetic force, and, therefore, have their lengths in the directions of the dipping needle, at the points over which they appear, is a well established fact deduced from many observations and measures made on them. Thus "the well remembered aurora of September 2, 1859, formed a belt of light encircling the northern hemisphere, extending southward in North America to latitude 22½°, and reaching to an unknown distance on the north; and it pervaded the entire interval between the elevation of 50 and 500 miles above the earth's surface. This illumination consisted chiefly of luminous beams or columns, everywhere nearly parallel to the direction of a magnetic needle when freely suspended; that is, in the United States, these beams were nearly vertical, their upper extremities being inclined southward at angles varying from 15° to 30°. These beams were, therefore, about 500 miles in length, and their diameters varied from five to ten and twenty miles, and perhaps sometimes they were still greater."*

The discovery that the auroral columns coincide with the curves of the magnetic force was a noble one, and I have ever loved to dwell upon the very words in which such truths are given to the world; for thus the inspiration of the discoverer infuses itself insensibly into the soul of the reader, and leaves ineffaceable impressions of the simplicity, the dignity, and the comprehensiveness of science. This discovery, from its very nature, is the result of many accurate measures made on these beams, and only when it had been clearly shown that these measures agreed with the hypothesis of the aurora

* The Aurora Borealis, or Polar Light, its Phenomena and Laws, by Elias Loomis. Smith. Rept., 1865, p. 220.

being subject to the directive influence of the earth's magnetism, was it that the discovery was really made. This work is due to John Dalton, the illustrious founder of the numerical laws of chemistry, and his beautiful revelation affords another argument in the proof of the earth itself being a great magnet. Seventy-seven years before him, I find that Dr. Edmund Halley, of England, had imagined very clearly the same relation, but with Halley it only remained in the region of the imagination, for he never really found its embodiment in the material world. Dr. Dalton's discovery is found in his "Meteorological Observations and Essays, Manchester, 1793," from which I give these few lines of his simple language:

"A very moderate skill in optics was sufficient to convince him that as the luminous beams at all places appear to tend toward one point, about the zenith, they must, in reality, be straight beams, parallel to each other, and nearly perpendicular to the horizon; and from the appearance of their breadth they must be cylindrical."

*   *   *   "The length of the beams bore a very great proportion to their distance from the earth, even so as to equal, or perhaps surpass, the said distance."

"Thus stood the author's knowledge and ideas upon the subject in the autumn of 1792. The very grand aurora in the evening of the 13th of October was that which first suggested and led to the discovery of the relation betwixt the phenomenon and the earth's magnetism. When the theodolite was adjusted without doors, and the needle at rest, it was next to impossible not to notice the exactitude with which the needle pointed to the middle of the northern concentric arches. Soon after, the grand dome being formed, it was divided so evidently into similar parts, by the plane of the magnetic meridian, that the circumstances seemed extremely improbable to be fortuitous; and a line drawn to the vortex of the dome, being in direction of the dipping needle, it followed, from what had been done before, that the luminous beams at that time were all parallel to the dipping needle. It was easily and readily recollected at the same time, that former appearances had been similar to the present in this respect, that the beams to the east and west had always appeared to decline considerably from the perpendicular toward the south, whilst those to the north and south pointed directly upward; the inference was therefore unavoidable, that the beams were guided, not by gravity, but by the earth's magnetism, and the disturbance of the needle that had been heretofore observed during the time of an aurora, seems to put the conclusion past doubt. It was proper, however, to observe whether future appearances corresponded thereto, and this has been found invariably the case, as related in the observations."

We now give the previous surmises of Dr. Halley, contained in these extracts, from his very ingenious and suggestive paper, which I found in the transactions of the Royal Society, "An account of the late surprising appearances of the lights seen in the air, on the 6th of March last; with an attempt to explain their principal phenomena. Anno 1716."

"But without inquiring how sufficient the Cartesian hypothesis may be for answering the several phenomena of the magnet, that the fact may be better comprehended, we shall endeavor to exhibit the manner of the circulation of the atoms concerned therein, as they are exposed to view, by placing the poles of a terella or spherical magnet on a plane, as the globe on the horizon of a right sphere; then, strewing fine steel dust or filings very thin on the plane all round it, the particles of steel, on a continued gentle knocking on the under side of the plane, will by degrees conform themselves to the figures in which the circulation is performed. Thus, * * * by doing as prescribed, it will be found that the filings will lie in a right line perpendicular to the surface of the ball, when in the line of the magnetical axis continued. But, for about forty-five degrees on either side, they form themselves into curves, more and more crooked as they are removed from the poles, and more and more oblique to the surface of the stone. As the figure truly represents, and as may readily be shown by the terella and apparatus for that purpose, in the repository of the Royal Society.

"Now, by many and very evident arguments it appears that our globe of earth is no other than one great magnet. * * * It suffices, that we may suppose the same sort of circulation of such an exceedingly fine matter to be perpetually performed in the earth, as we observe in the terella, which subtile matter freely pervading the pores of the earth, and entering into it near its southern pole, may pass out again into the other, at the same distance from the northern, and with a like force, its direction being still more and more oblique, as the distance from the poles is greater. To this we beg leave to suppose, that this subtile matter, no otherwise discovering itself but by its effects on the magnetic needle, wholly imperceptible, and at other times invisible, may now and then, by the concourse of several causes very rarely coincident, and to us as yet unknown, be capable of producing a small degree of light; perhaps from the greater density of the matter, or the greater velocity of its motion, after the same manner as we see the effluvia of electric bodies, by a strong and quick friction, emit light in the dark—to which sort of light this seems to have a great affinity.

"This being allowed, I think we may readily assign a cause for several of the strange appearances we have been treating of, and for some of the most difficult to account for otherwise; as, why these lights are rarely seen anywhere else but in the north, and never, that we hear of, near the equator; as also, why they are more frequently seen in Iceland and Greenland, than in Norway, though nearer the pole of the world. For the magnetical poles, in this age, are to the westward of our meridian, and more so of that of Norway, and not far from Greenland; as appears by the variation of the needle, this year observed, full 12° at London to the west.

* * * "And whereas in this appearance (and perhaps in all others of the kind), those beams which arose near the east and west, were farthest from the perpendicular, on both sides inclining toward the south, while those in the north were directly upright—the cause of which may well be explained by the obliquity of the magnetical curves, making still obtuser angles, with the meridian of the terella, as they are farther from the poles.

* * * "But whatever may be the cause of it, if this be not, I have followed the old axiom of the schools, *Entia non esse temere neque absque necessitate multiplicanda.*"

The fact that the earth's magnetic and geographic poles do not coincide, at once leads us to suspect that the needle cannot, on the meridians point directly north and south. Its departure from this direction actually exists and was no doubt the earliest experience of those who first made the great discovery of the directive property of a suspended magnet. The first recorded use of this most valuable discovery appears among the Chinese, where we find that "an apparatus of this kind (called *fse-nan*—indicators of the south) was presented during the dynasty of the Tschen, 1,100 years before our era, to the ambassadors of Tonquin and Chochin-China, to guide them over the vast plains, which they would have to cross in their homeward journey. * * From its use on land the compass was finally adapted to maritime purposes, and under the dynasty of Tsin, in the fourth century of our era, Chinese vessels under the guidance of the compass visited Indian ports and the eastern coast of Africa."

The mariner's compass was certainly known to Europeans in the 12th century, for in the great library at Paris is a manuscript poem called La Bible Guyot, written by Guyot, of Provins, about 1190, in which he speaks of it as well known.

Guyot tells how a needle which has been rubbed by the *mariniere* will point to the pole-star, and in the dark nights, without star or moon, will guide the mariner on his course.

The fact that the needle does not point to the true north, at one place, was early known, but the discovery that it changed its direction with a change of place is generally attributed to Columbus; but this is incorrect, for the needle's departure from the geographic meridian (called its variation, or declination) is marked down for different points of the sea, on the atlas of Andrea Bianco, which was made in the year 1436; but what Columbus really did discover was a line of no variation 2½° east of the Island of Corvo, in the Azores, on the 13th of September, 1492.

Some time after this, about 1620, it was found that the needle did not keep one line of direction even in the same place, but slowly moved year after year. Thus it was found that in the year 1580 the north end of the needle at London pointed 11° 15′ east. In 1622 only 6° east; while in 1660 the needle pointed due north and south. There in 1730 it pointed 13° west; in 1765, 20° west; in 1818, 24° 41′ west; in 1850, 22° 30′ west, and in 1865, 21° 6′ west. Here we see in the needle a most remarkable motion, governed by some cause acting regularly through a long period of time, which, after having given it a swing from the meridian to its extreme westerly position, in 158 years, is now slowly, year after year, throwing it to the meridian on its easterly swing. Thus, in about 320 years, it makes one oscillation; and what is yet more remarkable is this—it follows the same kind of motion as a pendulum; for from the figures, you see that it moves faster and faster, until it gains the meridian; then it slacks its velocity and gradually comes to rest at its extreme easterly or westerly position.

Surely this is a most noteworthy fact and well worthy of being studied and remembered. To impress this on your minds I have devised an experiment which shows this phenomenon in all the peculiarity of its varying velocity. It is shown to you not only to exhibit this great law, but also to illustrate to you the extreme mobility, the constant fluctuation, the regular ebb and flow of some mysterious unknown action which we call magnetism. I have here a heavy brass ring of eighteen inches in diameter, weighing several pounds. Springing up from this ring are two metal semicircles which meet exactly over its center. Through this point of meeting passes a steel axis, pointed at its lower end, which rests in a cup of agate placed in the top of this wooden column. This axis is a powerful magnet, and I place it on the column, near this lantern, so that its pole and the center of the needle of the vertical lantern are in the magnetic meridian. You observe that the needle is at rest in that position while the axis of the ring is vertical. I now set the ring in rapid rotation, and, inclining its axis, I let it take care of itself. See how majestically it slowly tilts its ring around the horizon, always keeping the same angle to it, while at the same time its magnetic axis revolves and swings around a vertical line. Thus the magnetic pole of this axis, revolving in a circle, is now to the east and now to the west of the undisturbed position of the needle, and you behold on the screen the lantern needle, slowly swaying backward and forward, in subjection to the guidance of the revolving pole. And observe how completely it represents, in a few minutes, what takes place only through centuries in the grand cycle of the needle's variation. The axis, in revolving around the vertical, has now gained its extreme easterly position, and the motion is nearly in a line with the length of the needle, and therefore the latter is at rest; but now the magnetic axis is moving westerly and the needle keeps pointing towards its pole, and is moving faster and faster, until now the axis is sweeping directly across the needle's natural position. The needle is with a gradually diminishing velocity approaching the end of its western swing, and now is again momentarily at rest, for the revolving pole is running on the western bend of its orbit. Thus every swing of the needle follows the same law of motion as rules the vibration of a pendulum, which is also the motion of the magnetic needle as through 320 years it moves from one extreme side of the meridian to the other.

Various hypotheses have been formed to account for this wonderful phenomenon. As far as observations extend, they seem to show that the very magnetic pole of the northern hemisphere is revolving in a direction opposite to that of the hands of a watch around a fixed geographic point, just as you have in like manner seen the pole of this magnetic axis rotating around a fixed vertical line; and into this polar revolution the magnetic equator is supposed to tilt its plane around the terrestrial equator.* Thus the change of position of the magnetic poles and equator † cause constant movements in the lines

* Observations on the Magnet Orbit, by the Rev. H. Grover, London, 1850.

† See Sabine's Chart for years 1825 and 1837, in his Contributions to Terrestrial Magnetism, 1840. Humboldt, Cosmos, vol. i, p. 178.

of the earth's magnetic force, and the needle, as we know, ever keeps its length in these curves. But the object of this lecture is not to prove, to support, or to discuss magnetic hypotheses, and I do not give this experiment as defining my opinion as to the cause of the needle's variation; but I do give it as showing, in the most complete manner, this fact, the constant fluctuation, the ebb and flow of the earth's directive influence. For, picture to yourselves the magnetic curves of this axis as it sways around its circle; they move with it, and stretching beyond and enveloping yonder lantern needle, it obeys their bends and flexures, and thus, as a matter of fact, sway and bend the magnetic lines on the earth's surface, though the present cause and future manner of such action we may be ignorant of.

If an elastic rod is clamped at one end and bent from its natural position, its free end will vibrate with a regular motion like a swinging pendulum; but it is also found that this free end can at the same time have shorter and quicker swings, and carry these along in its main vibration. Thus, likewise, vibrates the magnetic needle, for this, in its 320 years' swing, does not steadily move year after year, or even day after day, but, as Graham found in 1722, makes in its ground vibration many minor trembles and deflections. Some of these follow regular laws, others are without all law, and are called perturbations. Among the former is the regular march of the daily vibration. This depends upon the apparent position of the sun, and therefore follows the local times of the meridian on which the needle is observed. In the northern hemisphere, the northern end of the needle, four to five hours before mid-day, has its extreme easterly position; hence it begins to swing with an increasing velocity, which attains its maximum nearly at the moment when the sun crosses the magnetic meridian of the station. One or two hours after the needle comes to rest, and soon after begins its eastward spring, and comes, with a slight secondary vibration, to its first position, about sunrise. The arc of the daily oscillation is small, only from 5′ to 25′, and its extent changes with the seasons, being nearly proportional to the arc described in the visible path of the sun. Thus, from Dr. Bache's observations at Philadelphia, the mean daily arc of vibration for the year is 7½′. For summer it is 10½′, and for winter it is 5½′. This daily vibration also increases from the magnetic equator to its poles. On the equator it is only 3′, while Dr. Kane found over 60′ at Rensselaer Harbor, north latitude 78° 37′.

Yet another cause, apparently removed from the earth itself, affects the magnitude of the needle's daily swing; which, strange to say, seems to depend upon the condition of the sun's surface. We owe this astonishing discovery to the labors of three men. First, Counselor Schwabe, of Dessau, Germany, began, in 1826, daily observations on the number, size, and position of the spots which are nearly always visible on the solar disc. With an admirable perseverance, worthy of his nation, he has kept these up for forty-six years. This long siege at last made the sun reveal the order of his changing appearance, and in 1850, Schwabe announced that the amount of spotted surface, which yearly appeared on the sun, followed a regular law, going through a cycle in about ten years. Thus, in 1860 the number of spots visible was remarkable; then in 1865 very few were to be seen; after this they became more and more frequent, until 1870 they again appeared in profusion. About the same time that Schwabe gave this discovery to the world, Professor Lamont, of Munich, announced that the daily range of the needle's vibration went through a similar cycle. Very soon afterwards Gen. Sabine, of England, discovered independently the same fact, which he deduced from magnetic observations made at places so far removed from each other as Toronto in Canada, and Hobarton in Van Dieman's Land, and was thus led to refer the cycle to some cause exterior to the earth, and then pointed out the coincidence of the ten year solar spot cycle, and that of the maget's daily range of deflection; which latter at Göttingen, for example, is 4′ more during the year of the greatest number of spots than during the year of the least.

But we have said that the needle is subject to unruly vibrations, coming at unexpected times, and affecting, simultaneously, magnets suspended at great distances from each other. These disturbances are often, though not always, accompanied by outbursts of the aurora borealis, and it has been observed that the regular flashes and lateral movements of the auroral columns are always accompanied by simultaneous deflections of the suspended magnet.

The direction of present research in these interesting problems is to find a relation of concurrence between the sudden changes on the sun, now visible by the aid of the spectroscope, and sudden deflections of magnets suspended at many points on the earth's surface. This problem, however, is yet far from solved, and I will therefore merely make this hint as to its attractiveness and its importance.*

Again let us return to the contemplation of our magnetic curves, whose paths have already conducted us to some very important truths.

* Explosion on the Sun, C. A. Young, Ph. D.; Amer. Jourl. Sci., Dec., 1871, 3d series, vol. ii, p. 468. Compare this with Magnetometer Indications on September 7th, by C. A. Young, Ph. D.; Amer. Jourl. Sci., 3d series, vol. iii, p. 69.

So valuable, indeed, is their guidance in nearly all precise and delicate research in magnetism, that their attentive study has become necessary to the further advancement of the science. Thinking, therefore, that a method by which they can be firmly fixed on glass plates, so that they can be securely kept for study and measurement, serve for lantern slide and photographic negatives, would be welcome to students of physics, I devised the following process. A clean plate of thin glass is coated with a firm film of shellac, by flowing over it a solution of this substance in alcohol, in the same manner as a photographer coats a plate with collodion. After the shellac film is hard, the plate is placed over the magnet, or magnets, with its ends resting on slips of wood, so that the under surface of the plate just touches the magnet. Iron filings, made from very soft Norway iron, are now uniformly sifted over the plate by means of a very fine sieve, and the magnetic curves are now developed by letting fall, at different points on the plate, a light copper wire. The glass is now lifted off the magnet and placed on the end of a cylinder of pasteboard, which serves as a support in bringing it near the under surface of a hot metal plate. Thus the shellac is uniformly heated, and the iron filings, absorbing the radiation, sink into the surface and are fixed. The plates can now serve (1) for the most accurate measures upon the magnetic field; (2) for a photographic negative, which in the printing-frame will produce the lines in white upon a dark ground, giving most beautiful and distinct impressions; or (3) they can be used as "slides" for the lantern, and plates can thus be secured for exhibition to the largest audiences; and this is important, for it is not easy to obtain the best results in the quick experimentation required in a public lecture.

My assistant will now place in the lantern a plate which has fixed on it the curves of a straight bar magnet. Some of you will recognize this as the original plate of the engraving which illustrates Professor Tyndall's recent work, "Fragments of Science." From a photographic print from this plate Dr. Tyndall made his engraving.

Many philosophers have studied long and attentively these graceful sweeping curves.* You may ask, what can one arrive at by brooding over these forms? Let us see. As you know, a magnetic needle carried along a curve will always point in its direction,

* Gilbert, Physiologia Nova de Magnete, 1600. Munchenbroek, Essais de Physique. Fuss, Coment, Petropolit. Lambert; Hist. de l'Acad. Roy. Sci., Berlin, 1776. Playfair. Robison's Mech. Phil., vol. iv, p. 350. Leslie, Geometrical Analysis, Edin., 1821, p. 399. Dr. Roget, Jourl. Roy. Inst., vol. i, p. 311, 1831, and in Nat. Phil. of Lib. Us. Know., vol. ii, article Magnetism, p. 19. Cellerier, in De la Rives Traite d'Electriate, vol. i, p. 592. Faraday, Phil. Trans., 1852, p. 1. Pro. Royal Inst., Jan., 1852.

therefore these curves indicate the lines in which the directive force of the magnet acts, or, as philosophers are pleased to state it, they are the lines of resultants of the actions of the magnet, for the iron filings which trace them, are, when under the inductive action of the magnet, little magnets, and therefore they trace these lines exactly as the tiny needle did in our previous experiments, when you saw it always placing its length in the direction of a curve. But they indicate more, far more, than this. That wonder of experimental fertility, Faraday, in 1831,* made this remarkable discovery, probably the most subtile and far-reaching insight yet made into the mysteries of nature. He found that when a wire was closed on itself, forming what we call a circuit — that is, a metallic path along which electricity can pass — he found that when such a wire was passed along these curves, that is, without cutting any of them, that nothing happened, no electricity flowed through the wire; but, when this wire cut across any of these curves, then a current of electricity traversed the wire, going round and round as long as the wire was moved so as to cut these lines. Also, when the wire was moved, only in one and the same direction, then the electricity went in one direction through the wire, but, when the motion was reversed, the direction of the current was reversed also.

By this wonderful discovery — the production of a current of electricity from a magnet — the name of Faraday will ever remain illustrious. He did many good things, but this excelled them all. With a master's hand he traced the strong, broad outlines of the truth, and forty years' philosophers have pondered on these facts and have made thousands of experiments, yet have failed to fathom their full significance.

Faraday termed these curves "the lines of magnetic force," and wrote much of them. Their contemplation constantly suggested and directed his researches; and one of his last papers was devoted to calling the attention of philosophers to the deep insight which their study would give into the manner of action of other radiant forces.

Let us consider them with more minuteness. You observe that this is the axis, or the center line of the magnet; those lines run off in its direction; these appear to radiate or spread out, fan-shape, from its end, and when traced back they all converge to a point on its centre line, called its pole. While these, which are further removed from the axis, curve slightly in their upward or downward path, those nearer

* Faraday, Exp. Resear. in Electr., London, 1849; vol. i, p. 7. Royal Society, Trans., 1832. Phil Trans., 1852.

the center are yet more curved, and, following their direction, they lead us to points on the other end of the magnet, corresponding to those from which they emanated. But they all are curved, and have their origin in the axis of the magnet, and return to points on the other side of its center, symmetrically placed with those from which they emanated.

Viewing these lines, we are immediately struck with their analogy to the rays of light radiating from a luminous point, and would, therefore, naturally infer that the force expands itself in like manner, and produces less and less effect on one and the same surface as we recede from the magnetic pole. Experiment shows the truth of this conclusion; for we find that, when we quickly cut across these lines, always making one and the same sweep, the force of the electric current in the wire diminishes as we recede from the pole, just as the brightness of a light diminishes as we recede from it. But, in the case of light, if the rays are parallel, the brightness remains the same, whether we are at one foot, a thousand feet, or several miles from the point of origin; so, in the case of the magnetic lines, if they are parallel, the magnetic intensity, as evinced in the electric current, remains the same at all distances. Also, if the rays of light converge, the brightness increases as we approach their point of confluence; so with the magnetic rays, their magnetic effect on one and the same body increases as we near the point of their convergence. Moreover, if a beam of light of parallel rays has twice the diameter of another (from the same source), then the quantity of light in the first will be four times that in the second beam; likewise is this the case with a bundle of parallel rays emanating from the magnet, a beam of twice the diameter of another giving a fourfold quantity of electricity. Thus is completely established an analogy between these magnetic lines and the rays of light; a fact easy to remember, and of great significance in all reasonings and researches on magnetism. But we can establish the main facts I have given for ourselves; and this I now propose to do by experiment.

However, before we can attempt these experiments, it is necessary that we should clearly understand the experimental method by which we detect the presence of a current of electricity in a wire, determine what we call its direction, and ascertain its strength. All of these facts, of such fundamental importance for our further progress, are obtained by observing the deflections which a magnetic needle experiences whenever a wire carrying one electric current is brought in its vicinity. This most important discovery was made by Œrsted, of Copenhagen, in 1819, and since then many instruments called galvanometers, that is, measures of galvanic currents, have been devised by applying the following facts.

You observe on the screen the magnetic needle, supported on its steel point, around which it turns with the greatest ease. I will now bring quite close over it this copper wire, and stretch it in the direction of the needle, north and south. You now see on the screen the wire, one end only of which is at present connected with this small galvanic battery; when the other end is likewise connected, an electric current will pass, as we say, through the wire, and the needle will move. I now join the other end of the wire to the battery; look how the needle swings around, tending to place itself athwart the wire. If I place the wire below the needle, observe it swings in the opposite direction. Also, if the wire remain either above or below the needle, and I reverse the current, then the direction of rotation of the needle is reversed also. Therefore, if we pass a wire around a magnetic needle—enclosing it many coils—we have a most precious instrument, in which the direction of the needle's deflection shows the direction of the current, and the amount of the deflection shows the amount of the current.

But, as you have observed in these experiments, the wire is either above or below the needle, and to render the latter sufficiently responsive to an electric current, the wire has to envelop it with many coils; but such an arrangement will completely hide from sight the motions of our lantern needle. How, then, can we show its motions to so large an audience? The idea of using a galvanometer in this lecture weighed heavily upon me after I had decided to work before you, for heretofore the usual method of exhibiting the motions of a galvanometer needle consisted in attaching to it a light mirror, and observing the motions of a beam of light reflected from it on to the screen. A faint patch, or brighter band of light, on a screen, and the inadvertent approach of somebody's jack-knife, or the handling of some distant magnet, in an experiment, and this patch of light is off the screen and probably brought again to subject itself to our service, after your patience and my lecture's continuity are lost. It was evidently imperative that a new method of exhibition should be devised, and the result of the investigation is this galvanometer, which keeps the image of the needle itself always in full view, and exhibits and measures its smallest swings as its ends course round the divided circle you now see on the screen.

The plan of this instrument can be explained in a few words. You here see another vertical lantern, whose sides are made of thin mahogany boards, so that the circumstances of this horizontal condensing lens, *c*, over which is placed the graduated circle, and the magnetic needle may come as near as possible to the two vertical spirals S and S, each formed of about fifty feet of $\frac{1}{10}$ inch copper wire. The two spirals, you observe, are so connected by a short copper wire that a current of electricity revolves through both in the same direction. Whenever this takes place, the needle which swings between them instantly turns on its center, and from the direction and amount of its rotation, we have the direction and amount of the electric current. Under the needle is this inclined mirror, M, which sends the rays from this lime-light up through the graduated circle to the lens, L, whence they issue to be reflected from the swing-mirror, R, on to the screen, where you now see the enlarged image of the needle inclosed in the graduated circle. But a magnetic needle kept in its meridian by the entire directive power of the earth would require a strong amount of electricity to move it, and hence the usefulness of this lantern galvanometer would be very much restricted. To render its needle more sensitive, we neutralize the earth's directive action on it by means of these two large bar magnets, A and B, which you observe on this board which forms the base of the lantern. The poles of these magnets point in the same directions as the similar poles of the needle, and thus they oppose the earth's directive action on the needle. By approaching the magnets to the lantern the needle is rendered more sensitive to the current, and by rotating one or both of these magnets in a horizontal plane, we can immediately balance the magnetic disturbances inevitably produced in the course of these experiments; such, for example, as happen whenever we bring into action our great electro-magnet; and thus, we have both the sensitiveness and the direction of the needle entirely under our control. Without the aid of this instrument, the experiments which I will shortly make could not have been exhibited to you, and I therefore need hardly remark that this is the first time they have been solved in a public lecture. It was bold to attempt experiments of such finesse, but perseverance has crowned them with success, and it delights me to have the privilege of showing you their exquisite beauty, which I will now proceed to do.

You will notice that the two iron cores of our great magnet are placed but to but, thus forming one bar of seven feet in length; its ends are terminated with those iron cores, which you observe projecting beyond the spools of wire which envelop all the rest of the bar. Close behind the magnet is this large screen. I now place in another ordinary lantern this glass plate, on which I have fixed the curves of a small magnet, whose form was exactly proportioned to the length and diameter of that long iron core of the electro-magnet. You now see on the screen the greatly magnified image of these lines, which appear to me actually as if formed by that electro-magnet, on filings which have been spread over the screen, but to those at a greater distance they seem to emanate from the core of the magnet, for the axis of the image of the lines and the axis of the magnet coincide. These lines, therefore, can serve as accurate guides in working with the magnet's actual influence at a distance.

I hold in my hand a light wooden rod, attached to whose end is a wing of eighteen inches in diameter, formed of thick copper wire. Part of a long wire was bent into this ring, and the remaining lengths were carried down the sides of the rod and firmly tied to it. On the ends of the wire I fasten these binding-screws, from which wires can be led to the galvanometer lantern. Thus I have made an electric wand, as wonderful as that of Prospero, for with it I also can catch the stuff that lightning is made of, and send it where I will. We will now begin work on these lines, or rather on what they so clearly map out, the rays of directive influence surrounding this huge magnet.

There are two ways in which I can cut through these "lines of force." First, we can, as you see, do so by moving this ring's center over the line which is the prolongation of the axis of the magnet; thus, or secondly, by rotating this ring around an axis, thus—and I cut the lines fore and aft. By rotating this ring around any axis I can cut these lines as well; but I beg you to remark that during the following experiments, in which I will explore the magnetic condition of the space surrounding this bar—I will only rotate the mass I use around a vertical axis. The reason of this will soon be made evident to you. The plane of the ring now stands at right angles, square with the length of the magnet, and observe the lines appearing to go through it. My assistant will now connect the ends of my wire-wand with the conductor leading to the galvanometer. I will now move the plane of the ring toward the pole of the magnet. See how the galvanometer needle responds; its marked end moving upwards. The needle has now come to rest at its first position, though the magnet is active and the ring is, as during its motion, connected with the galvanometer, I wish you to remember this fact. I now move the ring away from the magnet; and observe how the needle moves as I recede, and it now rotates in the opposite direction to what it did when I approached the magnet. I will now rotate the ring around a vertical axis, in the direction in which move the hands of a watch. The needle at the same time moves its spear end towards the ceiling. I reverse the motion of the ring's rotation and the direction of the needle's deflection is reversed also. Thus we have found that whenever the ring moves so as to cut the magnetic lines, an electric current is driven through it; and on the direction of translation or of rotation of the wing depends the direction of the current.

We will now gradually recede from the magnet, moving in the direction of its axis, and rotate the ring at various points of our progress. Here the needle, you observe, is not swung over so many divisions of the circle as when we revolved the ring at our previous station; therefore the magnetic influence is diminishing. I remove yet further and the needle swings less than before. I do not know that I will get any deflection whatever at this distance; yes, but very little; the needle just nodded. Here, however, the needle responds to no motion that I give the ring. So far, then, extends the magnetism outward from that iron bar, but no farther. But may it not be that it is really here also, but that our means of detecting it only extend thus far in their indications? To test this supposition I will lay aside this ring of one turn of wire, and take up another, which is really a coil of nine turns of wire, and has a diameter of about eighteen inches. Nine wires will now cut twice the area of magnetic rays. Yes, the needle is deflected, and it replies even here—and here, but at this distance it barely moves; and here, the needle again refuses to notice the ring's rotation. But have we yet reached the boundary of the magnetic envelope of that bar? I will try again. I replace this coil by another, two and a half feet in diameter, and containing forty turns of 300 feet of $\frac{1}{30}$th-inch wire. I now hold this in a vertical position, with its plane perpendicular to the axis of the magnet. The ends of its wire are now connected with the galvanometer, and I rotate it about a vertical axis. Look; the needle moves. I recede to this position; even here the needle vibrates. I retreat to the extreme end of the stage, and even here the needle swings with the swing of the coil. But I can exalt the sensitiveness of the galvanometer a hundred fold by wrapping a coil of thick wire quite close around the needle, and then I can go to the farthest corner of this room; I can descend into the cellar, or place myself upon the roof; and yet, in all of these positions, the needle will swing to the revolution of the coil. The whole space inclosed by the walls of this house contains—is permeated with — something. It goes through your clothes, it penetrates your bodies, and saturates your brains. It must do so; something must be all around us and within us, for surely out of nothing I cannot evolve something — a current of electricity; and a current of electricity is surely something; it is everything, physically considered; for it is a force, and will do work; it is a power; the product of the motion of the wire; for, without its motion, the current will not be produced, and, whenever the current is produced, a break is placed on the motion of the wire, it requiring more force to turn the ring when the current traverses it than when it does not. In other words, part of the force which urges the rotation of the wire disappears in it, but reappears in the motion of that needle, and in the electric wave which traverses the galvanometer and these conducting wires. "But," as Faraday observes, in speaking of these phenomena, "mere motion would not generate a relation which had not a foundation in the existence of some previous state; and, therefore, the *quiescent* metal [the ring] must be in some relation to the active center of force" [the Magnet]. "He here," says Tyndall,* "touches the core of the whole question; and when we can state the condition into which the conducting wire is thrown *before* it is moved, we shall then be in a position to understand the physical constitution of the electric current generated by its motion." Yet, is there not something existing in and around the wire "before it is moved," and through which, in moving, the wire experiences a resistance? And does not the magnet either send out this something, or exert on something previously existing around it, a peculiar action, which action constitutes the propagation of its distant effects? Surely, in the language of Newton, "that one body may act upon another at a distance, through *a vacuum*, and without the mediation of anything else, by and through which this action and force may be conveyed from one to another, is to me so great an absurdity that I believe no man who has, in philosophical matters, a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly, according to certain laws; but, whether this agent be material or immaterial, I have left to the consideration of my readers." Yes, the whole of this building and the neighboring streets are permeated with something — immaterial or material, I know not — emanating from this magnet, or acted on by it. The street cars have run through it while I have been lecturing, and pedestrians have cut it with their legs in walking. What it is, I know not; we *call* it magnetism.

* Faraday as a Discoverer. Amer. ed., p. 132.

But if "the earth itself is a great magnet," it also must affect surrounding space — stretching thousands of miles from its surface — with this magnetic influence. The dipping needle has shown us its lines of force. These lines, stretched above this stage, show as truly the direction in which its magnetism acts, as this plumb-line shows the direction in which gravity acts. If a dipping needle were carried all over the area of this city it would be found everywhere to point parallel to these lines. Let your imagination lead your minds along their paths into their heights above us, just as we have seen the long streamers of the polar lights tracking them out for us.

But if all this be so, then why can we not evolve a current of electricity from the earth's magnetism, as we did from yonder magnet? That, indeed, would be a grand experiment? Let us hasten to try it. Here I have a coil of 300 feet of copper wire wrapped in a circle of 2½ feet in diameter. I place it thus, so that the earth's magnetic lines pass through its circle. You observe that its plane is at right angles to the direction of these stretched cords. The conditions, therefore, are absolutely those which we had when experimenting with the electro-magnet. Now, how will I cut these terrestrial lines? By rotating the ring around a north and south axis, just as we rotated this same coil around a vertical axis, when we obtained an electric current from the large magnet. The ends of the coil are connected with the galvanometer, and now look at the needle on the screen while I turn this ring. See, it moves; a current of electricity has passed round the coil and out of it into the galvanometer.* Consider the simplicity of the apparatus which has given us the astonishing result. Nothing but a coil of wire and a galvanometer. No battery used, as in the experiments which explained the galvanometer to you. No magnet near, as when we got a current from that one. Yes, no magnet near — but the earth. For now I can boldly say, "the earth itself is a great magnet," and not only a great magnet, but a strong magnet. Let us put it against our magnet. How far will we be obliged to remove ourselves from it to obtain the exact degree of deflection in that needle which the earth has just given? Then we can compare them; for, at the distance of so many feet from the poles of our electro-magnet (the coil being, in reference to its poles, similarly placed with reference to the earth's), the force it sets in motion in this coil exactly equals the force which the earth, at some thousounds of miles from its poles, sets in motion in the same coil. Let us make the calculation. Suppose we find from experi-

* Farady, Exp. Resear. in Electr.

ment that the force decreases, in its action, as the squares of the distances we recede to, from the magnetic poles; * that is, at a distance of ten feet, say the force is one; then at twenty feet it will be one-fourth of what it was at ten feet; and at thirty feet it will be one-ninth, and so on. Hence, the strength of our large magnet is to the strength of the earth's magnetism as the distance of the coil from the poles of the electro-magnet is the distance of the coil from the poles of the earth. By such a rough measure we will gain some idea of the enormous magnetic effect with which the earth influences surrounding space. Gauss, the illustrious German astronomer and natural philosopher, calculated this quantitiy, and taking as the unit of his measure a magnet of the size of this I hold in my hand — which is fourteen inches long, one inch wide and one-fourth inch thick, and weighs one pound — he found that the earth's magnetism is equal to 8,464,000,000,000,000,000,000 such magnets. That is, to this number of the hardest steel magnets, each weighing one pound, and made as strongly magnetic as possible.

But if the earth contains all this magnetism, from which we have a current of electricity, is it not likely that some of our previous experiments with the electro-magnet were vitiated by this earth-current coming into our coil? This supposition explains why I always rotated the coil around a vertical axis; for, look, when I do so I do not deflect the galvanometer needle, for I do not cut the magnetic lines in such a manner as to develop a current that can flow out of the coil, because the current in one-half of the circle of the coil is opposed to that generated in the other half, and they therefore neutralize each other.

In the experiments you have just witnessed, the electric current from the earth's magnetism produced a deflection of only 15° to 20° in the lantern needle; but if I connect this coil with the delicate galvanometor in my laboratory, I cannot lift one side of it six inches above the table, thus, without giving the needle a deflection of 20°, and if I place the coil in a vertical plane, and tilt eight inches toward the horizon, the needle swings through a quarter of its circle. With this coil and sensitive galvanometer, the difficulty is not to produce these currrents from the earth, but it is to prevent them from continually mingling with the other effects of your experiments.

* Tobias Mayer — in an important unpublished paper, read before the Roy. Soc. Gottingen, referred to by Lambert — showed, in 1750, that the law of variation of the magnetic attraction corresponds to that of gravity. Lambert, Hist. Acad. Roy. Sci., Berlin, 1776; "a memoir," says Robinson, which, "would have done credit to Newton himself." Coulombe, Roy. Acad. Sci., Paris, 1786 and 1787.

The earth is indeed a powerful magnet. Then why not use the electric current we have evolved from it? Let us put it in harness and make it work for us. But to swing this coil is laborious, and to facilitate this I will strap it on this large wooden ring, and now we literally have it in harness. Let not this simple mechanical intervention between the coil and the galvanometer perplex you; in fact, it is only here to enable me to give a continuous revolution to the coil, and, by means of this brass circle, and these metal bands to which its ends are connected, to cause the current evolved in it always to issue from the same end of the coil. This current of electricity, continuously evolved, can do many things; it can give out heat and light, and rend the elements of matter asunder; but the grandest application of electricity is to convey thought; and why not convert our apparatus into a telegraph? Here, in this ring, is the generator, which produces an electric current directly from the earth's magnetism. Here is the wire leading to the distant galvanometer. Here I separate the wire and reconnect through a telegraph key, and behold "a needle telegraph." This wheel is now turned, and look! the needle goes from 0° up to 90°, and now it stands steady at 80°. We can easily make an alphabet. Let one deflection to the left mean A; two, B; three, C; one to the right, followed by one to the left, D; one to the left, then one to the right, followed by one to the left, E; and so on. Thus we can form a series of signals that will spell out whatever we desire, and the galvanometer can speak for us through the deflection of the needle produced by the magnetic-electric currents of the south. Now I will bring the needle to from 0° to the left; it is coming to 0°, and now I hold it there by rotating the coil, and thus opposing its motion. I now deflect it, one to the right, then one to the left, and so on. You see we have actually telegraphed with a current from electricity, and evolved from this great magnet, the earth.

Now we have finished our experiments, and what have they shown? I have temporarily magnetized a bar of soft iron, by pointing it toward a pole of our large magnet. I did the same with the bar and the earth. I permanently magnetized an iron bar by directing its length toward the pole of the magnet, and vibrating it with a blow of a hammer. I did the same with a bar, struck when pointed toward the earth's magnetic pole. I have shown you the action of a small magnetic disc on iron filings placed above and around it. You saw that the earth produced the same action on the beams of the aurora. I showed you the action of this disc on a freely suspended magnetic needle; and pointed out to you the earth's similar action on a dipping needle carried over its surface. I have evolved a current of electricity from a magnet by cutting with a closed conductor across those lines in which a magnetic needle freely suspended places its length. I did the same with the earth by cutting across those lines which are marked out by the pointing of the dipping needle. Therefore, what am I authorized to infer? When the effects are the same, the causes must be the same; for, according to all the principles of philosophy, and conformable to that universal experience which we call common sense, like causes produce like effects.

Have I not shown you that the earth is indeed a great magnet? But I hope I have shown you more, much more than this; for I trust I have given you an insight into those methods by which men of science work out great truths. Truth, of all value in itself, simply because it is truth, irrespective of any practical application it may contain. Yet the process by which we have been led to such grand results teaches even more than I can express; and I retire behind the true eloquence of the great master of experiment, and leave you with these words of the good Faraday: "We learn by such results as these what is the kind of education that science offers to man. It teaches us to be neglectful of nothing; not to despise the small beginnings; they precede, of necessity, all great things. Vesicles make clouds; they are trifles, light as air, but then they make drops, and drops make showers, rain makes torrents and rivers, and these can alter the face of a country, and even keep the ocean to its proper fullness and use. It teaches a continued comparison of the small and great under differences almost approaching the infinite, for the small as often contains the great in principle, as the great does the small; and thus the mind becomes comprehensive. It teaches to deduce principles carefully, to hold them firmly, or to suspend the judgment, to discover and obey law, and by it be bold in applying to the greatest what we know of the smallest. It teaches us first, by tutors and books, to learn that which is already known to others, and then, by the light and methods which belong to science, to learn for ourselves and for others; so making a fruitful return to man in the future for that which we have obtained from the men of the past. Bacon, in his instruction, tells us that the scientific student ought not to be as the ant, who gathers merely, nor as the spider, who spins from her own bowels, but rather as the bee, who both gathers and produces."*

* The Life and Letters of Faraday. By Dr. Perce Jones. London, 1870, vol. ii, pp. 403, 404.

SCIENTIFIC LECTURE—IV.

SOUND: THE VOICE AND THE EAR.

By Professor Ogden N. Rood, of Columbia College, Dec. 28, 1871.

Probably every person who is present to-night has at some time stood on a sea beach, and watched the long lines of advancing waves as they swept inward, only to be followed by others, in a perpetual monotonous succession, so that it seemed as though the ocean was actually sending toward the coast vast masses of water from its inexhaustible magazines. But this beautiful appearance, like so much else in our world, is partly illusory; the water is *not* transported toward the coast, and, if the tide happens to be ebbing, it may have a real though slow motion away from it. The waves are produced merely by a momentary *heaping up* of the drops of water, along a great line parallel to the shore; an instant afterward the drops fall to their old level, and you say the wave has passed that spot.

Can, then, a mere up and down motion produce the appearance of an advancing wave? Yes, if that motion be executed *in suitable time*, as I will show in an instant; but let me first add, that the motion we are considering can also be *reversed;* the wave, after it has struck on a precipitous rock, is driven back from the shore, travels outward to the regions that gave it birth, its drops of water, meanwhile, remaining near their original positions, moving, for the most part, only *upward* and *downward.* When this reversal of the wave's motion occurs, we say that the wave of water has been *reflected*, just as the infinitely smaller waves we call light are reflected from a mirror.

Now, this transmission and reflection of a wave I can easily show you, under circumstances which forbid the idea of any motion of transportation. I have here a very elastic cord or rope, made of brass wire wound in a long, thin spiral, and when I strike it with my hand vertically, you see the wave which runs along its whole length, and then, meeting an obstacle in the hand of my assistant, who holds the other end of it, is reflected, returns to me, is again reflected, and so on, a number of times. But the particles of brass, in this experiment, are moved neither forward nor backward, they simply rise and fall.

Perhaps this fact may be made still more evident with a little apparatus I devised years ago. We now have on the screen a row of small bright spots, intended to represent a line of material particles at rest. I can communicate to them a wave-like motion; you see distinct waves advancing along their whole length, and, although these waves are so plain, pray notice that each particle merely rises and falls, *in suitable time.* Hence, to sum up, in the case of a wave of water, it is the *motion* which advances, not the material, and this advance of the motion may be brought about, as we have seen, by a movement of the material particles *at right angles* to the direction of the advancing wave.

Strangely enough, there is another kind of motion, which can be communicated to a row of material particles, which also will generate along them waves, but waves of a different character. In these new waves, which will give us so much occupation to-night, the particles are not pushed aside out of line, as in waves of water or light, but at one instant are *crowded together*, and afterward *fly apart*, remaining, however, always in the same original line. I have contrived a little piece of apparatus which will make the nature of this singular action evident. We have upon the screen a row of spots of light, representing material particles, and you readily see how this alternate *condensation and expansion* affects them, and it is plain that they are transmitting a series of wave-like impulses. If you select any individual particle for observation, you easily notice that, at one instant, it presses nearer its neighbors, and the next retreats from them, each particle beginning and ending its swaying motion *in such time* that the general effect is that of a wave in motion. I gave an experimental illustration of the first class of waves with the brass cord, and will now add that its spirals will just as easily transmit the waves we are now considering, though, of course, you do not see them. If you should hold the end of the cord, you would, however, be able to feel them, for, when they struck your hand, they would give it a little push and a pull. This thin elastic box will answer our purpose. I attach the end of the cord to it, and send along it one of these waves. As it strikes the box, a sharp, distinct sound is produced, in fact a series, owing to repeated reflections of the wave, which I generate merely by pulling back with my finger-nail for an instant one of the spirals.

The air with which we are surrounded is capable of transmitting such waves as these, and, when they strike upon our ears, we say we hear a sound. I cannot at all, to-night, even indicate the experiments and reasoning which, many years ago, forced physicists to believe in the existence of these sound-waves, which they had never seen and never hoped to see. But, perhaps, we may do better than thus to consume our time. Let us ask ourselves what ought to be the appearance of one of these sound-waves, out in the free air, and we will suppose, for simplicity, that it is produced by a single impulse. You know that, when a stone is thrown into a quiet pool of water, the wave which is generated is *circular;* it expands itself over more and more surface, but always retains the form of a circle, and analogy tells us that our sound-wave ought also to expand in a circle; that this circle should exist not only horizontally, but upward, downward, in all directions, or that our wave ought to be bounded by a great many such circles. Now, bodies which are thus bounded we call spheres; the sound-wave ought, then, to be round, like a globe, and we must think of it as a kind of hollow bubble, which is swiftly growing larger. So much, theory would indicate.

Wonderful as it may seem, the recent advances of science have actually placed in our hands the means of rendering visible these waves of sound; and, although it would be quite out of place for me on this occasion to enter into a detailed account of the method by which this magical triumph was achieved, still, you may be interested in a few hints with regard to the general line of thought followed by Professor Toepler, to whom we owe these beautiful observations.

A sound-wave consists, as we have seen, of a layer of air which is more, and of another which is less compressed than the surrounding atmosphere; in fact, of a layer of *denser* and *rarer* air. Now, when light which is traveling through the atmosphere meets with a denser or a rarer layer, it is usually turned a little out of its straight path; a very little, but enough sometimes to render the layer actually visible, if proper optical means are employed. Let me give a rough experimental illustration of this: All the lenses of the magic lantern have been removed, and the screen is illuminated by rays of light which emanate from the ignited lime; that is, which come from one point. The bottle in my hand contains a few drops of sulphuric ether, and the upper part of it is filled with its vapor, which, as you know, looks just like the air, that is, it is invisible, is in fact a kind of air itself, but *denser* than our atmosphere. When the bottle is uncorked, I can pour out this dense air, and you notice, on the screen, how the divergent beams of light render it visible; we see it streaming out, floating away, and can follow the wavy fluctuations it is subjected to by currents of air. If I had used the hot, rarer air which streams up from a candle flame, it would have been equally visible, at a distance of many inches above the flame itself.

In our experiment we plainly saw the layers which were denser than the atmosphere, by the aid of deviation of the light which they caused; and it is very evident that if we could only isolate just the particular rays concerned, getting thus rid of the overpowering glare of the unaffected light, the whole phenomenon would have been far more distinct. Toepler contrived to do this very thing, by the aid of a peculiar screen, and thus was able to deal with the far more subtile variations in density involved in the case of a sound-wave.

But a steady light, like the one we have employed, would have been of no use in such an experiment; the sound-wave travels as fast as a cannon-ball, and a light of this character would render visible neither one nor the other. It should be illuminated by an *instantaneous* flash of light, so that the wave would not have a chance to move perceptibly while lighted up, and for this purpose the electric spark was just what was wanted. Let me make an experiment to illustrate this point. We have before us a disc six feet in diameter, which is being turned so rapidly that you cannot see the design painted on it; the disc looks merely gray. The gas-lights having been turned down, I illuminate our swiftly spinning disc, from time to time, with the electric spark; it seems to stand still, and you readily see that it actually is painted in great black and white sectors. This talented young German physicist used then the electric spark to illuminate his sound-waves, and the snap of a second electric spark to generate them.

We have now upon the screen the greatly enlarged representation of one of these waves, as seen by Toepler's method; it is spherical, as we expected, and beautifully shaded.

Still more remarkable is the circumstance that this physicist also succeeded in observing the *reflection* of a sound-wave against a solid body. My copy of one of his drawings is on the screen, and you can see that the reflected portion is likewise spherical. Finally, after many efforts, he was so fortunate as to be able repeatedly to observe the transmission of a sound-wave from a dense to a rare gas, that is, to see a sound-wave *refracted*. This also is now before you on the screen; the wave leaves the air, and is entering hydrogen gas, and notice how the broken curve indicates that it travels faster in hydrogen than in the air; also observe the faint reflection which has taken place at the surface of the hydrogen. Hence, it is plain that Toepler's observations are in perfect harmony with the ideas long ago developed by the theory of wave-motion.

Let us pass on to another point. Waves of water, as you well know, differ much in length, the great ocean waves stretching themselves out a hundred feet and more, while the tiny wavelets in quiet water often measure less than an inch. So it is with sound; the deepest tones of the organ, which are almost felt rather than heard, are produced by waves thirty-two feet long, while the shrill sounds emitted by a child's whistle are due to waves only an inch or two in length. The *pitch* of note depends on the length of the wave; low notes are given by long waves, high notes by those which are short. I have here a couple of flute organ-pipes, which are so contrived as to furnish aerial waves of about twice their own length. This two-feet pipe is now sending through the house waves that are about four feet long; and, when we compare them with the waves furnished by the shorter pipe, we notice that the latter note is just an octave higher than the first. The long and short waves travel, however, with the same velocity; and, when I sound the two pipes together, both notes reach your ears at the same instant, and this would happen if you were a hundred times more distant from me. But, in order to do this, the short wave must take twice as many steps as its longer companion; it must, in the same period of time, *execute twice as many vibrations;* hence, finally, when long waves strike on the drum of the ear, they cause it to vibrate slowly, while shorter waves compel it to vibrate more rapidly.

This leads us to the remarkable conclusion, that if, by *any* means, we cause the drum of the ear to bend inward and outward, or to vibrate slowly, we shall perceive a low note, while, if the process be carried on rapidly, the sensation will be that of one which is high. I have here a brass wheel, originally contrived by the celebrated Savart, with its rim cut into teeth, and can cause them to strike, one after the other, on this visiting card; when this is done slowly, the separate taps are distinctly audible over the whole house, but, as I quicken the rate, the taps follow so swiftly that the ear fails to recognize them individually, and we have in their place a musical note, not quite pure, which, as you notice, rises and falls as I change the rate of the wheel's rotation. If this alteration in rate is effected rapidly, the sounds may be made, as you hear, to resemble human cries, not unlike those of infantile distress or anger. These sounds are sufficiently ludicrous, I admit; but they have for us a deeper meaning; they teach us that, in this *purely mechanical way*, out of the taps on a card, it is possible to build up sounds which bear some resemblance to those uttered by human beings.

I wish, in the next place, to make an analogous experiment, in which the resemblance to musical notes will be more complete. The little piece of apparatus I have in my hand is so contrived that, when set in operation, it allows the air to pass through it in puffs, like those of a tiny locomotive. With the organ bellows I drive a current of air through it, and now, leaning over it, I hear a succession of these puffs, which, as the current of air is increased, will follow each other more rapidly and also gain in strength. We have, at last, a deep musical note issuing from it, which, as you notice, rises regularly in pitch each instant, becoming at last quite shrill and loud. The instrument was contrived by Cagniard de la Tour, and is called a syren, because it is capable of uttering its musical tones under water. It is provided with an attachment, by which I could easily count the number of puffs emitted in a second, and thus determine the number of impulses due to a given note, and, hence, knowing, as we do, the velocity of sound in the air, easily measure the length of the wave producing that note.

But we must pass on to the consideration of another matter, and will return once more, for an illustration, to our waves of water. While out at sea, those of you who were able must have noticed that the large waves of water which lifted and rolled the ship were, for the most part, not simple in form, but covered with minor wavelets which curved their surfaces with ragged and ever-changing outlines. They demonstrate for us the possibility of the coexistence of two or more sets of waves, and show us the manifold forms assumed by water acted upon by several independent wave-like impulses. I have in my hand a large tuning-fork, which is vibrating in a certain way, and, by drawing the fork over this smoked glass, the little wire attached to it renders these vibrations visible, and we have them now delineated on the screen under the form of a straight band, which consists of a multitude of minute waves. But I can also communicate to the fork a second motion, still preserving the first, and you see it has traced on the screen a series of larger waves, whose mountains and valleys are built up of the little undulations. Just so it is with the waves of sound. They are often, indeed almost always, thus broken up; it being seldom that simple sounds, produced by smooth, clean-cut waves, reach the ear. Let me give some experimental examples. I sound this mounted tuning-fork; it furnishes us with a pure note, and you can observe its quality. This (flute) organ pipe gives the same note, a little mixed with the higher octave; but this reed-organ pipe, which also gives the same fundamental note, with the other two, has an entirely different sound, and one might imagine its note was an octave higher than those of its companions. But the notes are the same, as is announced by the beats, which I produce by sounding any two of the instruments together, and then lowering the note of one of them slightly by holding my hand near the top of the pipe.

The reason of the difference in the case of the reed-pipe is simple. It generates not only the four-feet waves of its companion, but many sets which are shorter, waves which give the octave the next higher duodecimo, etc. The fundamental or lowest note of the pipe, being mingled with all these noisy companions, fails, of course, to produce as decided an impression on the ear as otherwise would be the case. Now, these reed-pipes, with their train of multitudinous notes, have for us, as speaking human beings, a particular interest, and we must pause for a minute to examine their construction. They consist of a vibrating tongue down at the base, which lets the current of air from the bellows pass through in puffs, and generates a set of tones after the manner of the *syren*, except that the tongue remaining of the same length, the set of tones is always the same, whereas the tones of the syren, in my experiment, were always changing. But, you will ask, can single drops of air, as they are admitted by the vibrating tongue, generate *several* sets of waves? I have often noticed that the drops of water, as they fall from the blade of an oar in perfectly quiet water, generate several different sets of waves which vary greatly in length,* and it is the same with the waves or tones of our vibrating tongue. They are afterward strengthened or weakened by the pipe. By altering the shape and size of the pipe, you can strengthen or weaken particular notes which are present, and thus give the sound a different quality, without necessarily altering the pitch of the proper or fundamental note. I have here three reed-pipes, constructed for me by the well-known organ builders, Jardine & Son, which give exactly the same fundamental note, but, owing to the variation in the shapes of their pipes, the quality, as you notice, is quite different, one of them giving trumpet-like tones, while the others resemble in sound the hautboy and clarionet.

*This is intended as an *illustration*, rather than an explanation, of the formation of complex waves.—R.

It was remarked that reed-pipes had an interest for us, and it is because the human vocal apparatus is essentially built on the plan of a reed-pipe; the membrane in the throat, called the "vocal cords," corresponds to the vibrating tongue, and the cavity of the mouth and nose has the same function as the pipe. The section of a head on the screen shows the relation of these parts.

Let us make some comparative experiments. I have here the vibrating tongue or reed without its pipe, and, driving the air of the bellows through it, can, by varying the acting size of the tongue, draw from it a series of different notes, which have a quality which is evidently due to complexity; none of the notes sound in the least like that of the tuning-fork. Corresponding to this, I have in my hand artificial human vocal cords, made of sheet india rubber, and, as you hear, can, by stretching them more or less, draw from them a series of inharmonious, semi-human tones, which break up from time to time into an inarticulate howling. I add to my reed a short conical pipe; the quality of its sound is entirely changed, although the fundamental note is unaltered, and, opening and closing it with the hand, I easily cause it to pronounce the words, "ma, ma." Next, I supply my artificial vocal cords with a short, broad pipe or cylinder (slightly conical), and they easily utter sounds like "pop-par." Removing the cylinder, and substituting for it this glass flask, we have it pronouncing the words, "pa, pa," with a somewhat nasal twang.

All this shows that, by varying the shape and size of the pipe, or *the cavity and opening of the mouth*, without in the least altering the fundamental note, we can strengthen or weaken particular sets of the higher notes which accompany it, and thus entirely alter the *quality* of the resulting sound.

We are now ready to make an application of the information we have gained. The vowel sounds are the simplest articulate sounds uttered by the human voice; and, quite recently, they have been analyzed by Germany's greatest living physicist (I refer to the celebrated Helmholtz), who has confirmed the idea previously suggested by Willis, that they consist of a fundamental note, mingled in certain proportions with notes that are higher. The fundamental tones and the higher tones are simultaneously generated by the vibrating vocal cords, and by altering the shape, size and opening of the cavity of the mouth, particular tones or notes are strengthened or weakened, and vowel sounds are produced. Thus, Helmholtz found that the sound O was produced by the mixture of the fundamental note with its higher octave or first harmonical, the second harmonical or its duodecimo being present in small quantity, while the sound A was given by making the second harmonical moderate in strength, the third very strong, with the fourth and fifth harmonicals weak. For the production of E, we have the fundamental weak, the second harmonical strong, with a stronger fourth, the third and fifth being weak. In Ah the fifth and seventh harmonicals are characteristic. The *German* U is pretty well given with the fundamental note alone. These examples will make clear my meaning.

Having gone through with this labor, by methods which I cannot now even indicate, Helmholtz actually reconstructed the vowel sounds out of pure notes by using a series of tuning-forks, which were made to vibrate for any length of time by electro-magnetism.

When, then, a human being utters merely a vowel sound, its production requires that the cavity and opening of the mouth should have exactly such a size and shape as strengthens the appropriate notes to the proper degree; so that it is indeed no wonder that an infant requires the practice of a year or two before becoming practically familiar with these delicate operations, the real wonder being that children even learn to talk at all, for the construction of the *consonants* is far more complex; and although we know, for the most part, the *manipulation* necessary for their formation, their composition so far baffles all attempts at exact analysis.*

These illustrations will serve to give some slight idea of the mode in which we speak; and I now pass on to the consideration of the wonderful and mysterious apparatus with which we receive and actually analyze the sounds that are presented to us. We have on the screen a *plan* of the ear, not a correct drawing, for that would be so complicated as to be of little use; the sound-waves enter the outer ear, and strike on this not tightly stretched membrane, which we call the drum of the ear, and cause it to vibrate, to bend inward and outward, keeping exact time with the sound vibrations themselves. To this membrane, as you see, are attached three little bones, called, respectively, the hammer, the anvil, and the stirrup. The membrane shakes the hammer, the hammer beats the anvil, the anvil vibrates the stirrup, and the stirrup sets in vibration the water in this strangely shaped cavity, which is colored blue for distinctness. In this cavity, which is not without its unsolved mysteries, the nerves of hearing terminate, and transmit from it the sensation of sound to the brain.

* The morning after the delivery of this lecture, I received the new work of Dr. Oskar Wolf, "Sprache und Ohr," which contains an elaborate attempt at the analysis of the consonants, the merit of which can, of course, be determined only by future investigations.

A simple arrangement of the kind indicated would transmit to the brain merely a general sensation of sound, just as the blind, on turning their eyes to the sun, have a general sensation of light; but what is the apparatus which enables us to distinguish between *different* sounds, high and low notes, and notes of different quality? Let us place this question distinctly before ourselves; but, before answering it, allow me to make a couple of experiments that have a bearing on its solution. We have here a tall gas flame, issuing from a beautifully prepared jet (which was made and given to me years ago by Professor Mayer, of Hoboken), and I now arrange the pressure on the gas so that the flame is almost ready to flare or vibrate, of course at a rate of its own selection; and if I send to it sound vibration of its own chosen kind, it will instantly acknowledge the relationship; it will shorten itself, flare and roar. It pays, for example, no attention to the sound of this two-feet organ-pipe, but, as you see, instantly responds to the least sound from the bunch of keys. I pronounce to it the vowel sounds; it is evidently deaf to the German U, does not pay much attention to O, more to E, I, and much more to the sound Ah. As you notice, the least hiss, even from a distance, causes it to shorten and roar. So we see, in a general way, that a stream of gas can be set in vibration by the sound-waves which it has a tendency itself to generate.

But, still more accurately to the point is an experiment with two similar tuning-forks, which I now wish to make. There are two tuning-forks, in all respects alike, mounted on their boxes, and exactly in unison. When I set one of them in action, the feeble sound vibrations travel through the air and set the second fork, with all its mass of heavy steel, also in vibration, simply because it naturally vibrates at exactly the same rate, for, owing to this fact, the transmitted vibrations always reach it at the right instant for co-operation, all conflict being avoided. But, in this large house, the greater number of you would not be able to hear the feeble vibrations of the second fork, and I have caused this delicately suspended mirror, which, hanging by a hair that is fastened above and below, can be set in motion by the least vibration of the fork in contact with it. The mirror reflects a beam of light on the screen; it is now stationary; but the instant the bow is drawn over its companion, it begins to move, and the motion becomes each moment more violent, till now the spot of light sweeps over the whole screen, and you notice that, even at a distance of several feet, we have the same result reproduced. By the use of a single silk fiber, instead of a hair, the delicacy of the apparatus is so greatly exalted as to render it unfit for a locality like the present. I slightly lower the note of the first fork by loading it with a nickel cent, attaching it with wax, and observe that the second fork, with the mirror, now pays no attention to its call; the spot of light remains stationary.

Let us make an application of our experiment. In the ear, in the strangely shaped cavity, we find a multitude of very small elastic rods, fastened at one end just like our tuning-fork, and, like it, capable of vibrating only when the particular notes to which they are tuned are struck. When this happens to one of these rods, it is set in vibration, and affects the delicate nerve fibril connected with it, and we have the sensation due to a particular rate of vibration, due to a particular note. A drawing of some of these rods, enormously magnified, is on the screen. But, for the full illustration of this matter, I need yet one more experiment, and must ask you to make it for me when you go home this evening. Open a piano, and, while pressing with the foot on the right-hand pedal, pronounce in a clear loud voice over the strings, for example, the vowel sounds, and you will find that the strings, which are capable of giving the notes of which they are built up, will be set in vibration, and will echo back to you, in a far-off, ghostly way, the sound you have just uttered. So, in all probability, is it in the ear; for we find there, locked up in its bones, in the strangely shaped cavity, an instrument with not less than 3,000 strings, tuned, as we believe, to different notes, and connected with different nerve filaments, ready to transmit to the brain the sensations due to different notes. A drawing of a portion of this wonderful contrivance, which has been particularly described by the Marchese Corti, is on the screen, and some of the strings can be seen. Its probable action is as follows: When a sound composed of a number of notes reaches it, the compound tone is analyzed into its constituents, the corresponding cords vibrate as in the piano experiment, and, by their action on the nerves, reproduce the appropriate sensations.

The two contrivances I have described are well fitted to make us sensible of sounds which are sufficiently *prolonged* to allow of the reception of a certain number of vibrations by the sympathetic apparatus in the ear; but in those cases where the vibrations, though powerful, are very few in number, it is probable that the cords and rods would fail to take cognizance of them, that is, they are probably deaf to short, quick sounds, generated by a single blow or impulse, and yet it is just these sounds which often announce the presence of danger. This case has also been provided for, curiously enough, by introducing into the strangely shaped cavity small, rather heavy, solid bodies, which *will not* vibrate readily or easily. In certain parts of the labyrinth we find particles of calcareous sand, imbedded among the delicate nerve filaments, whose office it is to *resist* their motion, when they tend to vibrate along with the water which fills the cavity, and acting as *drags* to stretch, and thus stimulate them into activity.

I hold in my hand a long india rubber string, stretched by a weight; if I raise the string *slowly* the weight readily follows, and the string is not elongated more than before; but when I attempt suddenly to raise the string the weight resists, the string is greatly lengthened, and it is possible, by a quick jerk, to cause it, as you see, to separate from the weight. This last form of hearing apparatus is the simplest, the least elaborate of the three, and we find it among the lower animals, where the more complex contrivances are, to a greater or less extent, absent. As an example of the third class of sounds, I may mention the snap of the electric spark, which is due to the production of a *single wave*, as Toepler has demonstrated.

Thus it would seem that the Creator has provided man with a most elaborate and complicated piece of apparatus, with which it is practicable to perceive and distinguish several thousand *simple* tones, and the number of their possible *combinations* is, of course, infinite. Think of the delicate care required to keep such an instrument in order, its strings properly weighted and stretched, its rods all in tune, day after day, during the process of growth and waste, to which it, like the rest of the body, is constantly subjected. It gives us no care; we never think of it, as in our random way we supply ourselves with such food as we fancy, some of which is sure to be required for its use, and to be eventually incorporated into its tissues, by the aid of an unseen, unfelt hand, whose delicacy of operation surpasses our thought. And with what may seem to us a certain prodigality, we must reflect that He has also bestowed this same beautiful and complicate apparatus not only on the wildest of savage men, but likewise on many of the higher animals, "brutes that perish," and with the same fond, all-embracing care, preserves it for them in order during their lives.

* * * * * * * * * *

If you were to tell a thoughtful man, who happened to be quite ignorant of the mechanism and action of the voice, that there were living beings who endeavored to express their wishes, thoughts and feelings merely by the aid of *mechanical vibrations*, thus causing the particles of the air to swing, like invisible pendulums, backward and forward, in certain ways, your listener would be impressed by the *poverty* of the device, and would too hastily conclude that only a few of the simplest and rudest ideas could possibly find expression by the aid of a contrivance so clumsy. He would tell you it was conceivable, perhaps, that, by appropriate vibrations, the idea of joy, or rage, or fear, or possibly hunger, might be imperfectly expressed, with a few others of like character, but that to expect more would be visionary. He would urge that all vibrations were necessarily so similar in general character that it would be impossible to communicate to them the stamp of thought or feeling. And yet how wonderfully each one of us employs just such vibrations, and, with a skill which seems truly superhuman, impresses upon and commits to them an infinite variety of thoughts, feelings and ideas, which, at times, we pour forth in torrents that seem inexhaustible. The vastness of the result attained, the poverty of the means, are utterly overwhelming.

Think, also, for a moment, of that gift by which we read the stories written on the invisible waves of the air; how we instantly interpret and disentangle their complexities, as they roll in toward us, thousands in a second, with the velocity of rifle-bullets. The power to hear and to speak are gifts which, from purely physical and mathematical standpoints, are absolutely magnificent. And we, the possessors of such powers, is it *conceivable* that they have been bestowed on us only to be used as at present? Are they not the prophecy of a future for our race, when they will be employed in a manner which better accords with their inexpressible richness and grandeur?

SCIENTIFIC LECTURE—V.

ON COMBUSTION.

By Prof. C. F. Chandler, of Columbia College; January 5th, 1872.

(Reported Stenographically.)

Ladies and Gentlemen.—When a solid substance, capable of enduring heat without decomposition, is subjected to a high temperature, it emits light. A piece of platinum or porcelain, at a certain temperature, becomes red hot; it emits red light. If we raise the temperature until it becomes more intense, the light becomes whiter; and, at a still higher temperature, a violet tint appears. Thus the application of heat develops, first red, then white, and finally violet light. The lower temperature is illustrated by red-hot iron, and the higher by the Drummond light, which is simply lime raised to the temperature which produces the violet heat.

Bodies in this condition are said to be *incandescent.* If we withdraw the source of heat, the body ceases to be luminous, passing from the violet to the white, then to the red, and finally ceasing to emit light. If we examine the body after it is cooled, we find that it has undergone no change. This is simply *ignition.* A body is ignited when it is heated to such a degree as to emit light.

If, instead of lime, we subject charcoal to a high degree of heat, we find that at a certain temperature the charcoal emits light; but it continues to emit light after the source of heat is withdrawn, and it wastes away until it finally disappears, leaving a little ash; if the carbon were entirely pure, it would leave no ash or residue whatever. This is *combustion*, as distinguished from mere ignition. The charcoal burns, and its temperature is maintained by the heat it evolves by uniting with the oxygen of the atmosphere.

Combustion is intense chemical action; and any chemical action, if the temperature is raised sufficiently, may produce the phenomena of combustion. In other words, when the chemical action is accompanied by an evolution of heat sufficient to produce light, we call it combustion. Ordinary combustion consists of action between the burning body and the oxygen of the atmosphere; and as the materials usually employed by us for heat and light are composed of carbon, or of carbon combined chiefly with hydrogen, ordinary combustion is due generally to the chemical combination of carbon and hydrogen with the oxygen of the air. The heat is due to the chemical action, and the light to the heat.

We may, therefore, divide bodies into three groups. We call the members of one group combustibles. They are bodies which combine with the oxygen of the atmosphere. 2d. The supporters of combustion: oxygen, the atmosphere, on account of the oxygen it contains, certain gases rich in oxygen, etc.; and 3d. Bodies which are neither combustible nor supporters of combustion. These bodies are, for the most part, already burned; they are the ashes of the combustibles. Thus lime is the oxide of calcium, or the ashes of calcium already burned. Silica is the oxide of silicon. In fact, all the earthy substances, and the rocks, forming the earth's crust, belong to this group, being the ashes of different metals, or the products of their combustion.

OXYGEN NOT THE ONLY SUPPORTER OF COMBUSTION.

Combustion is not, however, limited to oxydation. Oxygen is not the only element capable of supporting combustion. As an illustration of this, I have here several jars of chlorine, in which we will burn different substances. Chlorine is an elementary gas, characterized by its green color and very disagreeable odor. I drop some antimony into this jar of chlorine, and you see that it takes fire, and there is produced a compound of chlorine and antimony. In the next jar I now show you the union of chlorine and phosphorus. In this third jar, also containing chlorine, I burn a piece of sodium, the metallic base of soda and of common salt. You see it now burns; the product is chloride of sodium, common salt.

In addition to oxygen and chlorine, there are many other elements which are capable of supporting combustion; as iodine and bromine. Sulphur even will support combustion. If we place a piece of copper in the vapor of sulphur, at a high temperature, it burns and produces a compound of sulphur and copper. Even sodium and mercury unite with sufficient violence to produce the phenomena of combustion, producing heat and light.

The Reciprocal Nature of Combustion.

I have stated that we call certain bodies combustible, and others, supporters of combustion; but this is simply a relation which is reciprocal. As our atmosphere contains oxygen, we call bodies which combine with oxygen combustible, and oxygen a supporter of combustion; but were the atmosphere composed of hydrogen, instead of oxygen, we should then regard oxygen as combustible, and hydrogen as the supporter of combustion. I have here an apparatus by which I propose to show you that oxygen is combustible, and hydrogen the supporter of combustion. This large jar is filled with hydrogen gas, and by introducing a jet of oxygen within it, and heating it to the proper point, you see that there is a flame of oxygen gas burning in the hydrogen, reversing the usual order of combustion. Water is the result of the combination, and the sides of the jar are already dimmed with the moisture produced by the combustion of the oxygen.

A few moments ago, I showed you chlorine as a supporter of the combustion of phosphorus, sodium and antimony. I now introduce a jet of chlorine into the hydrogen gas, and you see the combustion of the chlorine, producing hydrochloric acid.

I have here a jar filled with street gas, which, you will see, may also be made to support combustion. I first introduce the jet of oxygen gas, and you observe the flame of the oxygen, and the gradual condensation of the moisture produced, upon the jar. Even the character of the flame is the same as that of a candle; for, in the interior, we have the blue cone from the excess of oxygen, and, on the exterior, the yellow cone from the excess of carbon.

I now introduce a jet of chlorine, which is also consumed in the street gas, with the separation, however, of carbon, which refuses to unite with the chlorine.

To still further illustrate the reciprocal character of the phenomena of combustion, I have here a vessel containing boiling aqua ammonia, which evolves ammoniacal gas, a compound of hydrogen and nitrogen. Introducing the jet of oxygen, you see that we have a flame of oxygen burning in an atmosphere of ammonia; and now, allowing this same ammonia to escape by this jet above, and lighting it, we have also the flame of the ammonia burning in an atmosphere containing oxygen, the two flames illustrating the reciprocal nature of combustion.

The Products of Combustion.

Oxygen is the predominant element in nature. Nearly everything we see, excepting animals and plants, is already burned. The products of combustion are the compounds which are formed. If a body burns in the atmoshphere, it produces an oxide. If it burns in chlorine, it produces a chloride; as we have produced the chloride of phosphorus, the chloride of sodium, or common salt, and the chloride of antimony in these three jars.

THE THEORY OF COMBUSTION.

The subject of combustion attracted, at an early date, the attention of investigators, and various theories were advanced to account for the peculiar phenomena. The phlogistic theory was the first that received credence. Becker, a Prussian, claimed that every combustible substance contained *phlogiston*, and that combustion was due to the escape of the phlogiston; and hence the ashes were lighter than the substance. Ordinary combustible substances do appear to become lighter, for they pass into gas and disappear. But some of the metals, when they burn, leave behind all the products of combustion. Iron burns to a black, and zinc to a white powder. And thus it was found that the remains, which were supposed to be the elements minus the phlogiston, instead of being lighter were heavier; in explanation of which the theory was advanced that the phlogiston was so light as to buoy up the substance, as hydrogen buoys up a balloon; the loss of phlogiston leaving the body heavier than before.

Lavoisier, the great French chemist, who was afterwards guillotined, first announced the correct interpretation of the phenomena of combustion. Oxygen had been discovered in the atmosphere by Priestley, and Lavoisier announced that combustion was oxydation; that the oxygen of the atmosphere produced the phenomena of combustion.

Still difficulty was met with in explaining the attendant phenomena of heat and light. Some supposed that when bodies burned, they gave up their latent heat and light; others supposed that their capacity for heat and light changed. But both these theories were found to be untenable; for it frequently happened that the product of the combustion had greater capacity for heat than the materials, and consequently, upon this theory, combustion of such substances ought to produce cold, instead of heat.

Sir Humphrey Davy first gave the true theory of the evolution of heat. He attributed the heat resulting from combustion to the violent motion of the atoms of the body, bringing it in connection with that theory now so generally entertained of the correlation of forces by which heat, electricity and chemical action are supposed to be different forms of motion; combustion developing heat by motion.

THE QUANTITY OF HEAT DEVELOPED BY COMBUSTION.

With regard to the quantity of heat developed, it is fixed and definite for the same amount of chemical action. The quantity of heat does not depend upon the manner of combustion; it depends simply upon the amount of chemical action. If we determine how much carbon or hydrogen will unite with a given quantity of oxygen, we shall have ascertained how much heat will be produced by their combustion. We find that one pound of hydrogen requires eight pounds of oxygen, and that one pound of carbon requires two and two-thirds pounds of oxygen; the heat evolved is exactly in this proportion. Theory indicates that one part of hydrogen evolves on burning 2.66 times as much heat as an equal weight of carbon; and experiments on the heat evolved have brought out 2.61, showing the truth of the theory; the agreement being as near as could be expected in experiments of so delicate a character.

INTENSITY OF HEAT DEVELOPED BY COMBUSTION.

But while the quantity of the heat is fixed by the amount of chemical action, the quality entirely depends upon the mode of combustion. The intensity of the heat depends on the rapidity of the chemical action. If we shorten the time, we increase the intensity; if we prolong the time, we diminish the temperature of the combustion. A pound of iron buried in the earth, gradually undergoes oxydation, becomes iron-rust, and in that process produces exactly as much heat as when it is burned before the oxyhydrogen blow-pipe; but in the former case, the heat is produced in ten years, and in the latter in five minutes. The quantity of heat is identical in both cases; but its intensity is in proportion to the rapidity of the combustion.

CIRCUMSTANCES WHICH FAVOR OR RETARD COMBUSTION.

There are several circumstances which favor or retard combustion. One of these is temperature. Every combustible substance has what we call its burning point—the temperature at which it begins to burn. A few substances combine with oxygen at ordinary temperatures. For instance, phosphoretted hydrogen, when allowed to escape into the atmosphere, takes fire spontaneously. Zinc methyl takes fire spontaneously. In other words, their burning points are below the ordinary temperature of the atmosphere.

Some bodies have two kinds of combustion, which take place at different temperatures. Phosphorus, for instance, in the open air, is found to shine in the dark, undergoing slow combustion, producing phosphorous acid. If we allow the temperature to rise to 140° Fahr., it bursts into flame, and produces phosphoric acid. It has a slow combustion, and a high combustion; requiring for the former a temperature of 77°, and for the latter of 140°, Fahr.

Charcoal burns slowly at a dull, red heat. Sulphur takes fire at a temperature of about 550°. Most of the elementary bodies require a temperature of redness to cause them to take fire. When I introduced the sodium into this jar of chlorine, it was necessary to heat it to the temperature at which it would begin to combine.

Hydrogen has a curious relation to chlorine. If we mix them in the dark, they remain without combining; but if we allow the sunlight to fall upon them, they combine; so that the burning point in that case depends on the presence or absence of light.

If we mix phosphorus and iodine at ordinary temperatures, they combine, producing light and heat; but if we make the experiment in an atmosphere cooled by ice, they fail to combine. The burning point is about the ordinary temperature of the atmosphere.

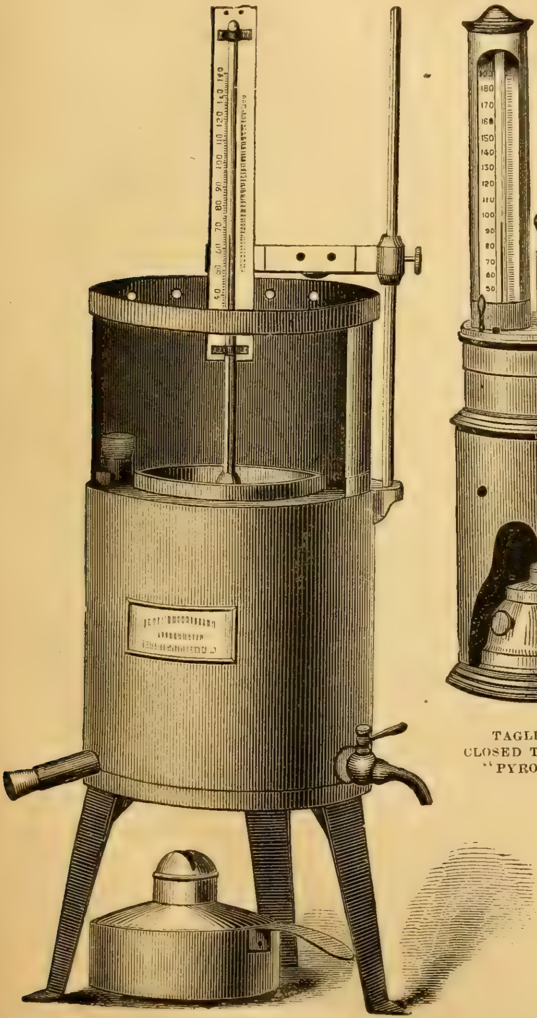
The burning point is a matter of great importance, with regard, particularly, to the petroleum which has been so extensively introduced of late. I have before me two products of petroleum. *This*, is a sample of a good quality of kerosene; and *this*, is a sample of what some unscrupulous persons sell in New York as "safety gas;" the burning point of which is so low, that, although I have made the experiment in the coldest days in winter, I have never found it cold enough to fail to take fire from a lighted match. I suppose the point at which it would refuse to burn, if there be one, must be 40° or 50° below zero. I shall experiment with these oils by and by. I will now merely explain the mode of testing them.

The operation of testing kerosene is very simple. It is merely ascertaining the temperature at which the oil evolves an inflammable vapor, the "flashing point," and the temperature at which the oil takes fire, "the burning point." But when I say the operation is very simple, I do not mean to say that any person is qualified to make the test in a reliable manner until he has been properly instructed. In careless, ignorant hands results may deviate twenty or thirty degrees from the truth; while in skillful hands four or five degrees will cover the most divergent results.

A suitable apparatus is required; consisting of a cup to hold the oil, surrounded by a vessel of water, which is heated by a small spirit lamp; the bulb of a thermometer is immersed in the oil. The tester legalized in the schedule of the English Petroleum Act is a very good one. The open tester of Tagliabue is a very good instrument,

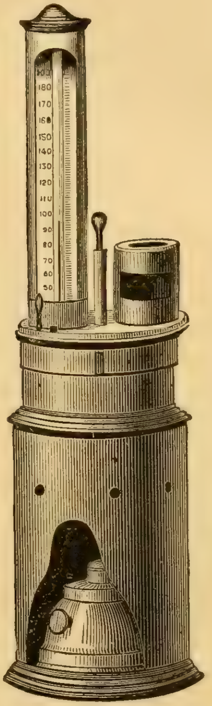
PETROLEUM TESTERS.

Fig. 1.



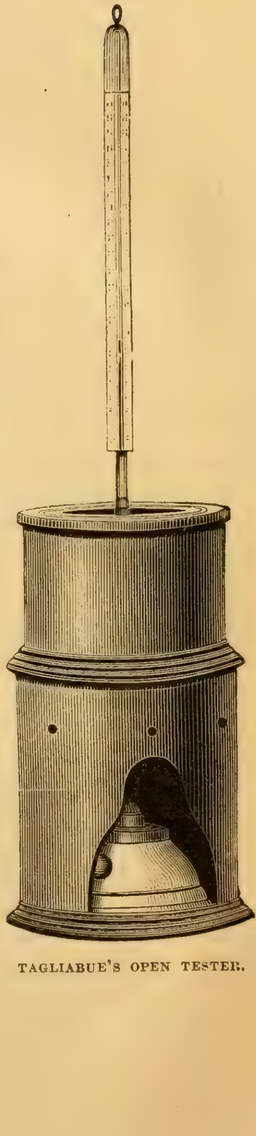
ENGLISH STANDARD TESTER.

Fig. 2.



TAGLIABUE'S CLOSED TESTER, OR "PYROMETER."

Fig. 3.



TAGLIABUE'S OPEN TESTER.

but should be protected from currents of air, when in use, by a screen.

The closed tester, or "pyrometer," I consider very unreliable, at least for determining the burning point, as the mass of metal (brass) over the oil is very liable to become heated by the burning vapor after the flashing point has been reached. The result of this is the igniting of the overheated petroleum at the surface long before the thermometer records is actual temperature. I have seen the oil ignite while the thermometer stood 20° below its proper burning point.

When heat has been applied to the water until the thermometer has risen to about 90° Fahrenheit, a very small flame shall be quickly passed across the surface of the oil on a level with the wire. If no pale blue flicker or flash is produced, the application of the flame is to be repeated for every rise of two or three degrees in the thermometer. When the flashing point has been noted, the test shall be repeated with a fresh sample of the oil, using cold, or nearly cold water as before; withdrawing the source of heat from the outer vessel when the temperature approaches that noted in the first experiment, and applying the flame test at every rise of two degrees in the thermometer.

The mere fact that an oil does not take fire from a match, does not prove that it is a safe oil, if it is at the temperature of the atmosphere. The oil refiners have selected the temperature of 100° Fahr. as the standard temperature at which a good oil should not emit an inflammable vapor, and 110° as the temperature at which it should not take fire. If it will not take fire at 65° it may not be safe; for at 70° we may reach its burning point. This test will, however, readily distinguish between a good kerosene and the gasoline or falsely called "safety oils" which burn at all temperatures.

SPONTANEOUS COMBUSTION.

Mechanical division has a great influence upon combustion. If we reduce a substance to a fine powder, we frequently find that it will combine with oxygen at a much lower temperature than otherwise. I have here tubes containing metallic iron in so finely divided a condition that it takes fire spontaneously in the atmosphere, as you see.

Charcoal reduced to fine powder is liable to spontaneous combustion. In gunpowder factories it is necessary to be very careful not to expose powdered charcoal to the atmosphere. Porous substances have the power of condensing gases, which raises their temperature; and finally it rises to such a point that combustion takes place. Tow, cotton, and rags saturated with oil, absorb air, which raises their temperature until they take fire. Some of the greatest fires have originated from the spontaneous combustion of finely divided substances. Drying oils used by painters are specially liable to oxydation; and where tow or rags are moistened with these oils oxydation takes place, and the temperature rises until they suddenly burst into flame. Olive oil, falling into saw-dust, will take fire. And even tape measures have been known to take fire. The fine oil-silk covers for umbrellas, when several have been placed together, have been known to take fire. Hay often absorbs oxygen so rapidly as to burn with flame.

Some years since, before this fact of spontaneous combustion was so well established, Professor Graham, investigating the cause of the burning of her majesty's ship Imogene, traced it to a bin containing a mass of oakum, which had burst into spontaneous combustion.

Coal often takes fire spontaneously. Where heaps of coal are kept, they have been found, at a temperature of not over 150° Fahrenheit, to take fire spontaneously. In one case, the coal was sulphureous, and the combustion was referred to the sulphur; but this accident frequently takes place where the amount of sulphur is very small; and it is due, not to the oxydation of the sulphur, but of the substance of the coal itself.

Even the rusting of metals may raise their temperature considerably. In the manufacture of one of the early telegraph cables, about 163 miles were made and placed in a tank of water. This cable was composed of copper wires, wound with tow, and protected by a coating of iron wires. It was found that the tank leaked, and it became necessary to draw off the water to repair it. This left the iron wire moist, and in contact with the moist tow, and although the temperature of the atmosphere fell several degrees, the temperature of the cable rose 10°, and there was danger of the temperature rising, from the oxydation of the iron, to such an extent as to destroy the cable.

The use of sheet-iron, as a covering for wood, introduces a new danger. Iron is such a good conductor that the heat passes through it and chars the wood beneath. Steam-pipes often contain steam at a high temperature, and the heat may change the character of wood exposed to it to such a degree as to cause it to take fire from very slight causes. Such has been the case with Perkins' hot-water apparatus; and several cases of fire have occurred from wood actually set on fire by pipes containing water at a high temperature.

Some years since there was a very general belief in the spontaneous combustion of the human body. In 1825, a woman burned to death in a kitchen, eighteen inches from the fire. The husband was tried for murder, but acquitted on the supposition that the woman took fire spontaneously, and was burned up. In another case, an old lady, eighty years of age, unfortunately addicted to brandy-drinking, was burned to a skeleton in her chair; water was thrown upon her without avail. There are no less than forty such cases on record. It has been noticed that these cases generally occur in the winter, when the party sits near the fire; that often they are habitual topers, and generally no other person is present. A morbid condition was supposed to exist, and it was supposed that the alcohol of the breath took fire from the burning wood, and communicated the flame to the body. This finally received the attention of scientific men, and Liebig wrote a long article on the subject, proving conclusively that it was utterly impossible. An ordinary man, weighing 120 pounds, contains eighty pounds of water, and it would be impossible to produce combustion until long after death had been produced by loss of moisture. The idea that a body may be so saturated with alcohol as to be burned up by it, is refuted by the simple experiment of moistening a sponge with alcohol, and setting it on fire. The moment the alcohol is burned the flame disappears, and the sponge remains intact.

FLAME.

Solids and liquids, when sufficiently heated, emit light. The light which results from heating a solid is simply the glow of incandescence. But when a burning body becomes gaseous we have a flame. The flame is composed of gases at a high temperature. If we mix a gas with a supporter of combustion we get an explosive mixture, as in the case of oxygen and hydrogen, because combustion takes place throughout the mass at once. We have a parallel case in mixing solids; gunpowder is a mixture of this kind. When we burn carbon in the atmosphere, a considerable length of time elapses before enough oxygen comes in contact with it to burn it up. But if we pulverize the charcoal and mix it with saltpeter, we have in the mass enough oxygen to burn up the carbon. Gun-cotton is another example. In gun-cotton we have the combustible and the supporter of combustion side by side. Any disturbing cause which will cause the carbon and the hydrogen of the cotton to unite with the oxygen produces an explosion. It is simply instantaneous combustion.

If we carefully scrutinize a flame we shall find that it is composed of several layers. We have in the first place a dark cone in the interior, which consists of unburned gases. Then there is an envelope of luminous gas outside of that, and an exterior mantle almost invisible.

Even in burning a candle we are burning gas; for the heat of the flame converts the spermaceti, the paraffine or the wax into gas before it is burned. The combustion takes place partly in the outer cone, and partly in the intermediate or luminous cone; but in the interior, where the air does not penetrate, there is no combustion.

The hydrogen burns before the carbon, and the particles of carbon, thus set free, and rendered luminous by the heat, are the cause of the light. What we call soot is simply a deposit of these carbon particles on a cold surface.

The form of the flame is due to the ascending current of heated air. It is the ascending current which carries the flame up. The color of the flame depends partly on the temperature, but chiefly on the substances evolved. Different gases produce different colors. Lithium produces a beautiful crimson, and sodium a yellow flame.

LUMINOSITY OF FLAMES.

The brightness depends partly upon the degree of heat and partly upon the presence of solid particles which are rendered incandescent. Flames which contain no solid particles emit very little light. The flame of hydrogen and oxygen burning together is very slightly luminous, although it has an extremely high temperature. Alcohol contains a large amount of hydrogen, but no carbon particles are set free; hence it is feebly luminous; its flame is blue. Oils which are rich in carbon give us a luminous flame.

Hydrogen produces a pale flame. I have here a flame of hydrogen. You see but little light, although the flame is hotter than that of a candle; but by introducing into the flame particles of carbon it becomes luminous. This apparatus is called a carburettor, being designed to add carbon to the flame. The gas is passed through benzole, which is a volatile fluid rich in carbon; it takes up a certain quantity of benzole vapor which renders the flame more luminous. This apparatus is intended for use with street gas, the luminosity of which is increased forty per cent by the consumption of a moderate quantity of benzole.

Bright flames are produced by bodies which either produce a very high temperature or a separation of solid particles, or both. I propose to introduce in this globe of oxygen gas some fragments of magnesium. Now, magnesium produces, by its combination with oxygen, a solid white product, which is intensely hot, and, consequently, very luminous. Magnesium does not take fire spontaneously, and I must, therefore, first raise it to its kindling point, in order to cause it to combine with the oxygen. The high luminosity of this flame is due to the solid particles of magnesia produced by the combustion. In the combustion of phosphorus in oxygen, which you see in this globe, the white cloud which rises is the result of the combination; and it is the incandescence of these solid particles which produces this pure white light.

We may destroy the luminosity of a gas rich in carbon by simply mingling it with air. We have here a little burner designed for the burning of street gas without the production of soot. It is called the Bunsen burner, and is used in the chemical laboratory to produce a flame for heating purposes. Air is admitted by these openings, and mingles with the gas before it is burned. If we cut off the air from these openings the flame becomes at once luminous.

The amount of heat depends on the amount of combustion; but the amount of light depends upon the production of a high temperature, and upon the solid particles which become incandescent. It is important, therefore, in burning gas for illumination, to produce a large amount of carbon and a high temperature; but, if we produce too much carbon, our gas smokes. In fact, in order to obtain the greatest amount of light from a given quantity of gas, it is desirable to burn it at the point at which it is on the eve of smoking. If we turn up the gas as high as we can without allowing it to smoke, we shall get the largest amount of light the gas is capable of giving.

The same is true of oils of various kinds. We adapt our lamps to the oil, in order to produce the largest amount of light without smoking. The chimney that we use upon the lamp is designed to make a draft and increase the temperature. Kerosene oil cannot be burned satisfactorily without a chimney, simply because the temperature produced by its combustion in the open air is not sufficient to burn up the carbon. Adding the chimney enables us to produce a more thorough combustion of the carbon. Each oil must have a lamp adapted to its wants, so as to produce a complete combustion of the carbon, and yet so as not to burn it with too much air. If we have too tall a chimney, it makes too strong a draft of air, burns up the carbon too quickly, and diminishes the illuminating power.

It is, perhaps, not out of place to say a word or two here on the subject of our street gas. It is a common subject of complaint that "our gas is bad"; "that it does not give us enough light."

Here we have an apparatus designed to determine the illuminating power of gas. It is necessary that it should be used in a dark room, in which all the walls are painted black, so that there shall be no reflection. We call this apparatus a photometer, or light measurer. We compare the gas flame with a spermaceti candle, burning at the rate of two grains per minute. If, on weighing the candle at the close of the experiment, we find that the consumption has been more or less than two grains per minute, we must correct the results in proportion. The gas-burner is intended to burn five feet per hour. The meter is so arranged that we can determine the amount with accuracy; and we regulate the burner to consume, as nearly as possible, five feet; and, at the conclusion of the experiment, make the proper correction if the quantity consumed has varied from five feet per hour.

It is necessary that the pressure should be advantageous. Too much pressure diminishes the light. There is frequently complaint of too little pressure. The truth is, the lower the pressure at which we can burn the gas, the more light we get from it. It is impossible that the pressure should be uniform in a large city. Near the gas-works, the burners may have a pressure of three or four inches; while at a distance there may be hardly enough pressure to carry the gas to the burner. At one of the gas-works in this city, it is necessary to have a pressure of five inches, in order to produce a pressure at the other extremity of the line of seven-tenths of an inch. Between these two points the pressure gradually varies from one extreme to the other. It is utterly impossible to have a uniform pressure through the whole city. The most economical pressure to employ is half an inch; and we have here a governor, a floating bell, so balanced with weights, that whenever the pressure tends to exceed half an inch, it will rise and partially close the opening through which the gas flows. It thus maintains a uniform pressure of half an inch.

In using the photometer, we use a clock that strikes minutes, telling us when to observe the meter. In making the comparison, we determine the relative amount of light upon the simple principle that light emanating from a point, and falling upon a surface, varies in intensity inversely with the square of the distance. Here is a disc of paper, having a ring rendered transparent by paraffine. This is placed between the two flames, that of the standard candle, at one end of this bar, and that of the gas at the other end. Moving this little disc back and forth upon the rod, we find the point where it is equally illuminated on its two sides. If the light from the candle which passes through the transparent ring is exactly equal to the light from the gas which falls upon the surface adjacent, the ring cannot be seen; and we know that at that point the illumination is equal, and that therefore the light is in proportion to the square of the distance of the disk from the respective flames. If, for instance, it is four times as far from the gas as from the candle, we know that the gas is giving sixteen times as much light as the candle. This bar is carefully graduated, so that, without making the measurements of the distances or the calculations, we can read from the scale the ratio of the two flames.

You may like to know the quality of the gas which we have here in New York. It is not popular, I know, to say anything in favor of the gas companies; but I have tested the gas of all the companies except the Harlem; and I have found it to range from sixteen to eighteen candles; that is, five feet of gas per hour, burned in an Argand burner, produces as much light as sixteen to eighteen sperm candles burning at the rate of two grains per minute. I am convinced from repeated experiments, that the three companies whose gas I have tested, the New York, the Manhattan, and the Metropolitan, are giving us gas which is of excellent quality.

You ask, then, why is the light so bad? The difficulty is not in the quality of the gas. It is in the quantity. In the district in which I live, we receive the gas from the Metropolitan Company. It is excellent in quality; but the mains are in many streets only three inches in diameter, and we cannot get enough gas. There is another difficulty; the pipes in our houses are put in by contract, and are too small. Then we put a five-light metre into the cellar, and attempt to burn fifteen or twenty burners.

But the great difficulty, after all, is in the burners. Only a week ago I perused a report of a committee in London, who had been examining the subject of gas-burners, and they found that some kinds of burners did not give half the light they should, although they consumed as much gas as good burners. They found that the burners did not average more than three-fourths the light the gas was capable of giving. Estimating the cost of gas at $10,000,000 per annum, no less than $2,500,000 were wasted from the use of poor gas burners.

You can easily see that if the burner brings too much oxygen in contact with the gas, it destroys the little particles of carbon. We must guard them carefully in burning gas for illumination to produce the best light.

I have here the best gas burner which has yet been invented. It is an Argand burner. In the first place, it is not constructed of iron. An iron gas burner soon becomes rusty, and it should never be used. A brass burner is better; but still better burners are made of what is called lava, really soapstone.

Sagg's patent London burner, which I have here, produces sixteen per cent more light than any other burner in use.

There are two kinds of ordinary burners in use—the fish-tail and the bat-wing. The fish-tail burner is provided with two little round holes, so situated that the two jets of gas impinge against each other and spread out into a flat flame. The bat-wing burner delivers the gas through a slit. A fish-tail burner, as a general thing, is much less effective than the bat-wing. It was found in the examination in London that the light of the fish-tail burner varied from one-half to three-fourths, while the bat-wing burner in some cases very nearly equalled the best Argand burner.

The Argand burner consists of a ring of holes, and has a glass chimney in order to produce a draft. When properly constructed, it produces a greater amount of light from the same amount of gas than any other burner. There is a general idea that the Argand burner consumes more gas than the fish-tail and bat-wing burners. This is not necessarily the case. A five foot Argand consumes no more gas than a five foot fish-tail, but it gives much more light.

Before we complain too much of the gas companies, we should provide ourselves with good burners. Then if the light is not satisfactory, we should look at the distribution, and we will often find this defective, particularly in the up-town districts of the city; for when the mains were put in, most of the streets were not built up, and it was not thought necessary to put in large mains. The difficulty in distribution is one that must gradually be overcome by taking up the three-inch mains and putting in six-inch mains in their place.

I have referred to the illuminating power of flame as due to the presence of solid particles; but Dr. Frankland has recently shown that it is not entirely due to the solid particles, but somewhat to the density of the gases evolved. He found that if the products of combustion are heavy, the amount of light produced is greater. He found, too, that pressure modifies the illuminating power. A candle burned on the top of Mt. Blanc did not produce as much light as when burned in a valley.

Circumstances which affect Combustion.

We have not time to discuss all the conditions which regulate or affect combustion; but a few of them merit attention.

As the rapidity with which oxygen is brought in contact with a burning body hastens its combustion, we make use of bellows to increase the supply of oxygen. Still, too rapid a motion of the air may extinguish a flame by cooling the burning body below its kindling point. When we blow out a candle, we send a blast of air across the wick which cools the wick below its bnrning point. But if we do not cool the body too much, the increased supply of oxygen increases the combustion. We avail ourselves of our knowledge of this fact, in supplying furnaces with oxygen on a large scale by means of blowing engines. Tons of air are forced through a blast furnace where iron is produced every twenty-four hours. In fact, more air is employed in the production of iron, than of any other substance; for the weight of the ore, the fuel and the flue combined, is not equal to that of the air which produces the combustion.

Another plan for hastening the supply of oxygen, is to employ a high chimney. All gas is made lighter by heat on account of the expansion. So, if we provide a long chimney, we obtain the advantage of the buoyancy of the heated air in it. The cold air outside, from its greater weight, presses the hot air up the chimney, with a rapidity depending on the height of the chimney; the combustion being increased in proportion.

A third method is by a common blower, which does not act exactly by either of these methods. In the ordinary open grate, the greater part of the air passes over the fire, and consequently does not affect the combustion. If we want a quicker fire, we put up the blower, which prevents the air from passing into the chimney *over* the fire, but forces it *through* the fire. A friend of mine asked Bret Harte if life was not rather fast on the Pacific coast. "Yes," he replied; "people out there always live with the blower on."

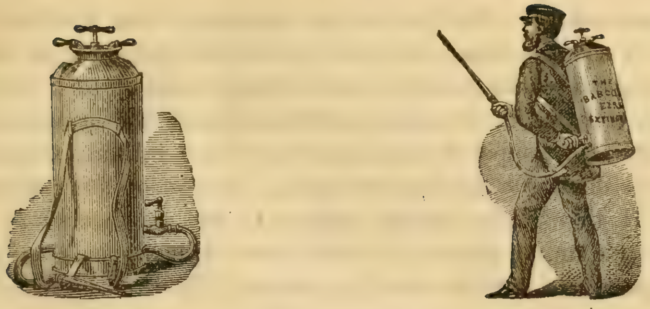
Bodies require a certain temperature to bring them into a state of combustion. This is the reason we make use of kindlings. Shavings take fire readily, because it is easy to bring a shaving to the required temperature. By a match we ignite the shavings. They set fire to the charcoal or kindling wood, which burns readily; and, by means of their heat, we finally bring up the anthracite coal to its kindling point. If bodies do not burn with sufficient rapidity to produce the necessary amount of heat to keep them at a temperature above their kindling point, they cease to burn.

When anthracite coal was first introduced in Philadelphia, it could not be burned. A man is said to have taken some hard coal from a friend for trial, and after keeping it on his fire for a week to have returned it as "fire proof." The man who sold the first wagon load of anthracite in Philadelphia had to hurry out of the city to avoid arrest for fraud. People had been accustomed to burn the soft coal, and were not familiar with the method of bringing anthracite coal up to the proper heat. Dr. Nott of Schenectady was one of the first to comprehend the difficulty and devise a remedy; and the old Nott stove will long be remembered, particularly in the neighborhood of Union College. He made the first experiment to see whether anthracite coal could be used under the boiler of a steamboat, on the Hudson river, by forcing air under the fire-grate; and it is hardly necessary to say that the experiment was successful.

Conditions Antagonistic to Combustion.

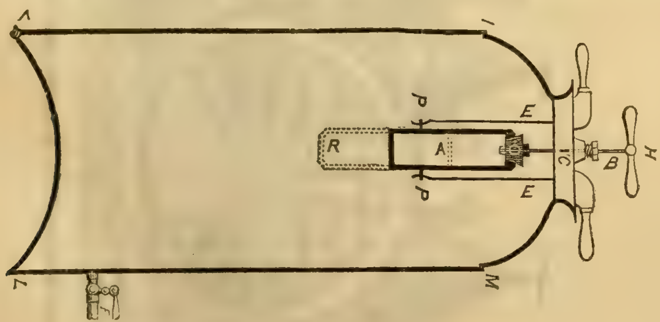
Fire-extinguishing substances act sometimes by cooling the fire; as water cools the body below the burning point; sometimes by covering the burning body with something to impede the access of air, as a rug; and sometimes by surrounding it with an atmosphere containing but little, if any, oxygen. The nitrogen in our atmosphere interferes with combustion, very fortunately for us, for we find it rapid enough even now. The reason the magnesium and phosphorus burned so much more brightly in pure oxygen was that there was no nitrogen present to take up the heat and reduce the temperature.

I have here a jar of sulphurous acid. Sulphur is combustible, but the acid produced by its combustion is no longer combustible. The combustion is ended. It is a common practice, when a chimney takes fire, to throw sulphur down. This seems rather a homœopathic treatment of the fire, but the explanation is very simple. The sulphur, in burning, very quickly takes up the oxygen in the atmosphere, and the combustion ceases because the air essential to combustion is excluded by the sulphurous acid which does not support combustion. I shall lower these candles into the jar, and you see that the moment the flames come below the level of the sulphurous acid, they are extinguished. Here, we have a jar of carbonic acid, which is equally antagonistic to combustion. Even if there is as little as six per cent of carbonic acid in the air, it is sufficient to extinguish the flame. If we breathe the air from our lungs into a jar, a taper plunged in it will be extinguished, as you now see.



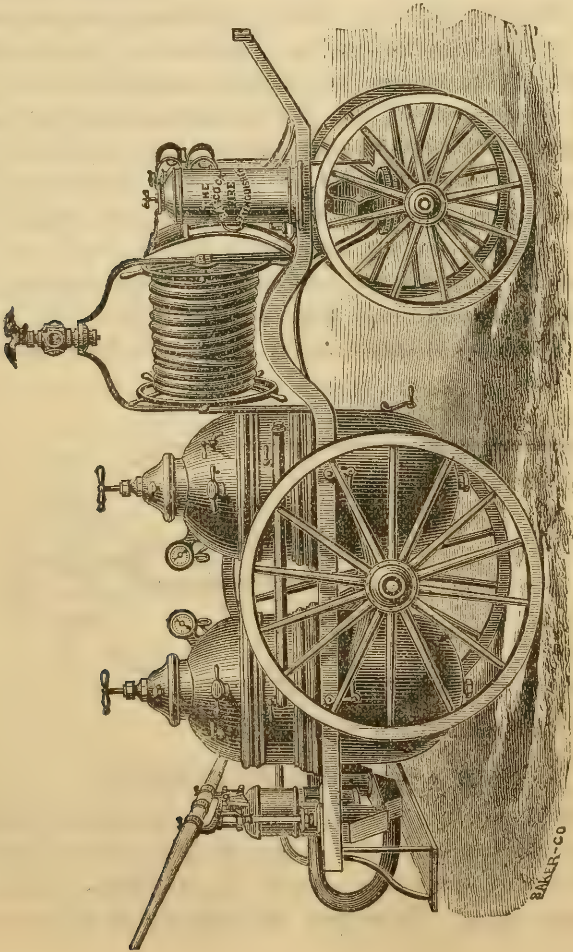
The Babcock Fire Extinguisher.

Carbonic acid has been made use of in extinguishing combustion. Here we have a Babcock fire extinguisher, a vessel containing bicarbonate of soda dissolved in water; this is a substance charged with carbonic acid. In the upper part of the apparatus is a cup of sulphuric acid. By turning the handle we set free the sulphuric acid, which acts upon the bicarbonate of soda, and the carbonic acid is evolved in the form of gas, which cannot escape till we open this valve, when a jet of carbonic acid and of water charged with sulphate of soda is thrown upon the fire. It is not claimed that this will take the place of water for buildings already wrapped in flames; but if we have it always on hand, so that it is only necessary to touch a spring to put it in operation, it enables us to put out the fire before it has done any serious damage. A great many fires have been already prevented by its use.



Interior of the Fire Extinguisher.

The construction of the fire extinguisher is shown in this diagram. The leaden bucket A, holds the charge of acid, and is kept in its upright position by the leaden stopper O, attached to the rod B, coming through cap C. To prepare the extinguisher for use requires about one minute. We dissolve the contents of this tin box (bicarbonate of soda) in water and pour it into the extinguisher, then fill the extinguisher with water to within three inches of top. We now pour the contents of this glass bottle (acid) into the leaden bucket, put in the lead stopper firmly, insert the bucket in the extinguisher and screw down the cap hard and tight. In case of fire, pull up the handle H, this draws out the stopper O, and the bucket A, turns bottom side up, as shown by dotted lines R, being only supported after the stopper is withdrawn by pivots at P P, thus discharging its contents into the carbonated water. Instantaneous chemical action takes place, supplying 100 pounds pressure to the square inch to throw the stream, and securing perfect readiness to play upon the fire in a few seconds of time.



Babcock Self-Acting Fire Engine for Cities, Towns and Villages.

This principle is not limited to small machines to be carried on one's back, but can be applied to engines of large size.

Even steam extinguishes combustion. In some of the oil refineries an arrangement is made by which any one of the apartments can be closed, and a jet of steam forced into it, rendering combustion impossible.

It has been suggested that liquified carbonic acid should be carried in ships. A pressure of 600 pounds to the square inch condenses it into a liquid, a gallon of which will fill fifty cubic feet upon the removal of the pressure. A few barrels of this, if there should be a fire under the deck, would fill the whole interior of the vessel, and the fire would necessarily be extinguished.

It has been proposed, and I believe a charter has been obtained from the Legislature, for a company to lay pipes in the streets to supply carbonic acid to put out fires. The idea is plausible; but we must remember that this gas not only puts out fires but puts out lives; and it becomes a question whether we shall have a death-dealing agent delivered at our doors, as well as a fire extinguisher. The street gas smells badly, notifying us of a leak; and it burns, so that a leak is readily found. But carbonic acid has no smell, and does not burn. A leak occurring in the neighborhood, even were the pipe not brought into the house, the gas might find its way into our cellars, and some unfortunate member of the family might be suffocated by it. It never would be safe to bring carbonic acid through the streets. It is better to have our fires, to lose our two millions of property every year, than to have our lives destroyed from the leakage of this insidious poison.

Rendering Fabrics Non-inflammable.

Various methods are known by which the inflammability of light materials, especially cotton and linen fabrics, used for ladies' dresses, and for window curtains, may be greatly diminished. Accidents are constantly occurring from the ignition of such fabrics, lace curtains from gas burners, but more particularly ladies' dresses. Most painful and fatal accidents have occurred in theaters from the foot-lights. In one instance the flames were communicated from one to another till the dreadful spectacle was presented of eight ballet dancers wrapped in deadly flames. A few years since, attention was specially called to this danger, I believe, by the death of a princess, by the ignition of her light muslin dress by a match carelessly dropped on the floor, on which she stepped. Queen Victoria requested Prof. Graham, Master of the Mint, to investigate the subject; he entrusted the investigation to Dr. Versemann, who experimented on a great variety of substances, and found that tungstate of soda and phosphate of ammonia were the salts best adapted to the purpose, the former being preferable to the latter. It is merely necessary to dip the fabrics into a strong solution of this salt, and after drying to smooth them with a hot iron as usual. I believe an enterprising grocer in London advertised "fire-proof starch," which was simply a mixture of starch and tungstate of soda to be used as a substitute for ordinary starch.

In order to show you how effective this process is for protecting fabrics, I have arranged these two muslin curtains; this one has been starched in the usual manner, and you will see how quickly the fire runs through it when I apply the flame; it is gone in an instant. Now, you see I cannot set the other on fire; it is prepared with tungstate of soda; it is merely charred where the flame is held in contact with it. Here are two muslin dresses which, expanded on their wire frames, call to mind our dear little treasures at home, who are constantly exposed to danger from the inflammabilty of their clothes, and the inclination to play with fire. There, you see one has disappeared in a moment, while I cannot cause the other to burn. I think a fortune could be made by some enterprising person in supplying the grocers with a "fire-proof starch," to be used for muslins.

Rendering Timber Non-inflammable.

This material can also be applied to timber to render it non-inflammable. It is absorbed, and enters into the pores of the timber. Lumber, to be used for building purposes, may be soaked in some saline solution, and thus be rendered non-inflammable. Such wood, if thrown into the fire, will be charred; but it would be impossible to set it on fire by itself. A solution well adapted for this purpose is the silicate of soda, or soluble glass.

Decay is Combustion.

Another form of combustion is the decay of organic bodies exposed to the air; they undergo slow combustion, or oxidation, and the products of this combustion are identical with those of rapid combustion by fire. Carbon yields carbonic acid; hydrogen yields water.

Decay is of two kinds: that which takes place when the air has free access, and that which takes place when air is excluded. The first is simply slow combustion, and yields carbonic acid and water, with a final residue of the mineral matters present, the ashes. The second occurs under water or beds of wet sand or clay. It develops a carbonaceous product which is our peat and coal.

Every piece of timber which is employed in our structures is gradually undergoing deterioration; and the timber of our forests is rapidly disappearing from being worked up into structures, and subsequently undergoing decay. The railroad and telegraph companies are making sad havoc in our forests.

It is estimated that $3,000,000 per annum are spent in replacing decayed telegraph poles alone, while railroad sleepers require a far larger amount.

In Europe, special attention is given to this fact; and departments of forests have been organized. Every land owner who cuts down trees, is compelled by law to plant a certain number of trees in their place.

In the early times it was though that these forests were so vast that they could never be exhausted by the railroad companies and telegraph companies. But now the attention of the government has been directed to the subject.

Various methods to prevent this kind of combustion have been devised: methods for preserving timber.

The best of these methods is to impregnate the logs with oil of coal tar. Coal tar contains carbolic acid, which prevents the decay. The durability of the timber is increased fourfold. Railroad sleepers, which, without the preparation, decay in six to nine years, in some cases, with the preparation, lasted forty (40) years.

Another form of destruction is from the attack of animals. In the southern waters the teredo navalis attacks the bottom of ships, and the timber of piers; but it never touches the wood if it is impregnated with carbolic acid.

Respiration.

Another form of combustion is respiration. Respiration is animal combustion. Combustion takes place in the animal economy and develops muscular heat. Our thoughts, our plans, our life, and our activity, are the results of combustion.

It is owing to combustion that we are able to exert activity. It is owing to combustion of the nervous matter that we are able to think. It is that which blood gives to the tissues. A man consumes fourteen ounces of carbon in his food every day, or 300 pounds per annum. This carbon is converted into carbonic acid, just as though it were burned in the fire.

The process of respiration simply draws in the oxygen for purposes of combustion. The whole respiratory, digestive, and circulatory system is designed to provide for this combustion. The tissues of the body are consumed by respiration. The blood vessels are the channels for communicating it to the most remote vessels, which ramify through the muscles, and the heart is the great forcing pump, more powerful than any engine.

The quantity of blood in the whole body is only about three gallons. The capacity of the heart is two ounces. At each pulsation it expels half an ounce, and this is forced throughout the circulating system. At each seventy beats thirty-five ounces of blood are forced out by the heart, 120 pounds of blood every hour, and 2,880 pounds, or 350 gallons, daily. All the blood in the body passes through the heart every six or seven minutes, and the heart beats seventy times per minute, 4,200 times an hour, and 100,000 daily, and 36,500,000 every year. If the heart stops beating — if the circulation of the blood ceases — death ensues.

The respiration simply draws in the oxygen, to be taken up at the lungs by the blood, to be carried through the circulation to the remote vessels into the capillaries, where the action of the oxygen takes place.

There are two sets of vessels, one going from the heart to the muscles, nerves and brain, and the other back to the heart, connected by their capillary vessels. The vessels going from the lungs and brain take up the oxygen and carry it to the heart, which distributes it through the body. The lungs are simply a mass of air passages. The cell capacity of the lungs is 220 cubic inches; but the minute cells of the lungs expose 440 square feet of surface. So that every time we inflate the lungs, we cause the air to come in contact with 440 square feet of tissue, and the blood is thus rapidly oxygenized. It is sent to the remote vessels, where it is carbonized. The oxygen is there exhausted. If we should have this flow of blood to the muscles interrupted they would become paralyzed; if cut off from the brain, we should become unconscious.

I have already stated that a man consumes fourteen ounces of carbon daily. Therefore one pound of carbon per day represents the combustion in a man. It represents the muscular power which is developed by the activity of a man. Three hundred pounds of carbon represent a man's work in a year! This is his muscular work in a year.

Heat is power. Coal burned under steam boilers supplies the power to move machinery, drive locomotives, propel steamships, run mills. It takes the place of human muscle.

Dr. Lardner has given us an excellent illustration of the power of coal. Herodotus tells us that it required 100,000 men twenty years to build the great pyramid of Egypt. Dr. Lardner estimates that 480 tons of coal would have hoisted every block of stone into its place.

The burning of coal is now a source of great national wealth. Great Britain now leads the world, simply because she mines and consumes more coal than any other country. In Great Britain 20,000,000 tons of coal are consumed in a year under steam boilers, which is equal to the muscle of 133,000,000 of men. What an enormous power is here represented in an industrial point of view! She has only 12,000 square miles of coal area; we have 130,000 square miles of coal area. Great Britain raises, for heat, exportation and other purposes, 110,000,000 of tons a year, while the United States has thirty times as much coal land, and only raises 30,000,000. We have a treasure of coal beneath our territory, which would enable us to do all the work of 400,000,000 of men. This is the secret of the wealth of countries where manufacturing industries prevail.

The Sun the Source of Power.

And the power which is derived from the coal is, after all, only sun power. It is the power of the sun that drives the steam engine; it was the chemical force of the sun which caused the plants to grow which produced the coal. Coal is sun power stored up hundreds of thousands of years ago for the use of man. Almost all the power and force that we have in the earth come from the sun. From the sun comes my activity this moment; it gives me food, and food makes my muscles, nerves and brain, which are now undergoing oxidation to supply the force by which I think, speak and act.

The sun, therefore, is the great source of power. We depend upon it for heat, for light, for thought. We live by it. It is the power which drives our steam engines. Its power is exhibited everywhere.

Fires — their Causes and Prevention.

I want to say a word or two with regard to fires, which are a most undesirable form of combustion. From September 1, 1869, to May 31, 1871, the last two years, the damage by fire, not counting Chicago, cost us $76,150,000, only about one-half covered by insurance. It therefore becomes extremely important to ascertain the causes of these fires. The first step in preventing fires is to ascertain the causes.

Out of 752 cases of fire, 200 were caused by incendiaries. In fact, the most frequent cause of fires is incendiarism, and this is more prevalent in the country than in the cities, because the buildings are more combustible and less protected.

Next in order comes petroleum. In regard to frequency, this stands second on the list. Out of these 752 fires, eighty-five were traced to kerosene and naphtha, the products of petroleum; defective chimneys caused forty-four; defective flues, three; spontaneous combustion, twenty-seven. To recapitulate: Of 752 fires throughout the United States, the origin of which was ascertained with tolerable certainty, there were due to,

1. Incendiarism	200
2. Kerosene, naphtha, etc.	85
3. Defective chimneys	44
4. Stoves and stovepipes	30
5. Spontaneous combustion	27
6. Furnaces	17
7. Steam engines	16

I glanced over very recently the report of the fire marshal of the city of New York, Mr. Charles N. Bracket, for the year ending October 31, 1870: 866 fires were reported to have occurred during the year, resulting in a loss of nearly $3,000,000. Carelessness with fires and matches, 236; children playing with matches caused thirty. Out of these 866 fires, 157 were traced to kerosene, liquid gas and other products of petroleum,—eighteen per cent of the whole number; twenty-four were the result of spontaneous combustion; incendiaries, forty-four. One cause of fires was lace curtains; whole number, forty-three. More than five per cent originated from lace curtains catching fire from gas-burners, which may be prevented by the use of such solutions as we have described.

KEROSENE FIRES.

These kerosene fires have attracted my special attention, because they are entirely unnecessary. There never should be another kerosene fire or accident from the use of kerosene; fires may unavoidably occur in factories where oil is refined in large quantities, but there should never be another fire from kerosene in our houses.

On examining this subject more closely, I found that the petroleum fires are classified as follows:

I. Fires caused by kerosene:

Explosion of lamps	71
Upsetting of lamps	30
Filling of lamps	8
Breaking of lamps	2
Carelessness in handling lamps	4
Ignition while pumping oil	1
From kerosene	116

II. Fires caused by the lighter products of petroleum, benzine, naphtha, gasoline, "liquid gas," "safety oil," etc.:

Explosion of lamps	18
Upsetting of lamps	3
Carelessness in filling lamps	6
Breaking of lamps	2
Ignition of vapor	8
Carelessness in testing, filling or pumping	3
Leak	1
From lighter products	41
Total from petroleum products	157

It has been estimated that the loss from kerosene and naphtha in the United States is $2,000,000 per annum, and that from one to two thousand lives are annually lost from the same cause.

Is this necessary? Of course, a certain number of accidents from fire must result, wherever fire is employed. They are unavoidable. There is a certain per centage of accidents and loss that we cannot escape. But is this true of our kerosene accidents?

The petroleum as it comes from the earth is a mixture of a variety of constituents, some safe, some highly dangerous. It is the duty of the refiner to separate these deleterious constituents, so that the refined kerosene shall be entirely free from the dangerous elements, and not liable to take fire. Many refiners do this already, and many more do not, who would do it were it possible to compete successfully with those who do not. The accidents are due either to the fact that the refiner fails to purify the kerosene properly, or else the retailer sells to his customers a mixture of good kerosene with naphtha, or naphtha all by itself.

Refining Petroleum.

Petroleum crude, as it comes from the wells in Pennsylvania, is generally a dark greenish-brown liquid, of a somewhat offensive odor, varying, in specific gravity or density, from 0.820 to 0.782, or 40° to 48° Beaumé. It is chiefly a mixture of a great number of hydrocarbons, compounds of carbon and hydrogen, the average proportion of the two elements in the mixture being:

Carbon	85
Hydrogen	15
	100

These hydrocarbons differ from each other in volatility. Some are so volatile as to evaporate rapidly at ordinary temperature, making it dangerous to approach an open tank of petroleum with a flame; others are much less volatile, some requiring a temperature of 700° to 800° F. to vaporize them.

The volatility of these component hydrocarbons is intimately related to their specific gravity or weight, the lightest ones being the most volatile, while the heavier oils possess the higher boiling points.

The inflammability of the oils is also intimately connected with the volatility and specific gravity. The light volatile oils ignite on the approach of a burning match, no matter how cold they may be, while the heavy, less volatile oils can only be ignited when they are heated above the ordinary temperature of the air.

The dark, offensive petroleum is subjected to a process of refining, in order to separate, from the portion designed for burning in lamps,

First. The lighter oils, which are very inflammable, and, owing to their volatility, evolve vapors at ordinary temperatures which, when mixed with the proper proportions of air, constitute explosive mixtures.

Second. The heavier oils, which do not burn well in lamps, but are excellent lubricators. From these oils is obtained, by chilling and pressing, the solid paraffin which is used for candles, for waterproofing cloth, etc.

Third. The tarry matter, which would crust the wicks of the lamps.

Fourth. The coloring matter.

Fifth. The compounds which cause the offensive odors of the crude oil.

Refining, as usually practiced, involves three successive operations:

First. Fractional distillation.

Second. Agitation with sulphuric acid.

Third. Agitation with hydrate of soda or ammonia.

For fractional distillation the apparatus employed consists of an iron still, provided with a coil or worm of wrought iron pipe, which is submerged in a tank of water for the purpose of cooling it. When the still has been filled with crude oil the fire is lighted beneath it, and soon the oil begins to boil. The first products of distillation are gases; at ordinary temperature they pass through the coil and escape without being condensed.

Soon the vapors begin to condense in the worm, and a stream of oil trickles from the far end of the coil into the receiving tank. The first oils obtained have a gravity of about 95° B.; as the distillation proceeds the product becomes heavier, 90° B., 85° B., 80° B., 75° B., 70° B., and so on.

In most establishments it is customary to run the product into one tank till the gravity reaches 65° B. to 59° B.; the product known as crude naphtha being subsequently separated by redistillation into (1) gasoline, the lightest; (2) naphtha; (3) benzine. When the stream of oil runs from the coil with a gravity from 65° to 59° B., it is diverted into the kerosene tank and continues to run into this receiver till the gravity reaches about 38° B., or until the color deepens to a yellow. This second fraction is the burning oil or kerosene, and is subsequently purified by sulphuric acid and alkali.

After taking off the burning oil, the stream is directed to the paraffin oil tanks, and continues to run there till nothing remains in the still save coke. The last products have a gravity of about 25° B.

The burning oil is deodorized and bleached for market with sulphuric acid and alkali; the crude naphtha is sold for from three to five cents per gallon, and poured down the oil wells nominally to clean them, but practically to be sold to the refiner again in the crude oil at fourteen cents per gallon, or it is sold to be redistilled for gasoline, refined naphtha and benzine. The well owners are many of them dishonest enough to pour the naphtha into the crude oil tank. This adulteration now averages fifteen per cent.

Some manufacturers, who pride themselves upon the superior quality of their special brands of oil, separate certain portions of the distillate and send them to market as unusually safe oils.

The astral oil is probably the oil which runs from about 54° to 44° B.; in other words, the "heart" of the burning oil. As it does not contain the lighter portions of the ordinary oil, its flashing point is 125° F., or 25° above the standard of safety, although its average gravity is 49° B. The "mineral sperm" is a heavy oil, which probably runs between 40° B. and 32° B., averaging 36° B. This is so heavy and requires so high a temperature to volatilize it that it does not evolve an inflammable vapor below 262° F., nor take the fire below 300° F. Practically it is as safe as whale oil.

The reason why most of the kerosene in the market is unsafe is this: The crude naphtha sells at from three to five cents per gallon, while the refined petroleum or kerosene sells for twenty to twenty-five cents. As great competition exists among the refiners, there is a strong inducement to turn the heavier portions of the naphtha into the kerosene tank, so as to get for it the price of kerosene. They change the direction of the stream from the coil of the still when it reaches 65° to 63° B., instead of waiting till it reaches 58°. Thus the highly volatile explosive naphtha or benzine is allowed to run into the kerosene, rendering the whole highly dangerous. Dr. D. B. White, president of the board of health of New Orleans, found that, experimenting on an oil which flashed at 113° F., an addition of

One per cent of naphtha caused it to flash at					103° F.
Two	"	"	"	"	92°
Five	"	"	"	"	83°
Ten	"	"	"	"	59°
Twenty	"	"	"	"	40°

After the addition of twenty per cent of naphtha the oil burned at 50° F.

It is, therefore, the cupidity of the refiner that leads him to run as much benzine as possible into the kerosene, regardless of the frightful consequences which result from the frequent explosions.

This is the secret of the entire difficulty. Either the refiner or the retail dealer wants to get twenty-five cents a gallon for the five cent naphtha, and in order to do so he sells this murderous mixture.

On every gallon of naphtha run into the kerosene tank there is a profit to the refiner of twenty cents, or on every per cent of naphtha added to the kerosene a reduction of one-fifth per cent per gallon in the cost of production, which, with kerosene at twenty-five cents per gallon, amounts to one and one-fourth per cent. For every gallon of naphtha sold as kerosene the refiner can afford to throw away four gallons. Nothing is more desirable than the discovery of some use to which the naphtha can be put, which will make such a demand for it as to raise its value above that of kerosene, that it might be the interest of the refiner to separate as much instead of as little as possible. It must not be supposed that the specific gravity of the oil can be considered a safe index of its quality. On the contrary, the specific gravity gives very little idea of the quality, for while naphtha tends to render the oil lighter, the average gravity of good oil is maintained by the heavier oils present. A poor, dangerous oil may be heavier than a safe oil.

The astral oil illustrates this fact. While it does not flash below 125° F., its gravity is 49° B.

Ordinary kerosene flashes at 86° F., but has a gravity of 47° B.

The cheapest process for making an oil that will not flash, that is, emit an inflammable vapor, below 100° F., is the following:

1. Run off the naphtha down to 58° B., instead of 65° to 62°, the usual point.

2. Then expose the oil in shallow tanks to the sun or diffused daylight for one or two days.

The increased expense of this plan of refining would not reach more than a few cents per gallon. This addition would be cheerfully paid by the consumer to insure himself and his wife and children from a horrible death.

But, the refiner says, I cannot get the advanced price because the consumer does not know my oil is safer than the cheaper article. This is true, and our only hope is in strict laws, rigidly enforced, which will make it a crime to sell an unsafe oil.

Naphtha and Benzine under False Names.

These strong statements fail, however, to do justice to the enormity of the crimes practiced by some of the oil dealers. Naphtha and benzine are freely sold under false names, selected in many cases to convey the idea of special safety.

Processes have been patented and venders have sold rights throughout the country for patented and secret processes for rendering gasoline, naphtha and benzine non-explosive.

Thus treated, these explosive oils, just as explosive as before the treatment, are sold throughout the country under trade names, such as liquid gas, aurora oil, safety gas, petroline, puroline, black diamond, septoline, anchor oil, sunlight, non-explosive burning fluid, etc., etc. These processes are not only totally ineffective, but they are ridiculous; roots, gums, barks and salts are turned indiscriminately into the benzine, to leave it just as explosive as before. One of these patents will be sufficient for illustration. Patent No. 59,797—Gasoline, forty gallons; sulphur, five pounds; rusty iron, 100 pounds; onions, one bushel; rosin, five pounds.

Naphtha, under whatever name it passes, is in one respect more dangerous than gunpowder. Gunpowder never explodes unless fire is brought to it. Naphtha, on the other hand, sends out its inflammable vapor and brings the fire from a distance. Gunpowder is thus a passive agent, while naphtha is an active one; and when introduced under the treacherous disguise of a safe oil, it is not to be wondered that frightful accidents occur.

None of these oils are explosive *per se*. They only become so when their vapors mingle with the air. It is improper to say that they will explode. It is only the mixture of their vapors with air that is thus explosive. All of them are inflammable. They emit these inflammable vapors, which make an explosive mixture when commingled with the air. If a match is put very near one of them, the vapor draws the flame down to the fluid, and the fluid takes fire.

I took the trouble, some time since, to send around to the various retail dealers, and purchased 736 specimens of the kerosene in use. Some of them were called kerosene, some liquid gas, some safety oil, some safety fluid. And out of these 736 samples only twenty-eight were found to be safe! Only twenty-eight samples out of 736! At the present time I know of very few brands of safe oil in this market. The refiners cannot compete with the trade if they sell the pure article. But there are dealers who sell safe oil. And I am going to mention the names of two or three of them, at the risk of criticism for gratuitously advertising them. Every encouragement should be held out to make safe oil.

EXPERIMENTS IN OILS.

Here is a sample of standard kerosene, manufactured by the Downer Kerosene Oil Company. Its flashing point is 115° F., and its burning point 128° F. It is thus 15° above the standard of safety, 100° F., by the flashing test, and 18° above the standard of safety, 110° F. by the burning test.

This is a specimen of the beautiful "Astral Oil," manufactured by Mr. Charles Pratt. Its flashing point is 125° F., its burning point 138° F., or from 25° to 28° above the conventional standard of safety.

With oils like these accidents never happen. At no temperature to which they are exposed in ordinary use do they evolve inflammable vavors, nor do they ever become hot enough in lamps to take fire from a flame.

This is a still safer product of petroleum; it is the "Mineral Sperm Oil," manufactured by the Downer Kerosene Oil Company. It does not flash below 262° F., nor burn below 300°. It is thus from 162° to 180° above the standard of safety.

I will now make a few experiments to show you the difference in the inflammability of these various products of petroleum. I should be glad to illustrate the explosive character of mixtures of air and the vapors of gasoline, naphtha and benzine, but some of my lady hearers extracted a promise from me not to make any explosions, so we will confine ourselves to the inflammability.

This saucer contains *gasoline.* You see, the moment a flame approaches, there is a flash from the ignition of the vapor, which reaches out in every direction, and which conveys the flame to the oil. Water, you see, has no effect upon the flame, for the oil floats on the water, and; by spreading out the oil, the water actually increases the flames. Now we will smother the flames by means of sand, which covers and absorbs the gasoline, and excludes the air necessary for its combustion. This second saucer contains *naphtha,* which is not quite as volatile as gasoline; still, you hardly notice any difference in its inflammability when I apply the flame. The same is true of the *benzine* in this saucer, which is a little less volatile than the naphtha.

Here is a sample of the common, unsafe kerosene, which is so generally sold throughout the city. It has a gravity of 47° B., flashes at 51° F., and burns at 68° F. You see, the moment the flame approaches, it flashes and takes fire, almost as readily as the benzine. This is a specimen of kerosene not as dangerous as the last, but still many degrees below the standard of safety. It has a gravity of 47° B., flashes at 82° F., and burns at 95° F. You see, I cannot cause it to flash or take fire from a flame, yet when it has been burning an hour in an orninary lamp, it will have reached a temperature at which it will be dangerous.

In these saucers are standard oils, "Downer's Standard Oil," "Astral oil," and "Downer's Mineral Sperm." I cannot cause any of them to flash or burn on applying a flame.

Here is some of G. L. Smith's so-called "Safety Oil," which is sold at 40 East Broadway. It is simply naphtha, having a density of 72° B., and emitting inflammable vapors, and taking fire at all temperatures. I have cooled it down as low as 18° F., and found it just as dangerous as at ordinrry temperatues. You see how readily its vapor takes fire now.

This is Danforth's so-called "Non-explosive Petroleum Fluid." It is simply naphtha, as is apparent from the readiness with which it takes fire.

It is a pity Smith and Danforth do not furnish fire extinguishers together with the naphtha. They both claim that they have rendered these oils non-explosive and safe, and make experiments to prove their statements. They pour some of the oil into a can and apply a flame, when it takes fire and burns without exploding, simply because they have taken care not to mingle the air and vapor in the proper explosive proportions. An excess of either prevents explosion.

Naphtha is not explosive; vapor of naphtha is not explosive; it is a mixture of naphtha vapor and air, in certain definite proportions, which is explosive. If, in experimenting, we do not hit the proper proportions, we fail to produce an explosion. Any oil that will emit an inflammable vapor at any temperature below 100° F., is liable to form explosive mixtures of vapor and air, and is dangerous. I know of no process by which the lighter products of petroleum, gasoline, naphtha and benzine can be made non-explosive or safe, nor do I believe that there is any such process. If any oil takes fire at ordinary temperatures, or below 110° F., it is proof positive that it is dangerous, and no argument or experiment can prove anything to the contrary.

This coat on its iron frame is a good representation for our purposes of a victim to kerosene. I will drench him with good kerosene; you see now that though I hold a candle to him he is in no danger. I will now throw a little of Smith's "Safety Oil" upon him; you see the moment the candle is brought near him he bursts into flames. I will save the poor wretch from a painful death by bringing the Babcock Fire Extinguisher to bear upon him. I have put him out; but were he human his days would be numbered, as a painful death would be sure to follow such frightful burns as those he has suffered from Mr. Smith's safety oil. It is said, and I believe with truth, that the burning of a square foot of the human body is sure to cause death. Before leaving this portion of the subject, I want to show you how safe it is possible to make petroleum oil. I have here a pail containing three gallons of Downer's "Mineral Sperm Oil." Into it I will plunge this mass of cotton waste till it becomes saturated with the oil; now as I raise it you see it is dripping with the oil. On holding the candle to the oily mass you see I have considerable difficulty in setting it on fire, but by heating it in one spot I shall finally heat a portion to a temperature above 300° Fahrenheit, its burning point when it will take fire. Now you see I have succeeded in starting combustion, and the burning oil quickly heats the rest of the mass till we have now a flame ten or fifteen feet high. You need not feel alarmed, for I have the flames entirely under my control. I will now plunge the burning mass into the pail of oil; you see it is at once extinguished. The "Mineral Sperm" is actually *a fire extinguisher.* But this oil will stand a much more severe test. Here we have a large pan of oil on a water bath. These two large alcohol lamps have raised the water to boiling; you see the steam escaping from this vent; the oil is at 212° F., 112° above the standard flashing point and at 102° above the standard burning point of safe oil. Yet you now see that this mass of cotton waste which was saturated with the oil, and was but a moment ago wrapped in flames, is now quietly extinguished. The "Mineral Sperm" is a fire extinguisher even when heated to 212° F. Am I wrong in saying it is practically as safe as whale oil?

The So-called Safety Lamps.

A great number of safety lamps have been patented, with a view to make it possible to burn the explosive, inflammable naphthas without danger. Many of these have been submitted to me for examination, and the conviction is unavoidable that they are anything but a blessing. No matter how well they realize the idea of protecting the oil they contain from explosion, they are treacherous friends. They allay one's fears of explosive oils, and the accident, which is always much more likely to occur outside than within lamps, is just as likely to take place.

The lamp is dropped and broken; it is filled while burning; the servant neglects to screw in the wick tube; the oil can is upset or left uncorked, or the servant uses the oil to kindle the fire. In some way or other fire gets to the vapor of oil, and an explosion occurs. Even when the "safety lamp" has an ally in the form of a "safety can," it still fails to make naphtha safe. It is an axiom that no lamp is safe with dangerous oil, and every lamp is safe with safe oil.

Half the so-called "safety lamps" are no safer than those which make no claim to safety; while the other half are only safe as long as they are in perfect order, and subject to no carelessness in the filling or handling. Persons will be careless and thoughtless; it is human nature to be so. What we want is safe oil; with it all lamps will be safe. The safety lamp is positively objectionable, as it leads persons to purchase dangerous oils without question.

Another device, by which these oils are brought into use is, by means of gas lamps, so called. They are a contrivance by which the volatile liquid is converted into gas, and then burned. This is simply the ordinary oil or naphtha placed in a lamp with a long tube running upward; a wick passes up through the tube, and there is a large number of holes around the top of the tube. It is necessary to continue the application of heat to this tube for a few seconds until the fluid is vaporized, and then it gives a pretty flame. There are various modifications of this principle in the construction of lamps, but the fluid used is still this dangerous naphtha. None of these devices are safe.

"Vapor" and other Naphtha Stoves.

In this connection the "vapor stoves" demand some consideration. These stoves are supplied with naphtha (sold under various names) from a reservoir at one side, the supply being regulated by a stop-cock. The naphtha flows into a tube or chamber, which is maintained at a high temperature by the combustion; here it is vaporized to escape through suitable orifices and burn. These stoves are arranged for cooking, as well as for heating apartments. These contrivances are all, without exception, highly dangerous. They are supplied with benzine or naphtha, which is always liable to take fire, and to produce explosive vapors. Several large fires have been already caused by these stoves, and when they shall have been more generally adopted we may expect accidents to multiply rapidly. A keg of gunpowder in a building is not as dangerous as one of these stoves.

Petroleum a Great Boon to Man.

And yet this kerosene is one of the greatest boons of the age. Certainly an illuminating material which gives, in a cheap lamp, an amount of light equal to that of eight sperm candles, at a cost of one-third of a cent an hour, is an inestimable boon to the world. It adds several hours to the length of the day, and enables the working classes to devote the long evenings to the improvement of their minds by reading; or where the labors of the day must be prolonged into the night, it saves the eyes from the inevitable ruin which would follow the use of insufficient light. The sanitary advantages of a clear, smokeless light are inestimable. Without attempting to follow out all the good influences which may be attributed to the new illuminating material, it is safe to say that petroleum is one of the great civilizing agents of the nineteenth century.

The cost of light obtained by kerosene is very much less than that from any other material. A light equal to eight sperm candles, obtained from good gas at three dollars per 1,000 feet, will cost three-fourths of a cent an hour. This table shows that the average cost per hour of light equal to eight sperm candles is:

From sperm candles, at 42 cents per pound	$5\frac{76}{100}$	cents.
Gas, at $3 per 1,000 feet	$0\frac{75}{100}$	"
Mineral sperm oil, in German student lamp, at 75 cents per gallon	$0\frac{57}{100}$	"
Mineral sperm oil, in Merrill's lamp, at 75 cents per gallon	$0\frac{48}{100}$	"
Mineral sperm oil, in Dual wick lamp $\frac{5}{8}$ in.............	$0\frac{56}{100}$	"
Mineral sperm oil, in Dual wick lamp $\frac{7}{8}$ in.............	$0\frac{54}{100}$	"
Astral oil, flat wick lamp, at 50 cents per gallon	$0\frac{46}{100}$	"
Astral oil, German student lamp, at 50 cents per gallon,	$0\frac{44}{100}$	"
Astral oil, in Merrill's lamp, at 50 cents per gallon.....	$0\frac{34}{100}$	"
Standard kerosene, in flat wick lamp, at 40 cents per gallon	$0\frac{33}{100}$	"
Standard kerosene, in German student lamp, at 40 cents per gallon	$0\frac{31}{100}$	"
Standard kerosene, in Dual wick lamp $\frac{5}{8}$ in............	$\frac{35}{100}$	"
Standard kerosene, in Dual wick lamp $\frac{7}{8}$ in............	$\frac{31}{100}$	"
Standard kerosene, in Merrill's lamp, at 40 cents per gallon	$0\frac{28}{100}$	"
Common kerosene, unsafe, in flat wick lamp, 30 cents per gallon	$0\frac{27}{100}$	"

Petroleum Legislation.

Every effort thus far to procure suitable legislation upon this subject has proved unsuccessful. There is no law on the statute books which effectually protects the public from these dangerous oils. There has always been some defect in the construction of the law, and the judges have been obliged to throw cases out of court in consequence. In several cases, when parties were brought before our city judges, the cases were thrown out of court simply because the party stated in his affidavit that he rendered his oil non-explosive by certain chemical processes. It is now perfectly legal to sell these dangerous oils according to the rules of the court.

In order to have an effectual law, we must, in the first place, make it a crime against the people to sell burning oil for illuminating purposes which will emit an inflammable vapor below 100° Fahrenheit.

The failure in many cases is because the whole business has been put into the hands of inspectors who are controlled by political motives and influences. It should be detected and prosecuted like the crime of murder, arson or theft, and any person that can prove that the oil sold was below the standard should be an acceptable witness.

The apathy of the public in regard to this matter is beyond my comprehension. These facts are well known in almost every community, and yet, although it is now twelve or thirteen years since this class of oils came into general use, we have as yet no adequate legislation for the protection of life or property.

It is now four years since the Metropolitan Board of Health took up this subject and presented it to the public in its true light, and yet to this day we have no results, no improvement in the character of the oils sold. The blood of more than 1,000 women and children, cruelly murdered in the United States during the past year, cries to heaven for vengeance on those who sacrificed them for a profit of a few cents on a gallon of oil. Where are our legislators? Why do they not enact efficient laws to protect us? Look to Albany, where they are peddling votes to rival railroad schemes, while their constituents are writhing in the fatal flames of naphtha and patent safety oil.

Nothing but the most stringent laws—making it a State prison offense to mix naphtha and illuminating oil, or to sell any product of petroleum as an illuminating oil or fluid, to be used in lamps, or to be burned except in air gas machines, that will evolve an inflammable vapor below 100° F., or, better, 110° F.—will be effectual in remedying the evil. In case of accident from the sale of oil below the standard, the seller should be compelled to pay all damage to property, and if a life is sacrificed should be punished for manslaughter. It must be made extremely hazardous to sell such oils.

Combustible Character of our Buildings.

The frequency of fires in this country is largely due to our peculiar system of building, To be sure, this is to a great extent necessitated by the character of the materials which we are compelled by economy to employ. Outside of a few large cities, where wooden buildings are not permitted, the most available material is pine wood, which is highly inflammable, much more so than the hard woods generally used in Europe. But our system of building is unfortunate; we make our floors hollow, and our walls hollow, so that there is free communication from cellar to roof within the walls, floors and partitions, by which the flames are enabled almost unseen to wrap an entire structure in their fatal embrace. Then we place smoke and hot air flues in thin partitions and walls, in far too dangerous proximity to wood work. Often the floor timbers are run into absolute contact with bricks of flues which are liable to become over heated. Even in laying the bricks of chimneys and flues great carelessness prevails; care is not taken to lap the joints. Smoke flues should always be covered by two thicknesses of brick, and both the vertical and horizontal joints of the inside tier should be covered by the outer tier, so that no flame and no sparks can possibly escape through spaces left unfilled by mortar.

As a substitute for two thicknesses of brick, and one which offers, I think, greater security, the smoke flues may be formed of cement pipes, well jointed with a single layer of bricks over them.

FIRE-PROOF BUILDINGS.

Our system for constructing fire-proof buildings is very good, though no building can be called fire-proof which is not protected by well made iron shutters. Our rolled iron beams, twelve or fourteen inches high, and brick arches, make fire-proof buildings too expensive for many purposes; banks, railroad corporations, insurance companies and rich firms can afford them, but hotels can rarely afford them, and they are out of the question for private dwellings. The increased expense is not due to the iron beams and arches alone, but to the fact that the enormous weight of the floors makes it necessary to build deeper and more massive foundations, and thicker walls. Nothing is more desirable than a system of cheap semi-fire-proof buildings; buildings which, while not sufficiently fire-proof to withstand a great conflagration, should be so non-inflammable as to make great conflagrations impossible. A great fire like that which destroyed so much of Chicago would be impossible in most European cities, simply because the buildings are so non-inflammable that fire rarely passes from one to another. Almost every house in Paris is semi-fire-proof. Even with the aid of petroleum, the communists failed to destroy any large portions of the city. Stone, iron and plaster of Paris are the building materials chiefly employed there, with some bricks and but little wood, the latter hard wood. The floors are made of iron and plaster of Paris, with a covering of boards above. Light iron beams, not more than three or four inches high, are set about three feet apart; at right angles to these, about three feet apart, run short, light flat iron bars which hook at the ends over the beams, and hang even with their under edges. Parallel with the beams, and loosely resting on the cross bars, run strips of hoop iron, two or three between every two beams. When this light iron net work is complete, a temporary table is placed in contact with the under side and plaster of Paris poured in from above, nearly even with the upper edges of the beams; this sets hard in a few minutes, forming a solid floor only three or four inches thick, consisting of artificial stone on a strong skeleton of wrought iron, which is fire-proof. On this is laid, if desired, a floor of boards. Partitions are made by setting up a row of rough hard-wood strips with spaces between them, and, with the aid of boards placed temporarily on each side, plaster of Paris is introduced, which solidifies, forming a solid stone wall, one and a half or two inches thick, with its wooden skeleton. Thus the walls and floors are not only solid without spaces, but they are non-inflammable. Such buildings are little more expensive than our combustible structures.

I remember I was once passing the Palais Royale in Paris, when a fire broke out in a room in the second story, used as a restaurant. I was at that time, like other young men, very much interested in fires, although I was not a member of a fire company, and I ran to the scene of action. I was very much struck with the difference in the circumstances of a fire there and at home. Several times I was compelled to take to my heels to escape the police, who charged on the crowd of spectators to secure men to pass buckets of water. Instead of a steam fire engine, I noticed a very pompous body of men coming down the street with a hand engine apparently about the capacity of one of our garden engines, and instead of having such a suction hose as we are accustomed to see attached to our engines to draw water from the hydrants, the water was actually brought from a hydrant a block distant in a barrel on wheels, and poured into the engine, which could hardly throw a stream to the second floor.

I was utterly astonished not to see the entire building wrapped in flames. And yet the only loss sustained was the furniture and contents of this one room. The reason was that the partitions were solid, the floors were solid, and any room might be burned out, and rarely set the building on fire.

And as I went away from that fire I moralized over it. At first I was inclined to ridicule the French *pompiers* (pumpers). But on second thought, remembering that *prevention is better than cure*, I concluded that they exhibited their wisdom in making their buildings so fire-proof as to need no steam fire engines or efficient hose companies.

We have attacked this question from the rear, *a tergo;* we began by providing a most efficient fire department; though lately we have secured a very good fire and building law, and shall by its enforcement greatly diminish the dangers of fire. Still much remains to be done, and it seems as though we might get some valuable hints from the experience and practice of our French neighbors.

A Fire-proof Building for the American Institute.

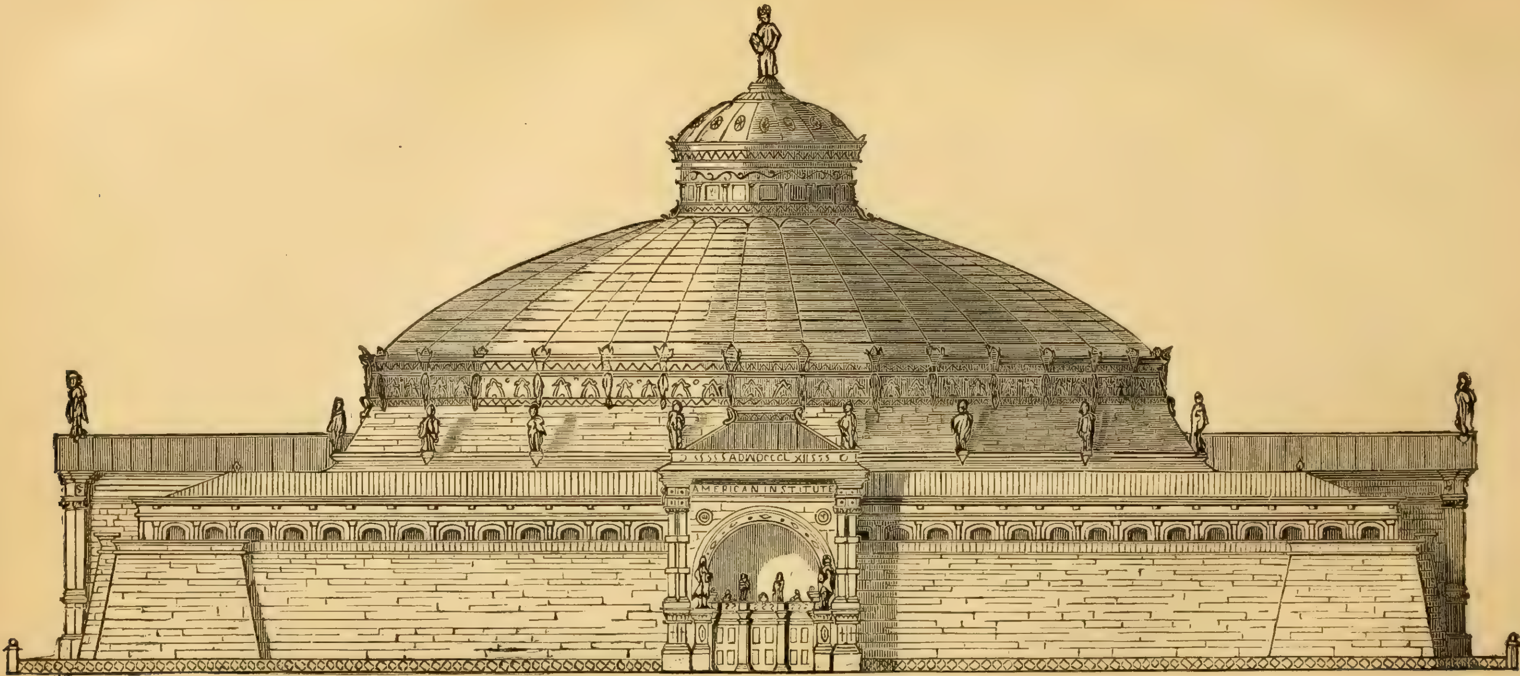
Before closing my lecture, to which you have listened with surprising patience, I must say a word with regard to the importance of a suitable building for the exhibitions of this Institute. The last exhibition was most creditable. Under the great roof of the Rink could be seen illustrations of every art and trade, the products of all, and the machinery of many in actual operation. The pumps, the saws, the printing-press, the busy loom, and hundreds of other labor-saving machines, were in full activity. As a means of education, nothing can be more valuable or effective; but it must be made permanent, and, as an inducement to exhibitors, it should be held in a fire-proof building. My attention has been called by my friend, Mr. E. D. Lindsay, of this city, who is an accomplished architect, to the advantages offered by the reservoir on Fifth avenue. It has been stated in the papers that it is the purpose of the city government to abandon the use of this structure as a reservoir, and to dispose of it to the highest bidder, as it is said to be no longer required by the Croton department. Its capacity is only 20,000,000 gallons, less than one-fourth the daily consumption of the city, while the reservoirs in the Central Park have a capacity of 1,038,000,000 gallons.

Considering the importance of the object, in its effect on the education of the people, nothing would be more proper than for the city to hand the reservoïr over to the American Institute, to be converted into a grand Palace of Industry, for permanent exhibitions. Its location is admirable, and, on special occasions, the adjacent park could be made use of for special classes of machinery. The dimensions of the reservoir are 460 feet square, or more than four acres. The walls are most massive, sloping inward and outward, and containing a series of chambers connected by arches, which could be used as a grand arcade running entirely around the building. The cross-wall of granite, which divides the reservoir, would furnish more than enough material for the construction of four massive entrances, one on each face of the building. A light arched roof of iron and glass could be erected over the interior, leaving a gallery to surmount the walls, which would be fifteen feet wide and 1,840 feet, or one-third of a mile long, admirably suited for statuary, paintings, photographs, and other works of art. The floor of over four acres would furnish ample space for everything it would be desirable to exhibit, with room for thousands of visitors. An inside gallery would furnish seats overlooking the whole. Five rows of seats would accommodate five thousand persons. A space could be reserved in the center for a platform, and the building could be used for monster concerts. Twenty thousand persons could be easily admitted to the exhibitions at one time.

Mr. Lindsay has kindly furnished me with interior and exterior sketches of the proposed building, which have been photographed on glass, and which I will now project upon the screen, with the aid of the magic lantern. He estimates that the total expense of adapting the reservoir to the wants of the Institute would not exceed half a million of dollars, a sum which is trifling when the importance of the object is considered, and which, I am sure, we can readily secure.

Even should it be desirable to continue to use the reservoir for the purpose for which it was constructed, this plan could still be carried out, as a substantial floor of iron could be laid above the water-level.

This is, perhaps, a crude project; but there is still considerable plausibility in the idea of converting the old, useless reservoir into a great, permanent school for the instruction of the public in all branches of applied science, chemistry and the mechanic arts. Perhaps, emboldened by your patient attention to-night, I may some day venture to lecture to an audience of twenty thousand in the Industrial Palace of the American Institute, on Fifth avenue.



PROPOSED BUILDING FOR THE AMERICAN INSTITUTE, ON FIFTH AVENUE, NEW YORK.

PROCEEDINGS OF THE FARMERS' CLUB.

RULES AND REGULATIONS OF THE FARMERS' CLUB OF THE AMERICAN INSTITUTE, ADOPTED BY THE COMMITTEE ON AGRICULTURE.

1. Any person may become a member and take part in proceedings, by conforming to its rules.

2. The officers shall be a President and Secretary, to be chosen by the committee, in April, and hold for one year, and until successors are chosen or appointed. In absence of President, a chairman *pro tem.* shall be chosen by the Club.

3. Any member, for disorderly conduct, may be expelled by a vote of a majority present.

4. The Secretary shall keep the minutes of the Club and have control of the same.

5. The President may at any time call a person to order and require him to discontinue his remarks.

6. The meetings of the Club shall be held every Tuesday, at one o'clock P. M., and continue for two hours, unless otherwise determined.

7. Discussion shall be confined to agriculture, horticulture, pomology, and subjects connected therewith, and what relates to rural improvement.

8. All members of committees shall, so far as practicable, be members of the American Institute.

9. Questions or inquiries shall be made through the chair, but answers must be brief, and not lead to debate.

10. Any person desiring to speak shall rise and address the chair, and avoid personalities, and confine his remarks to the subject before the meeting; and the vote of any person may be challenged, unless a member of the American Institute.

11. No person shall speak more than twice on the same subject, or occupy more than ten minutes, unless by consent of the meeting.

12. Particular subjects may be fixed upon for any meeting, and in that case shall be taken up for consideration at two o'clock.

13. The usual parliamentary rules shall govern, when not provided for by these rules.

Members of the American Institute are members of the Club.

May 2, 1871.

The regular session of the Club was held on Tuesday at one o'clock P. M. Nathan C. Ely, Esq., the president of the Club, called the meeting to order; Mr. John W. Chambers filling the post of permanent secretary.

HOG RAISING.

Mr. Richard Skinner, Athens, Texas.—I write to congratulate Dr. J. V. C. Smith upon his late heresy vindicating nature's laws respecting the animal creation, and especially the hog. I am satisfied that, like many other things at one time denominated heresy, it will become one of the first principles of the established church. I have practiced the same heresy for the last fifteen years, never during that time having confined a hog to a "stye" or close pen. Nor have I killed or eaten one that might be considered a "gob of fat." If he weighs 200 pounds at two or three years old, that will do. I could write a lengthy dissertation upon hog-raising in this county and State, but desist. Our pork costs us about on an average three and a half cents per pound. I found from observation many years ago that the hog fattened in a stye or close pen, and made so fat that he could scarcely stand up, when killed had a diseased liver, and frequently the kidneys literally riddled with kidney worms. I also imagined that the meat smelt of the pig stye. Now, when I fatten upon corn, I let the hogs run in an open field, or, if penned, give them a large, roomy one, and instead of cooking their food I give them a variety, some raw, some soaked, and soured, etc. The hogs make their own beds and exercise as they see fit. I have just such meat as I desire. Although he can be fattened faster on cooked food and in a close pen, I believe it bad economy. Bestow the same labor and cost on a greater number and let them run and grow a year longer and you will find that you have as much meat, and that that is healthier, and also a heavy increase in the number of your stock. Ask any of the learned gentlemen of your deservedly famous Club if he ever ate any of the bacon of a hog that was fattened upon fish? If so, did it not taste fishy? Again, of a hog raised and fattened at a distillery. Did not the meat taste like the odor of whisky? And again, if fastened exclusively in the horse lot, did he not imagine that the meat had some of the odor of the stable about it? In all such cases it is necessary to put the hog up and feed him on proper food if you want palatable meat. In this country we fatten on corn, peas, slops, etc., one year in four, and partially one year in four. The other two years our hogs got as fat as we want them on the mast. Those two years we have the sweetest and best meat, but the lard is not so firm and white, but equally sweet, and the hogs so fattened have never eaten more than one bushel of corn each. We look for such a year in 1872, and if I live I intend to send to the Farmers' Club a shoulder, middling, and ham cured with native salt, and that alone, and let them boil, broil, fry and bake, smell and taste what I call good enough for anybody to eat, except a Jew. I have fifty head of hogs. They all eat one peck of corn per week, worth twenty-five cents. It requires that much to keep them gentle. In addition to that they get a little milk and salt slops, etc., etc. That is sufficient until the mast begins to fall in November. If no mast, they take the run of the corn-field, and are fattened on dry corn, peas, etc., from four to eight weeks; if the mast is good they are fat by the first of January or February. If the mast is not good we kill only what will do the family, and let the rest run another year, as the older the hog the easier he is to fatten.

Mr. H. L. Reade.—Recurring to the subject of cooking food, there is a notable fact, namely, that during the past five years probably five thousand farmers have tried experiments, and probably nine-tenths of the number have found the use of cooked food an advantage of at least twenty-five per cent.

The Chairman.—Our Texas friend makes the point that the cooking deteriorates the quality of the meat produced.

Robert W. Clay, Olney, Ill.—Dr. Smith's essay on raw victuals has to me the right ring. The idea of a few modernists to improve or change the laws of nature certainly is absurd. I know that many men have demonstrated (to themselves) that cooked food is far superior to raw food in producing mutton, beef and pork, but their cases are isolated ones, and only appear true from the stubborn fact that art has exhausted all her resources while nature has not. Give a hog all he will eat of sound corn, or other raw food, with plenty of salt and water, and he will be healthier and more thrifty than under any other treatment.

Application of the Salt Mixture to Corn.

Mr. Joseph Bagstock, Spring Mills, N. Y., made allusion to a large crop of corn. The ground, sand, gravel and loam, first had thirty loads of manure. Then was ploughed eight to ten inches deep, thoroughly pulverized, then plated with the rows each way, spatting the hills with the hoe as planted; then, as soon as possible after the planting was done, he applied a composition of salt, gypsum and ashes, thoroughly mixed together at the rate of one bushel of salt, two bushels of gypsum, and four bushels of leached ashes to two acres. Two rows left without any of this composition were cut up, shocked and husked, as were the two adjoining rows by themselves, and both weighed. The result was thirty-eight per cent gain by the use of the composition, and the increase in fodder was worth enough to more than pay the cost.

Mr. H. L. Reade—I consider this subject one of the most important that could come up for consideration. Salt is destined to act no inconsiderable part in furnishing, either directly or indirectly, plant food within the next ten years. I have experimented somewhat with it, and am prepared to say that on light soils, especially if they are both sandy and dry, it is worthy far more in comparison to its cost than any fertilizer I have ever used. How to apply it, mix with what other material, and in what proportions, must be determined by careful testing. Some of these experiments are now being tried, and I hope to be able later in the year to make a report. I would advise farmers everywhere to try salt both on potatoes and corn, and carefully note its effects. They will learn something valuable themselves, and their knowledge may benefit others.

Prof. J. A. Whitney—There can be no doubt that on all soils of a sandy character the use of salt will be found of great benefit, applied at the rate of from two to five hundred pounds per acre. It acts mainly as a chemical agent to dissolve silica, which is needed to give stiffness to the straw, and which forms an essential part of the hull of the kernel. It does not, however, show any decided advantage for cereals, such as wheat and rye, unless used with the nitrate of soda, which is now imported and sold at moderate prices in New York. Equal parts of nitrate and salt are found to be much better than the same weight of either alone. Sown as a top-dressing on rank pastures it reduces the quantity of herbage, but improves its quality, making the grass sweeter and more tender, so that cattle graze upon it with more avidity. It is a specific manure for mangel-wurzel; but while it greatly increases the crop it is thought by many that the nutritive properties of the root are lessened. On the right kinds of soil there is probably no manurial substance that will pay a greater profit on the outlay, but on stiff clays and soggy lands little or no benefit can be expected from its use. A series of original experiments with salt, used by itself and in combination with other manures, would be of great value if their results were accurately observed and recorded and made public through the Farmers' Club. Let a dozen farmers in different parts of the country each select three or four pieces of land a few rods square and having a light loam or sandy soil. Manure one with a given weight of salt alone, another with salt and ashes, another with salt, lime and plaster, another with salt and barn-yard manure, and another with salt and nitrate of soda. Note down the general appearance and growth of the crop. Weigh the straw and chaff, and the same with the grain, and send the results to the chairman of the Club. This will give facts which are always needed to confirm the scientific principles of agriculture.

Mr. C. D. Bragdon—Will the professor please state what would be the effect of salt on alluvial soil?

Prof. J. A. Whitney—If the soil contains an excess of organic matter I would treat it with lime before applying salt. The advantages of the use of salt are almost wholly apparent on sand, for the reason mentioned a moment ago, and I should say that on a peat soil the benefit would be slight. There is no doubt that salt dissolves many other matters besides silica, and helps to carry them into the circulation of plants with more readiness than the organic solutions commonly present in the soil. Salt differs from ammonia, potash, and other constituents of plant nutrition in this, that whereas ammonia, potash, etc., are assimilated and combined to form new vegetable matter, the salt in solution often circulates through the plant without being assimilated at all, and can be obtained by proper analysis as pure as when it was applied to the ground, having undergone no change whatever.

Mr. H. T. Williams—Some horticulturists in Pennsylvania claim to have proved that salt has large influence in preventing pear blight, and they are using it liberally, having increased the application from 200 to 400 bushels per acre.

GREAT CROPS AND HOW GROWN.

D S. Curliss, Harrisburg, Pa.—The soil was a light sand on a small ridge twelve miles from Chicago. In the winter he spread a good thickness of fresh barn-yard manure all over it; then, in April, he ploughed it under, with furrows about six inches deep, and gave it a thorough harrowing; then, with a small plough he ran furrows about four inches deep, north and south, four feet apart, and marked across them, east and west, three feet apart; at the corners he put a light shovelful of well-rotted manure, and planted the corn, four kernels in the hill, and covered it well, about two inches deep, after soaking the seed six to eight hours in copperas-water, and dried it in ashes or sand.

When it was fairly up, so as to show the rows, he put a small quantity of old leached ashes on each hill; carefully hoed it once, and thrice worked it with a cultivator — once each way of the hills — cleaning out all weeds. When it had a good growth, about two feet high, he went through it and carefully cut out all but two stalks to the hill, leaving the stoutest stalks; and what was cut out more than paid for the time, in best kind of food for his cows. From this treatment he harvested, as above, 100 bushels of good, sound corn to the acre, at about two-thirds the cost of corn per bushel, where only sixty bushels to the acre were harvested. The second year, that is, soon after harvesting the crop, he again covered the ground with manure and ploughed it under the same fall; then, next spring, ploughed again, an inch or two deeper than the fall ploughing; planted and treated the seed same as first year and obtained the same yield. Two acres of potatoes were treated in the same manner, except not soaking the seed, but planting them in furrows (not hills), dropping two pieces every sixteen to eighteen inches apart in the furrows, and then covering them with the plough by running it along and covering the furrows back over the seed. When they were dug with the same plough running a furrow under them. The yield was 500 bushels per acre for two successive years.

BEE-KEEPING.

Mrs. Ellen S. Tupper, Brighton, Iowa, the accomplished apiarian, forwarded the following facts and suggestions, which were thankfully received: Many letters have reached me the present spring from persons who are in bee-keeping, asking information on various points. Most of these I have answered, but some have neglected to give their address, and these perhaps may be reached through you. One question repeatedly asked is this: "Will bee-keeping pay one who has no experience?" To this I answer, that it will, undoubtedly, if one is contented to begin in a small way and only increase as they gain knowledge and experience. Begin in this as in anything else — by degrees. Purchase one or two stands of bees, take care of them yourself and study their habits, and experience comes as rapidly as the bees increase. Be contented to take the counsel of others as your guide until you know something yourself by actual observation. No enterprise requires less capital or experience in making a successful beginning. The trouble with most who commence is, they find it so much easier than they expected, that they are soon too confident and go faster than more experienced bee keepers dare advance. I have seen beginners often who knew more the first season they keep bees than Quimby or Langs both ever taught them; but I usually remark that they know less after a year or two and rely more on the experience of others. Another question is, "Is there any advantage in an improved hive over an old-fashioned box hive?" I have no wish to decide upon the merits of patent hives. Their name is legion—every one "the best in all respects" if you take the word of the patentee—while the practical bee-keeper finds most of the so-called "improvements" worse than useless. Some form of movable comb hive is absolutely necessary to successful bee-keeping. The use of them makes the business a certainty instead of guess-work. With them bees can always be kept understandingly, because their wants may be known and supplied—weak ones can be added or united with others, queenless ones supplied with "mothers," and honey taken with ease from all that have a surplus. Have their frames in as simple form as possible, with no moth traps, slides or extra "fixins." "Is there danger of overstocking the country with bees?" I have no experience with eastern bee pasturage, but am convinced that in the west and south the country will never be overstocked. The honey resources are so abundant that whenever one colony can do well any conceivable number will find more honey than they can gather while it lasts. I cannot imagine bees enough to store the honey secreted here in the countless blossoms of the sugar maple, the wild fruit, the linden or the white clover. If your bees are not prospering in a favorable season, seek for the cause in the condition of the colonies rather than in a deficiency of bee pasturage. What is a honey extractor? It is an invention for taking the honey from the combs without injuring them, after which they can be returned to the hives and the bees refill them. The Germans call it a "honey slinger," and this is the proper name, as by the centrifugal force it "slings" the honey from the combs. Its introduction is a great advance in bee-keeping, for by its use the yield of honey from each hive is largely increased. At present this honey does not sell as well as "honey in the honey-comb," but as it is more widely known it will find favor.

To Preserve Trees that have been Girdled.

O. H. Huester, Groveland, Mich.—When the leaves of the girdled tree begin to open, and the bark parts freely from the wood, is the time to begin. Cut a number of scions, according to the size of the girdled tree—from two to four, or as many as eight. At each point you propose to bridge over, cut the rugged bark away, above and below, to that which is sound, and make a slight longitudinal incision in the bark, so that it will admit the scion without bruising its bark. It would be well to raise the points of the bark on each side of the incision. Now cut your scions to the proper length, allowing an inch and a half at each end to slip under the bark of the girdled tree; pare off the scion at each end, as far as it is to go under the bark—on one side only. Now slip the scion down, flattened side next the tree-wood, under the bark, at the lower incision, and, by gently bending, shorten it back to allow it to be entered above. In this manner insert the requisite number, tie a string over each splice, to keep the bark from rolling up, and cover all the several splices with grafting wax, and your tree is sure to live and outgrow the accident—provided all is done with average skill and care. I have trees in my orchard that I repaired in this way four years ago, and now, except a slight enlargement at that point, one would never suspect that they had ever been girdled; in fact, I consider them just as sound as any other trees.

Mr. S. Seeley, Long Hill, Conn.—I have kept from 100 to 300 fowls for twenty or twenty-five years past. I have kept correct account during that time of the number of bushels of grain the hens eat during each year, the amount the eggs sold for each year, the market price of the grain, etc. The eggs sold, taking one year with another, including the worth of the manure, and the eggs and chickens consumed in the family, was about fifty cents per hen more than their feed came to, at the market price of the grain. I raise but few chickens; it is cheaper for me to buy. The hens are kept in one flock; they are, most of them, the old-fashioned dung-hill fowl. I feed and water once a day, and give them all they will eat of corn, oats and buckwheat, with small potatoes when I have them, boiled and mashed, with meal mixed in them; also plenty of shell and bones cut fine; some meat in the winter. One year I had about 100 hens; I weighed all the grain. The hens ate fifty-five pounds of grain each, and laid 100 eggs per hen.

Adjourned.

May 9, 1871.

NATHAN C. ELY., Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

GROWING ORCHARD GRASS.

Mr. E. Scofield, Memphis, Mo., having read the frequent allusions to the excellence of orchard grass, desires to be informed if it can be successfully cultivated in the northeastern section of this State; also, "whether it is all it is claimed to be, and where I could procure some of the seed." He was informed that "orchard grass grows anywhere in the United States." H. W. Severance, Scottsville, N. Y., also wrote in regard to the same subject: "I have a very high opinion of 'orchard grass,' formed principally from reading of the same in the Club reports. Now, we are growing a grass quite extensively in this section, which starts early in the spring, makes good pasture, and if well fertilized does well as a meadow. I allude to 'quack.' Does orchard grass and quack bear any resemblance in point of permanency?"

Hon. George Geddes.—It is difficult and almost impossible to exterminate quack, which is not true of orchard grass.

Mr. A. S. Fuller—The species is entirely different.

COST OF COOKING FOR CATTLE.

Mr. Samuel Chase, Buxton, Me.—I have seen quite a number of statements in the papers of late in regard to the advantages of "cooking food for stock;" and as I live in a part of the country where we are considerably behind the times in regard to modern agriculture, as well as almost everything else, I wish to ask the Club what the apparatus for cooking the fodder for twenty-five or thirty head of cattle will cost, and if it is best to cut the hay with horse-power? If you, New York farmers, can save 33⅓ per cent by steaming the food, why can't we Maine farmers do the same? If it won't cost too much I want to be all prepared before another winter for the business.

Hon. George Geddes—This is a subject in which, fortunately, the farming public have great interest. I felt this some time ago, and so "interviewed" a neighbor of mine who, I think, has the best and most convenient arrangement I have seen. Like the gentleman in England who wrote a book which was to reform the world, and returning from a provincial tour found that only three copies had been sold, I am a little put out to perceive that no one seems to have read my article. The neighbor I allude to keeps 116 head of cattle, and, by cooking their food, saves $2,000 a year. He is cunning enough to make the same steam run the cutter which steams the hay. He has a little engine costing $400, a cutter, the value of which is probably $75, and a strong box or bin clamped so as to resist about thirty pounds pressure of steam. The man who has one cow may cook enough for her on his kitchen stove. The farmer who keeps twenty or thirty, or more, will find it profitable to have apparatus on purpose for the work, but there is an intermediate class who would not make this pay. Each person must judge for himself. Circumstances alter cases. But where it does pay to cook, it is a saving of from twenty-five to thirty per cent. This is proved beyond controversy.

PROFITS OF FARMING.

O. M. Tinkum, said he was born of poor, but honest parents, and commenced life for the first time on fifty acres of land somewhere in New Enland. He didn't make it pay, though he worked hard. He tried to make it an intellectual employment, as some of the city editors advised; but somehow last spring he failed to convince himself that there was anything intellectual or even poetical in drawing out manure from a wet barnyard over fields full of "sink holes."

The chairman remarked, that he should have cast a long look ahead, and seen, in his mind's eye, the golden harvests, which would follow in the wake of liberal application of manure, and deep ploughing.

FARM FENCES.

Mr. D. Y. Roger, Minburn, Iowa.—The west is to-day bankrupt with fences, more especially those portions which are lately settled, and whose people have not yet passed the tribulations of the new comer; and strange as it is, this class who suffer most, stick the most tenaciously and insanely to the old folly; they must be brayed in the mortar awhile longer before the majority will see the need of change. Here and there one finds a neighborhood, whose distance from "timber" or railroad, drives them to dispense with this fence nuisance; and the results to them in better houses, better out-buildings, more land broken the first season, and the general thriftiness and home-like look of their farmsteads amazed even the owners, and they own most reluctantly to the truth. I repeat it, the west is bankrupt with fences. Its thin woodlands are slaughtered, and lie rotting in unsightly strings about the prairie; the settlers shivered in leaky cabins last winter on account of that "string of fence." They couldn't break but twenty acres last season when they needed eighty on account of that "string of fence." Their cattle shiver and dry up for lack of shelter, the orchard was not planted, and shade trees were neglected for lack of time — good deep wells of water are wanting, good cellars, books, papers, all sacrificed to that "string of fence," and the hopes for future competence and peace are pushed far ahead by this incubus of farm fences. There is not a single sensible reason under the canopy for this waste of time and timber and muscle, not one; and the whole aim and intent of civilization is in direct opposition to it and demand a reform. Argument can be piled on argument to prove the truth of these assertions, but I only enter protest against farm fences, as I have these twenty years, and wait.

Adjourned.

May 16, 1871.

Nathan C. Ely, Esq., in the chair. Mr. John W. Chambers, Secretary.

Eastern Virginia.

Mr. Marshall, Petersburgh, Va., expressed wonder that so few people came his way, when there is, in his opinion, so much to draw them. There is, he said, despite Ku-Klux, not a more law-abiding people in the world than the people of Virginia. "I do not know of a single overt act that has occurred against a northern settler since the war. I am a northern man myself, came here with the army, and have been an earnest and active republican ever since the republican party has been in existence, and yet I have always been treated with courtesy by all with whom I have come in contact, and have made as many friends here as I could have made in any other section of our country, and mine is not an isolated case. Any northern man that may come here can rely on the friendly disposition of the inhabitants. So much in reference to the people, and now a word about the land. Our lands are well wooded and well watered; and, considering the primitive way that farming is carried on here, really productive. According to the agricultural report of 1869, you will find that our average yield per acre is fifteen bushels of corn, ten bushels of wheat, fifty bushels of potatoes, 418 pounds of tobacco, 146 tons of hay, which, considering that nine-tenths of our farmers never manure their lands, and the greater part have only a one-horse plow and some only a hoe to raise their crops with, speaks well for the fertility of the soil. Our markets are a fair average with the best in the United States, our public school system is equal to any in the north, our roads tolerably good, the health of the country unsurpassed anywhere, railroads and canals numerous, churches of all denominations in every direction, and land abundant at from five dollars to twelve dollars per acre. We have 20,000,000 acres of land, scarcely one-fourth of which is occupied; and yet, if this country were thickly settled, it could be made the garden spot of America.

Mr. J. B. Lyman —There is some good land on the river banks, but one of our farmers would take the chills if he were to work there. Away from the rivers the usual yield of wheat is about five bushels, and the corn crop not over twelve. It is good clover there that cuts a ton to the acre, and most of which I have seen would not give over 1,500 pounds. How can such land be built up without stock to make manure? How can stock be fed without grasses? How can you grow grasses on sterile sands, cold pipe-clay, and worn-out tobacco fields?

Yet there are parts of Virginia that I can recommend — the lands in the Piedmont counties — as Orange, Culpepper, Farquier, and over in the valley. Northern men will find that a far more suitable country for them than those dull, pine flats about Petersburg.

FOOD FOR PIGS.

Mr. D. D. Metcalf, Auburn, Ind.—I have a nice lot of pigs, twenty-five in number, ranging from two to three months old, and wishing to get them in market this fall, I would inquire how I had better manage them, cook the food or not? Had I better keep them in pen or on pasture, or in small lots? If cooked food is the best, had I better grind it first? I have plenty of clover pasture and corn.

Mr. F. D. Curtis —These pigs are too young to eat much clover, but it would be better for them to run out and have a chance to eat all they want. I have five Victoria pigs, young ones, which I want to make grow as fast as possible, and my orders are to feed them wheat, bran and middlings, mixed with what milk we may have. Milk is the best feed for pigs, but I take it our correspondent, like myself, has but little of this. A little shelled corn is good, but it must be a small quantity, not more than a gill at a time. Buckwheat is not good for young pigs. Fine or heavy feed of any kind will not do. The bran in the wheat will keep the bowels distended and healthy, while the finer portion will afford the nutriment. To promote growth, rye meal or shorts is not good food. I have tried all these, and have settled down on wheat middling as the best. It will pay to cook the food for as many pigs as our correspondent intends to feed.

Hon. Geo. Geddes—I agree generally with what has been said, except I have found barley excellent food for hogs.

Mr. F. D. Curtis—I have fed it to sows with young pigs, and it is admirable to make milk.

Hon. Geo. Geddes—I feed together till weaned. It will not pay to cook for a few pigs, but it will pay for a considerable number.

Make pigs contented, and now and then scratch their backs and get them to take a little corn for variety.

Durham Bulls for the Great Plains and the Pacific Slope.

The President announced the presence of Mr. Dewey, of the Pacific coast, and gave him opportunity to speak for the favored land. Mr. Dewey, in some graceful remarks, alluded to the fact that he, like many others in California, had long read and received benefits from the reports of Club proceedings, and that it was great pleasure to him to be present and get the matter in all its freshness. "It is an agreeable thought," he continued, "that I see here the parent of a similar institution to be founded on the Pacific slope. I remember that some of you last summer were impressed with the importance of a first-class agricultural journal for our States, and so urged. That hint has been acted upon, and we have a Pacific Rural that is received with great favor by our farmers. Our climate, soils, seasons and fruits are so different from yours, that, while we can take your teachings as a general guide, we need instructions more precisely calculated for our people and their wants."

Mr. F. D. Curtis—Since the subject of California is up, Mr. Chairman, I desire to say that I have received a letter from one of our correspondents, Mr. Quinn, Yreka, Cal., in which he says: "I see Oscar Eaton is driving the same kind of nails east that most of our cattle men drive here, to wit: That cattle can be raised in large herds roving through dry, worthless mountain lands, so cheap that those investing in good stock and land cannot compete with them. I wish the Club would discuss this subject." I am quite certain that improved stock, kept in the manner that Mr. Quinn speaks of, will deteriorate very fast. Under this system the breeding would be heterogeneous, and bad qualities, which are easier bred, would be reproduced as well as good ones. I am sure Short-horns under this system will run down, and fresh blood have to be constantly brought in to keep up the character of herds. The milking breeds will be injured also, for the reason that the grains and dry grasses of the climate are not adapted to the production of milk. Fine stock cannot be made without care and judgment in their breeding, neither for beef nor milk. The beef of the plains is different from the eastern. It is drier, and has a sort of wild, uncertain taste. The more the raising of cattle is increased in the wild, roving way, the greater will be the contrast between them and the thoroughbred stock, which will be required more and more to cross with them to improve them in all points.

The Chairman—But this is only opinion. Are there any of us here who have facts?

Mr. Bragdon—We know that our own stock has been improved by importations from the old country, where a more scientific and highly civilized system of breeding obtains.

Mr. H. T. Williams—During a recent visit to Omaha I had occasion to observe with much satisfaction that better stock is being introduced in that vicinity and further west, and that in this way the standard of native animals is being elevated.

Mr. J. B. Lyman—When railway facilities are increased, Texas cattle can be brought to this city for twenty-five dollars. This will give a stimulus to the trade, and ranchmen even there will take an interest in growing better stock. The question is whether our choice Kentucky will fall when a Texas bullock can be driven out of a car at Communipaw at twenty-five dollars.

Hon. Geo. Geddes—I once thought that the wool for our eastern markets must be grown west of the Missouri. I afterward learned I was wrong. The truth is, Texas cattle brought all the way by rail would make worthless beef. They must start as calves, and come east by easy stages, and grow a year or so at each station, stopping by the way and eating, as our friend John S. Gould says, 6,000 bushels of corn.

THE CROW.

Dr. J. V. C. Smith—From a general expression of hostility to crows among farmers, predicated altogether on mistaken views of their habits and character, the object of this paper is to overcome an unjust prejudice by simply adverting to facts familiar to naturalists, which are really of importance to the agricultural interests of the country. Like sharks, which have had immense labors to perform in every period of the world's history since the coal formations, the family of corvidæ, to which the crow belongs, have also held an interesting position from a remote epoch in the geological revolutions of the globe. They abound in Europe, Asia, Africa, and extensively in America from the Atlantic to the shores of the Pacific, and far into the warm regions of the south.

Such are the functions imposed upon them in the economy of nature they were necessarily organized for being at home almost in every climate. And for better enabling them to act efficiently, they combine, both in structure and sagacity, the physical properties of several groups of birds. Crows are exceedingly voracious. Their digestion is rapid — and consequently they are always in pursuit of something more to satisfy an urgent appetite. They are also omniverous, and in that respect resemble swine. It is their prescribed office to limit the increase of certain classes of small birds, rats, mice, gophers, moles, many reptiles, insects, worms, slugs, etc., which, if unmolested, would make such havoc with the vegetable kingdom as to peril the resources of others wholly dependent on grasses and plants for their daily sustenance. This, of course, is a philosophical explanation of their widespread diffusion over the earth. So essential is their service to the common good, in concurrence with other workers in the same line of activity in past times, the crow's genealogy antedates the existence of man. Mr. Swinton says the crow unites in itself a greater number of properties than are to be found individually in any other genus of birds, as if, in fact, it had taken from all other orders a portion of their peculiar qualities for the pupose of exhibiting in what manner they could be combined. From the rapacious this type of types takes the power of soaring in the air and seizing prey on the wing, as do the hawks; while the habit of devouring putrid substances and picking out the eyes of animals is derived from vultures. They possess the rare faculty of discovering prey of which they are fond, even when quite deep in the ground. In cunning, and making calculations which involve contingencies of safety to themselves, they are marvelous, especially in their ability to counterfeit the human voice. No people are so proverbially distinguished for their tender regard for birds as the Arabs, with one single exception; orthodox Mohammedans hate crows with an intensity that is actually barbarous. Tradition reports that when Mohammed was fleeing from persecution in Medina, he concealed himself temporarily in a cave. As he was entering, a crow perched at an elevation, keeping ward while its companions were foraging; saw the prophet scudding for life, and as his pursuers came running past the opening, screamed "Ghar-ghar!" a word for cave in the ornithological language. Not comprehending its meaning, however, they kept on their way without suspecting the intentions of the noisy watchman to put them in possession of the object of their vengeance. When the alarmed messenger of the new faith came safely out from the hiding-place, such was his exasperation at the conduct of the crow, he doomed all crows ever after to be black, and to be incapable of sounding more than one note, and that should be ghaw! Whenever an Arab kills one the body is torn open quickly and the gall secured, which is considered a valuable remedy for certain diseases of the eye to which they are predisposed. As this is designed to be a practical analysis of the character of the crow, with a view to determining a mooted question, whether it is absolutely such a foe as represented, a vast amount of curious information relating to the developments of its intelligence under an orderly system of training, must be passed over. It is appropriate to observe, however, in this connection, their lingual acquirements are represented on reliable testimony to surpass the monosyllable accomplishments of the best educated parrots. Personal observations on the habits of the subject of this memoir on four continents justifies the remark that the crow exhibits the same essential traits in all countries. There may be slight modifications in the shape of the bill or some imaginary shadings of plumage, due to variations of temperature and other local circumstances, where successive generations have flourished undisturbed beyond the approach of enemies. By a deplorable misapprehension of the true character of crows and undervaluing their usefulness on cultivated lands, a warfare has been waged against them, which has been transmitted in our time from father to son, quite difficult to overcome, even by appeals to common sense, supported by researches and the testimony of science. Several States have enacted laws for encouraging their extermination. Bounties are even now paid annually from public treasuries for their heads. The result of such ignorance and worse policy is obvious; they are rapidly disappearing. With all their instinctive ingenuity and industrious efforts, the poor persecuted crows, with posted sentinels in the tree-tops to give notice of the approach of their most dreaded foe, civilized Christian man, can scarcely gather food enough for sustaining life on the borders of his domains. By and by they will be spoken of as rare birds; and yet God created them and endowed them with special qualifications for the performance of acts in accordance with that scheme of universal good which is discoverable in all the beneficent arrangements of a divine Providence, and which, if rightly understood and appreciated by farmers, would be hailed with grateful admiration. Crows, undisturbed, would keep down an excessive increase of worms, slugs, noxious bugs, and depredating gnawers and nibblers at the roots of succulent radicals, tender plants, shrubbery, fruit, and trees, were they not wickedly persecuted in their legitimate pursuits. The crow's affection for its young, and the touching fidelity of the parents to each other when once mated, teaches a lesson of moral sentiment far surpassing the poetic attachment of turtle doves, that might be imitated by those claiming superior attributes in the false pursuit of happiness.

Their positive necessities unquestionably compel them to do what the farmer considers a villainous outrage in the ploughed field, because they pull up an incipient sprout of Indian corn in searching for a much worse enemy nestling in the hill. They are unconscious of doing wrong. It is the easiest mode suggested by their intelligence for capturing a grub at the bottom. An empty stomach demands food, and we in our wisdom, under precisely similar circumstances, solace ourselves with the maxim that necessity knows no law. Farmers interpose no objections to their feastings on carrion. It is acceptable service when a dead horse, tainting a whole neighborhood, is taken in charge by a band of crows, quickly changing Professor Huxley's offensive protoplasm into living relations. Such nutriment is not their choice, since to keep down the too great multiplication of those annoyances regarded as baneful to the farmer's prosperity is their special sphere of action. Therefore let crows alone. They are neither thieves or robbers. A perpetual aggressive war against them and many other equally useful birds is a disgrace to our vaunted civilization. Strong legislative measures are required for their protection, or, in the coming future, armies of devouring insects which crows before they have wings or commenced propogating, and which other flying vigilance committees arrest if they escape their searching detective ability, will ruin crops and blight the expectations of cultivators of the soil to an extent to be deplored as a national calamity.

The Chairman—I hope Senator Geddes will let us hear his opinion, and that it will be favorable to our sable friend.

Hon. George Geddes—There is good in the crow. I agree with almost all the statements contained in the paper, but I think the doctor is in error in this, that crows pull the corn for the sake of the grub. If you roll the seed in tar before planting they refuse to touch it; so it would appear, at least, that they know the taste of corn, and when to let it alone. They go for the corn and not for grubs; and 'tis the truth I tell you, doctor. Nevertheless, I never shoot crows; I regard them as friends and not foes, as more help than harm. Sometimes, however, I have brought myself to the point of using a little strychnine in the vicinity of a nest.

African Wheat for Southern Farms.

P. A. Boudinier, Louisiana, Mo., stated that he was once a farmer in Africa, in the vicinity of Algiers, and that when there he became thoroughly convinced that for southern climates the hard wheat, also called native wheat and African wheat, is the most prolific, the most certain, the most sure among all other varieties of wheat. It has not a superior quality, for it sells a little lower than our tender varieties, but, considering the quantity, the crops will fetch more money. He has never seen it fail, while others of tender sort have been withered and killed before maturity, during a warm and sultry season. It withstands the sun of Northern Africa to the end, without flinching. Therefore, he thinks it would be a good acquisition for the United States, and worth while to try its adaptation in those parts of the Union where wheat cannot succeed on account of too much heat. The hard wheat is so called, because its straw is hard and stiff, being filled like a rush, and, hence, not hollow like other kinds, but the grain is no harder than any other sorts; its straw, being more substantial, permits it to stand up in places where others will lodge and rot on the ground. Its heads are bearded, and, consequently, resist the depredations of ants, when there are any, like in Africa. The bread made therefrom is good, sweetish and nutritious, principally in the form of biscuit, like it is done among the peasantry. But bakers do not favor its flour for the reason that the fermentation is not so lively as in other varieties.

SHOBE'S APPLE PARER.

The committee appointed to test a newly-invented machine for paring, coring and slicing apples and other fruit, at one operation, by James Shobe, of Cecil county, Md., the patentee, beg leave to report: That the machine is strongly built, very simple in construction, pares as rapidly as any ordinary apple parer, and at the same time takes out the core and cuts the apple into four or eight pieces lengthwise. The slices drop from the machine, as also the core. There is nothing to do but to stick on the apple, set the paring knife into position, and turn the crank a few times, and the work is done, and the machine is ready for another apple. In our judgment it is a valuable machine, and will prove a useful auxiliary to the housewives of America. The work is done speedily and neatly, while the low price of the instrument (two dollars and fifty cents) will make it a formidable rival to those now in use.

FRANK CURTIS,
J. B. LYMAN,
H. T. WILLIAMS,
Committee.

Adjourned.

May 23, 1871.

Nathan C. Ely, Esq., in the chair. Mr. John W. Chambers, Secretary.

Immigrants to Louisiana.

Mr. K. A. Cross, Clinton, La., wrote to say that the people of his section have long been anxious for an immigration of a good, industrious population, and with the view of bringing about this result, they have formed a bureau with authority to take the necessary steps. This plan is based on the fact that there is a large area of arable land furnished with necessary accommodations for laborers and for stock, which is now not in use on account of the contraction of the labor resources of the country. In order to utilize these lands, which have been improved with no little expenditure, it is proposed to furnish immigrants the use of land and houses one year gratuitously. In accepting this proposal the immigrant would have the opportunity of visiting the country and giving it a fair trial before he makes a final determination as to making permanent investments in the purchase of lands. If he like the country, he has, furthermore, the opportunity of selecting the most desirable localities. He would thus be subject to few of the hardships and difficulties generally incident to a change of base. His arrangements can be made in advance through the bureau of immigration, and when he reaches his destination he will be received at the place established for the purpose, and sent out immediately to the lands prepared for him.

Keeping Rabbits from Young Trees.

Mr. W. A. Wise, Holden, Mo., asked for "a certain remedy to protect young apple trees from rabbits." He stated that during the deep snow of last winter he had more than a hundred gnawed all around so that the most of them died.

Mr. Wolff—Put around each tree a straw rapping, and smear it with tar.

Mr. R. J. Dodge—It has been recommended to daub the bark with blood. I protect my trees by putting strips of tin around the trunks. These, where they can be procured at all, cost nothing.

Mr. A. S. Fuller—My old uncle, living out on the prairies, grows sweet corn, and leaves a few bunches in the orchard over winter ; the rabbits feed on this, and if you want to get rid of them it would be easy enough to poison the corn.

Mr. C. D. Bragdon—I have seen thousands of trees in Illinois protected by binding cornstalks around the trunks. These are cheaper than straw and last longer.

RIDDING PASTURES OF MOSS.

Mr. F. R. Palmer, Centreville, New York, stated that the farmers in that vicinity are mostly engaged in dairying. "Many, with myself, have large pastures where the land is naturally good, but the grass is running out, and a dark, green, mossy substance is taking its place. Can such land be economically reclaimed, and grass be made to grow by any top dressing other than barnyard manure? If we plough up such land and reseed it it will be all right again, but many pastures are so situated that it would make much inconvenience to do so. If men who have had experience in such matters, belonging to your Club, can give us some good, practical advice, we will be much obliged."

Col. Slipper—Use lime. Mr. Mitchell tells us that in this way he brought up the hill-pasture at Edgewood, which, though several acres in extent, was at the outset too poor to afford forage for a single cow. Now, each acre supports a cow, and it has had no treatment but stone underdrains and a good coat of lime.

Dr. Isaac P. Trimble—In many cases, as a chemical agent, lime may be useful, but by liberal application of barnyard manure you will make the grass crowd out less desirable growth.

Dr. H. E. Colton—I have in my mind a mossy lawn in Brooklyn which was much helped by application of lime.

Mr. H. L. Reade—Moss is becoming an intolerable nuisance. I believe that its eradication in the eastern and middle States would add thousands of dollars to the value of lands that are every year becoming more and more covered with, and for the time ruined, by it. I have succeeded in killing it only by ploughing at least three times, sowing after the third plowing grass seed, to form a sward. In six years the process needed repeating. What we want is some top-dressing that will effect what ploughing does, with the further good of killing it forever.

The Chairman—I put two tons of bone-dust on three acres of grass land, which had much growth of moss, and the grass took such a start that it choked the moss, as Dr. Trimble says it always will.

Mr. H. B. Smith, of Westfield—I have a low-lying meadow of about four acres, which was formerly covered with moss, and didn't produce hay enough to keep one cow. I limed a part of it, with good results; to another part I applied manure; but the thing which proved most effectual was the turning on of the wash from the roadside. When this is practicable it seems to me as good a plan as any. I ought to have premised by stating that I began operations by thoroughly underdraining the land. Now, the surface that starved one cow, keeps three horses and two cows, and they are sleek all summer.

Mr. J. W. Gregory—I have known good effects from the application of soot to mossy pastures.

Mr. Charles D. Bragdon—I know a piece of mossy land which was thoroughly scratched over with a sharp-pointed harrow and top-dressed with plaster and strong bone manure, and with good effect. Anything which supplies ammonia will kill out the moss.

DAKOTA.

Mr. Jud. Pierce, Elk Point, Dakota—Now, that the season of emigration is at hand, I would like to say to the hearers and readers of your proceedings, who are westward inclined, come to souteastern Dakota. Here they will find a climate not enervatingly warm nor frigidly cold, in climate not unlike that of the middle States, but in weather much freer of rain and snow in winter; a soil rich beyond comparison; free and limitless pasture, and hay lands of nutritious native grasses; streams of pure spring-fed water, with abundant and cheaply-developed water-powers, and above all free land, unchanged and untampered with since it came from the hand of God and the government surveyor—in short, all that is necessary to make it a desirable home for the farmer, the mechanic, or the manufacturer, except the single article of timber. As there is a herd law, none is required for fencing except a corral for the stock at night. For building lumber the government land is yet near the Missouri, where lumber can be got at about the same rates as east. As for fuel, there is enough for present use, and with the rapidity with which timber grows on these prairies, and a little care, I doubt not farmers can burn home-grown timber in four or five years from planting, with as little yearly expense and work as it now takes to get it from the "wood lot" east. Coal has been found, and promises to supersede the use of wood for fuel. It seems to be a law of nature that men will be happier and healthier in a climate to which they are accustomed than in one warmer or colder, and emigrants from the Northern States of the Union will find the climate of south-eastern Dakota much more like that of their old homes than that of Kansas or Colorado, where the seasons and methods of farming resemble those of Egypt, more than of our own Yankeeland. The chief advantage Dakota has over her sister Territories and States is that there are and can be no speculators' lands. None of Dakota's soil can be obtained from government except by homestead and pre-emption; no wide wastes of speculative land here surround the frontier settler, as in most of the Western States. But even this excellence has operated against Dakota's settlement, for as no one had land to sell, its advantages were unheralded and unpuffed by "disinterested" newspaper correspondents or agents of colonies; while those of less favored sections, because advertised, are known and sold, second-hand, at many times the government price, to settlers and colonists. Of the particular part of Dakota that is most desirable, of course "there is no place like home," and my preference is for the valley of the Vermilion, where is located the claim of the subscriber. There we have a (to us) beautiful mingling of valley, bluff and upland, well watered and fertile. Government land may be had bordering the stream. Two grist-mills are to be built on or near what is now government land, and a cheese factory is hoped for. I will be happy to answer any letters of inquiry addressed to me at Elk Point, Dakota.

PARIS-GREEN FOR THE POTATO BUG.

The secretary, in reply to several correspondents, submitted the following facts, which, he stated, were condensed from an article by Mr. Sanborn Tenney, of Williams College, contributed to the American Naturalist. The article described a visit to James Hudson, of Niles, Michigan. In April, 1870, Mr. Hudson, in ploughing his fields, ploughed up the full-grown beetles, and they walked about, being very lively. He planted early rose potatoes about the 13th of April, and as soon as they were fairly up the beetles commenced their attacks upon them. He began to kill them by squeezing them between two paddles, going over the ground daily, but apparently without checking them. He then mixed paris-green with ashes and sprinkled the mixture on a dozen rows, the vines at this time being a foot high and from these rows he secured a fair crop of potatoes. Where the mixture was not sprinkled the bugs ate all the leaves. and in many cases they ate the stalks to a considerable extent. They now began on a new field hitherto untouched, appearing in such numbers as almost literally to cover both the leaves and the stalks. They were so numerous that in less than an hour one man gathered about twenty quarts of them. The beetles swept right through this field, going at the rate of about ten or twenty rods in a week. Their yellowish eggs were always abundant on the inside of the potato leaves; but they also laid their eggs on wood, spires of grass, and even on dry sticks. While the havoc above described was going on no other species of insects attacked the potatoes. At this time the Colorado bugs were abundant about the farm buildings, and even entered the house. Toads are their natural enemies, eagerly devouring them. But on this farm the hens were never seen eating them. On the farm above mentioned the bugs disappeared suddenly in the early part of September. It may be added that they seem to prefer the Chenango potatoes to the early rose, and that they would hardly touch the early Goodrich, though growing side by side with the Chenango, which they eagerly devoured. I would also add that the insects do not confine themselves to the vines, but enter the hills and attack the potatoes themselves.

THANKS TO GEORGE GEDDES.

Mr. G. S. Knight, Brownsville, N. Y.—If I were not an invalid of ten years I would come to New York, if for no other purpose than to move a vote of thanks to the Hon. George Geddes, the distinguished agriculturist and practical farmer, for his many essays and the great good sense he has evinced by his pen and his remarks in the Farmers' Club. From the wisdom and experience of such men, the Farmers' Club is sustained and the world benefited. I cannot claim a personal acquaintance with the gentleman, although I had the honor of grasping his hand on an introduction by a mutual friend some years ago, and have long respected his worth. I will deputize friend Trimble to make that motion, as a thank-offering for helping the doctor so handsomely out of the "Worth's" corn-crib.

A LADY-FARMER USES WOOD ASHES.

Mrs. H. E. Galpin, Oswego, N. Y.—I have derived frequent aid and much information which has greatly assisted me in carrying on a small farm, four miles from this village. When I came in possession of it five years ago, the grass on the best meadows did not average more than ten inches in height, and yielded about one-half ton to the acre, and was red, in haying time, with sorrel, for which I sowed hard-wood ashes, one barrel to the acre, all I could obtain, and the next year the same rate in other fields, and so on each year; and now there is not a blade of sorrel to be seen, and my meadows average three tons to the acre, and some yield more than four. I have half an acre in vegetable garden, and for the last ten years have had no trouble with club-foot cabbage. My seed beet is liberally mixed with hard-wood ashes, and the plants, which show signs of club-foot after being set out, receive a sufficient quantity of white lye to thoroughly wet the root, which kills the worms and makes the plant thrive. The lye also kills the worms at the foot of squash vines. One year I lost nearly all my vines by these worms, and after trying various remedies which did no good, the lye saved the vines, and they yielded abundantly. The cabbage which have worms in the root can easily be distinguished when the sun is hot and the ground dry; they look wilted.

CHEESE-MAKING ON SMALL FARMS.

Mrs. S. Hastings, Flemington, N. J., says she was one of eleven children, all raised to middle life by her mother, the wife of a country preacher, who never received over $400, and generally not over $300 per year as salary. She made excellent cheese every summer, and this was her process: She took the stomach of a calf, say one about five or six weeks old, filled it with salt, and fastened it together; this was done in the spring; the cheese season was not till July, when the weather was too warm for butter. When she wished to make cheese she took this rennet, took out the salt, and put it into a pint of new milk; she strained the milk for cheese at night into tin pans or pails; in the morning she heated the night's milk to the warmth of the morning's milk, and added the milk from the rennet, and let it stand till it became a thick curd; then, cutting it through with a long knife, the curd would separate from the whey; then spread a linen strainer over the top, dip all the whey off into a clean brass kettle, heat it to a boiling point and turn it back through the strainer into the curd; let it stand till it is cold; have ready a dry cloth and mold for your cheese; spread the cloth over a cheese-basket and dip your curd into the basket; let it drain two hours; put it into the cheese mold or hoop; have a round board that will go easily into the hoop, and after making it all as smoothly as possible in the hoop, put on the board, with the cloth between it and the cheese, and put it in the press. Press it sufficiently hard, so that when it is taken from the mold it will retain its shape. In three hours change it into a dry cloth, and let it stay in the press over night. In the morning cover it with thin cloth to exactly fit the cheese, a straight band, with two round pieces the size of the cheese. Grease this twice a day with fresh butter. Don't forget to salt the cheese before pressing it; the quantity of salt according to the size of the cheese. A smart farmer's wife can tell by the taste of the curd, and any one that cannot tell by the taste had better not try, for she will spoil the cheese.

Raising Two Crops of Early Rose in One Season.

Mr. James Rolph, Stockton, N. Y.—Early rose potatoes will produce two crops in a season. Last April I planted some in my garden. They ripened in August, when some of the tubers began to sprout. I took some of them from the hill and planted them. They came up immediately, and produced vines a foot and a half long, from which I dug, in October, potatoes as large as hens' eggs.

Improving Poor Lands.

Mr. R. S. Hinman, Riverside, Conn.—Not being able to attend Farmers' Club personally, will you be so kind as to present the following inquiries, and report answers. I am trying to improve some of our Connecticut worn-out or neglected land, and have this summer a piece that I have cut the brush from, ploughed, and intend to sow with peas, and 100 pounds of guano per acre. Can you tell me what time I can most profitably plough in the crop of peas? I want to sow rye on the lot, and want it enriched sufficiently to keep the rye from winter killing. Ten loads of compost, made of barn-yard manure and muck, per acre, will accomplish that. Will my 100 pounds guano now, and the pea-vines, should they grow well, accomplish as much? Will clover take well after ploughing in peas? Guano isn't natural manure for clover. I can't well get ashes, and plaster does not work wonders on my land. Should like the cheapest way to get a crop of clover, with land a little too cold for it to grow naturally. I propose this fall to sow the adjoining field with buckwheat, and seed with clover, putting on compost enough to make the clover take, and next year repeat the operation, ploughing in a grass crop every year. Will that make fertile land? I shall plough but once each season; shall try the same plan with turnips, except that I shall possibly add phosphate or guano, to increase the crop of turnips. Is there any special manure that can take the place of barn-yard manure, in seeding down land for pasture or meadow? Will bone-dust do it, and do it profitably? I have heard a Connecticut farmer say that $100 worth of ashes at twenty-five cents per bushel was profitably applied to pasture land, per acre, to his knowledge; that said land carried a cow per acre, and continued to do so for years. Is there any manure in the market that can be profitably applied that way? In other words, are there any marketable manures that can be used to build up instead of running down a farm? They will all raise good crops for a year or two, but that's not my object.

Mr. H. L. Reade—Turning under buckwheat is a good step, but it is only one step. He should not omit the ashes; they will help him wonderfully in getting in tame grass; but for a permanent fertilizer for grass he can buy nothing better than bone; ground bone. Three tons will cost him a little over $100 at the mill; but the true policy for him is to raise roots on his rich land, increase his stock, keep them up, save every drop, compost, and have manure in abundance. He should use ashes and bone only as stepping stones to *that*.

BLASTING VERSUS BURNING BOULDERS.

Mr. Charles P. Gilson, Plymouth, Vt., criticised the advice of the gentleman who counseled farmers living in rock-bound neighborhoods to burn big rocks. "I have," he said, "just finished a six weeks' job on boulders, and I have to record that three men—two to strike and one to hold the drill—will blast more rocks in one day than twelve men can dispose of by burning, even if the wood is all delivered on the field; and wood at three dollars per cord would take ten dollars worth to $1.50 powder. I have spent one-quarter of a day and burnt three-quarters of a cord of wood on one rock which five cents' worth of powder would have blown to pieces. Therefore I can see but two advantages in burning: First, when the rock is flint, and so hard a drill will not hold; and, second, in some place where you do not wish the pieces to scatter. Probably our New Hampshire friend does not know how to put a blast to be effective, or may be he is afraid of powder; if so, keep on burning; but do not come over into Vermont begging after wood. Where would the railroads of his State have been if not for powder, or the Hudson River railroad, for powder or its equivalent? I can only compare the difference between burning and blasting rocks by being conveyed in a canal boat or stage to a palace car or an express train. I have only one thing more to say on the subject: I believe the Almighty put it into man's head to make powder to remove these obstructions in his way, not to kill one another with.

REPORT ON PHILLIPS' CORN HUSKING MACHINE.

The committee appointed to examine and report on Phillips' patent spiral corn husking machine respectfully report that they have seen the machine in operation at the office of the company, No. 32 Cortlandt street, where it has been run by steam power, and it seems to your committee to fully justify the statements made, as simple, durable and practical, effectually accomplishing what they claim for it. The machine in operation is calculated for two horse power and to be worked by two men, which is the only size now made. We understand a smaller machine of one horse power is proposed and to be operated by one man; but in view of the extra work to be accomplished, the present size is deemed most advisable and economical. The price of the machine now made is $100. This is exclusive of the horse power. The committee are of the opinion that it is a very great labor-saving machine, and from its simplicity and strength we think it well adapted to sections devoted to the cultivation of corn. We suggest that a hand machine for husking the ears after they are picked, and selling it less than fifty dollars, might be a great advantage to the whole farming community.

S. BALDWIN,
JOSEPH B. LYMAN,
Committee.

Adjourned.

May 30, 1871.

NATHAN C. ELY, Esq, in the chair; Mr. JOHN W. CHAMBERS, Secretary.

SUCCESS WITH ASPARAGUS.

Mr. James Smith, Pittsford, N. Y.—Two years ago this spring I bought fifty cents' worth of "Colossal Asparagus Seed." I transplanted the roots one year ago according to a notion of my own, which corresponded with the plan of Mr. Bruen, published in the Club reports a few weeks ago (excepting that I found my roots at one year old quite large for transplanting). I am now cutting strong, healthy sprouts for the table liberally every day, and only the third year from the seed. Mr. Bruen's advice to grow one's own roots is certainly good, unless they can be had of a near neighbor. I previously failed twice myself by purchasing roots that had been out of the ground too long. Indeed, Mr. Bruen's article throughout is to me the most common sense thing that I have seen in a long time. Whether this strong growth of my plants is a characteristic of this supposed new variety or owing to any superior cultivation of mine, I leave others to determine.

Mr. Fuller expressed the opinion that the difference in asparagus is owing to difference in culture, and he questioned if it would be easy to prove him in error on this point.

The Chairman thought Mr. Conover at least entitled to credit for introducing and illustrating the importance of better cultivation.

IRRIGATION IN CALIFORNIA.

W. S. Powell, Visalia, Tulare county, Cal.—As many as four out of five years' ploughing and other farm work is done every month from September to May. Last winter, and this also, ploughing has been done on my farm every month. We generally have a very hard freeze in December, lasting about a week, never as much as a month. It then moderates, and during the rest of the winter the weather is splendid; frost comes out of the ground by January and after that it only freezes an inch or two at night to thaw out again by noon of the next day. Last year I kept a record of the days I did not see the sun shine, and it proved this to be a country of fine weather. Only three days in the whole year were totally cloudy, to wit: The 24th and 25th of April, and the 11th of August. That was for 1870. Thus far this year we have seen the sun every day. I will report again at the end of this year. Cattle do live here, and do not often lay on "downy beds of" cactus to die, though thousands have not a mouthful of food of any kind except what they get on the range. I have a pair of horses now on my plough that were turned out last November and were not fed even once until last week, when they were caught and put to work ploughing. Although they were not fat when taken up, they looked better than hundreds seen in city carts any day. In my neighborhood there is about 200 head of stock of all kinds running out without feed and, I do not know of any dying this year. It is true we have late and early frosts here, but in this dry air it does not injure vegetation as it does where the dews are heavy. I could show Mr. Nichols snow fifty feet deep in August, within forty miles from where he could see all kinds of tender vegetables growing faster and larger than any he ever saw east of Colorado. I have seen a cabbage head, with stump cut off, weighing fifty-six pounds, and other kinds in proportion. Mr. Meeker's judgment of the country between Cache la Pondre and Thompson rivers is correct, as it is a splendid farming and stock-growing region, with abundance of coal and water.

SIX RULES IN IRRIGATION.

W. S. Powell, Tulare county, California—Having a large practical experience in irrigation and constructing canals, I purpose giving some conclusions drawn from sixteen years' observation of the results of artificial moistening.

1. Construct your main ditch from the source of water supply to the land to be irrigated sufficiently large to carry all the water you want, giving it a grade of not less than eighteen inches nor more than six feet to the mile, depending upon the size of the ditch and the soil through which it runs.

2. Construct your lateral ditches so as to command the highest part of your land; for it is a maxim in this business that, if you thoroughly irrigate the high places, the low ones will take care of themselves.

3. When you irrigate, do it thoroughly; wet the ground at least eighteen inches deep.

4. After irrigating, always (except it be grass or grain land) stir the surface soil as soon as its condition will permit. This is imperative, if you wish to enjoy the full benefit of irrigation and enrich your land every time you water it.

5. Don't irrigate too much; a thorough wetting every three weeks, where there is no rain-fall, is amply sufficient. Too much irrigating causes a spindling, unhealthy growth.

6. For gardens, small fruits, etc., irrigate under the surface by means of covered tiles or boxes, and you will see a growth on poor soil that will far surpass the growth on the richest land unirrigated. I have been experimenting the last five years on this peculiar system of irrigation for gardens and small fruits, and know it to be a thorough success. Any person having a small piece of land and the command of a little water can have a certainty of a crop, and bid defiance to the seasons.

CROWS, ENEMIES TO BIRDS.

Mr. J. H. Parsons, Franklin, N. Y.—We have in our yard more than 100 trees, large and small. Orioles, robins, cat-birds, wrens, sparrows and other birds seem to appreciate the situation, and warble forth their thanks every morning, to the infinite delight of the family. Last year, in June, during the earliest morning hours, the crows would come within twenty feet of the house, searching among the trees, not for "grubs," but for birds' nests. Later in the morning they would be seen in the orchards, flying from tree to tree on the same nefarious business, or pursuing parent birds on the wing. Admit that a crow destroys several hundred grubs during the season, it is equally true that he destroys every bird's nest he can find. Meadow larks, which, twenty years ago, were numerous, have nearly disappeared with us, and the bobolinks are becoming fewer every year. The mowing-machine may have contributed to this result in part, but the crow, a notorious marauder, renders ten birds' nests tenantless where he leaves one untouched. The question, then, is whether a few hundred grubs, devoured by the crow, are an offset against the several bushels of grubs, worms and noxious insects not destroyed by the score or more of birds which perished in infancy or in embryo by this black villain? Long since I adopted two maxims; never to pass a burdock in blossom without drawing out my knife and cutting it up, and to kill every crow I can. And these rules, especially the latter, are more like the laws of the Medes and the Persians to-day than before I read the recent discussion of the crow question by the Club.

VARIOUS SOILS DISCUSSED.

Mr. J. B. Smith, Patmos, Mahoning county, Ohio—The subject of soils was discussed recently in your Club, and some time previous. But it seemed to me not thoroughly; there was not sufficient importance attached to the character of the soil. People in buying land want to buy a naturally good soil; and they should know by external signs how to judge of it. A good or first-class upland soil is worth twice if not ten times as much as a poor one. A first-class soil in eastern Pennsylvania is the limestone land. The subsoil of clay is sufficiently porous for the water to sink. It is naturally drained; lime and plaster act very beneficially on it. Then there is red shale land; that, when just right, is nearly equal to it. But sometimes it is too dry and shaly; and sometimes interspersed with it there is heavy clay land, indicated by white oak timber, and not large. The good land has black and red oak, hickory, and sometimes some white oak and chestnut. Where the timber is small the shale is too near the surface. This land is nice to work; lime and plaster act like a charm on it.

Then there is a belt of land in Bucks county called the Newtown vein, underlaid by gravel. The surface being a sandy loam, it is very nice land to work, and very productive — perhaps equal to limestone when in a high state of cultivation, in all but grazing; on this soil lime is also the charm. The low lands between Trenton and Philadelphia are nice and good farming land, but rather sandy for grass. Then there is white oak land in the east that is a cold, heavy clay, very wet in wet weather, and it bakes and cracks in dry — passible for grass, oats and wheat, if the winter don't kill it. Lime benefits it. It requires under-draining. Blue shale land is cold and wet. The kind of timber in a measure indicates the character of the soil. In the east, black oak and hickory indicate good land. White oak, cold, heavy clay, with a light subsoil. Chestnut, a light sandy soil. But in western Pennsylvania and eastern Ohio, large white oaks and chestnuts grow side by side. And the soil is nearly equal to the best limestone land; has a porous subsoil. Large sugar trees indicate good land, and in the White river bottoms in Indiana, the best land I ever saw, apparently pure sand, but raising 100 bushels of corn to the acre without rain, the largest kind of sycamore and sugar trees abounded. For grazing, beech and sugar-maple lands are best in the west. The stumps don't sucker; those come in green grass and white clover, and the older the pasture the better. The soil is retentive of moisture; where the water can run off, sour grass does not come in; the hard-pan under is somewhat porous, and where the land is rolling springs abound. When first tilled it produces as large crops as any upland I have seen. I have noticed that the good lands of this country are cultivated by the good people. A soil must be excellent for some great staple, in order that a high civilization may flourish. As fine people as breathe are found on lands specially good for grass. In fact, I put the grass civilization above that which is based on corn and pork, and it is fully equal to that based on the white grains.

I would say that people on good soils get rich, and on poor ones stay poor; that timber in a measure indicates the character of the soil; that flat white oak land is poor; that red oak and soft maple also indicate poor land; that shell-bark mostly grows in cold, wet land; that flat beech and sugar lands are good for summer crops and grass, but not for wheat; that rolling beech and sugar lands, where large poplar and black-walnut abound, are fine grazing lands, and produce, when new, large crops of all kinds of grain except wheat, when it is winter-killed; that large white oaks and chestnut growing together, and black oak and hickory, indicate a loose subsoil; and that lands where the water soon sinks into the sub-soil are much the most valuable for grain; that a soil that will raise large crops of all kinds of grain, and then clover and timothy, and after they run out will come in with green grass and white clover, is the best.

Adjourned.

June 6, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

GAS LIME AND CAUSTIC LIME.

Mr. F. C. Johnson, Oswego county, N. Y.—Is spent lime from the gas factory valuable as a fertilizer? If so, what is it worth per bushel, and how is it to be used?

The Chair—If it lays out of doors long enough to be washed it may be of some little use, but it is dangerous to touch in connection with agriculture. This has been discussed before, and that is the conclusion arrived at.

Mr. Lyman—After it has been exposed to rains it is worth from six to ten cents a bushel. I have just been buying some for application to a dark peaty soil. It is by no means equal to caustic lime, but it costs me only half as much.

Mr. Fuller—I do not think it is worth having. I believe in caustic lime.

Mr. Lyman—There are places where caustic lime cannot be obtained for less than twenty cents a bushel, while this gas lime may be had for less than half that price.

The Chair (to Mr. Fuller)—Perhaps you will define what you mean by caustic lime?

Mr. Fuller—Caustic lime is that which is just slacked; the other is inert, and has little virtue. The proper line of inquiry is how farmers may get oyster shells to their farms, and burn them, at a cost of a few cents a bushel.

Mr. Reade spoke of having used lime to some extent, putting it into the hills of corn, and asked if that was the proper way to use it.

Mr. Fuller—You should put more vegetable matter in it. I do not believe in lime as a fertilizer if applied when there is no vegetable matter; but if there was, then it would do good by decomposing the vegetable. The Jersey farmers leave the soil for two or three years until a little crop of weeds comes up, and then they apply the lime, and say, "only see how much good the lime has done," when it was the presence of the weeds which were dissolved by the lime that produced the effect.

Dr. Weaver—I doubt whether lime is of much use except in a caustic state.

LIQUID MANURES.

Mrs. S. S. N. Greeley, of Oswego, N. Y., writes thus—"As a plant stimulant in our little parsonage yard we have a barrel partly filled with stable manure, to which we add fine charcoal and soapy dish-water. While it acts well as a fertilizer, it is often an offense to our nostrils, the charcoal not proving a complete deodorizer. What will be better? Will permanganate of potash or copperas answer the purpose, or would they in any way be injurious to plants?

Mr. J. B. Lyman—She has not put in charcoal enough. I have tried this plan: to two or three bushels of hen droppings add some matters gleaned from the kitchen, all sorts of trash, the debris of the household; over this put a little lime, with some rotten chip dirt on top of all, making a leach into which all the refuse slops of the household pass, and from which one can have a tubfull of rich liquid manure. If the smell is bad throw a bag of charcoal into the old tub that sets under the leach. If you want an active stimulant there is nothing like this for asparagus or vines, or for the strawberry plant.

Mr. H. L. Reade—I have adopted the same plan, only I have a barrel—a tight kerosene barrel—that we can keep covered close. It brings forward plants in a very remarkable manner. I think the barrel is a good plan.

Mr. Daniels—I have tried the leach system with great success. It affords families who have but little ground the best means of enriching them promptly and at the same time disposing of household sewage. But it will not do to neglect the leach nor allow vile matters to lie uncovered on the top of it. A box of dry chip dirt or of fine dry clay should stand near the leach, and a half peck of it be used daily.

Is the English Sparrow a Nuisance?

Mr. D. Augustus Vanderveer, secretary of the Farmers' Club, Freehold, N. J.—At a meeting of the Monmouth County Farmers' Club, held May 11, the question was asked, are the English sparrows a benefit to the farmer and fruit grower? No one knew much about their habits and food. The Club wished me to write to your Club for information on the subject. We know they are a benefit to the cities, but thought they might be very destructive to seeds and small fruit.

The Chairman—I cannot say as to the general question relating to the country, but I know what I observed in the lot at the back of my house, where I have some rose bushes, cottage roses, variegated, sometimes white and sometimes red, and for that reason I like them. They are like the XVth Amendment, and every morning there comes over from the lot about seven sparrows. They first go along upon the lattice work, where runs the wisteria, going the whole length of the fence; and after they have gone through that they come upon my rose bush. They are quite tame, and I have been close to them, and I have seen them come up to leaves that are stuck together, and they open it carefully and peep in, and then make a dive and bring out the green slug. I have watched more than a hundred operations like this, and have witnessed them with great satisfaction.

Mr. D. B. Bruin—I have seen them go into a nest of caterpillars in the same way; they would strip the bark down and pull out the insects.

Mr. P. T. Quinn—Ever since the sparrows have been introduced, we have been warned more than once through the agricultural journals to beware of the ravages of the sparrow. There is no doubt in my mind but that they will feed upon insects when they can get nothing else to eat; but they will also become very destructive and injurious to the fruit-grower in the country. There is a great deal of sentiment about birds. I know that some of them are the allies of the fruit-grower, but I was born where the sparrows were pests in the worst sense of the term; where they not only eat the fruit, which we would be willing to forgive, but they feed also on the blossoms; and so the subject comes up whether that variety of bird will greatly benefit the fruit-grower. I have a neighbor, and he called me into his fruit-garden and showed me the blossoms of his trees all picked off; he said he had not seen any sparrows around, but his place is only a stone's throw from mine, and we had had quantities of them, and there was no doubt but that the sparrow was the depredator. If he would only eat the ripe fruit I would say let him have it, as much as he can eat; but when he eats the buds, then he is an injury, and I fear that we shall regret that they have ever passed out of the city.

Mr. A. S. Fuller—My brother brought out two pair to our place, and they have driven all the rest of the birds away.

Rev. Joshua Weaver—I think that they will be a very serious injury to the country, although it cannot be denied that they are a benefit to the city. In England they are regarded as a nuisance, and people are constantly asking if there is not some way of destroying them.

Mr. A. S. Lyman—They were first introduced into New York city, and have there proved of great benefit in the parks and along the streets, but when taken out from this island and carried abroad where they have access to fruits, berries and buds, they will do more mischief than good.

Mr. A. S. Fuller—Sparrows were introduced when the trees swarmed with the span-worm, but at that time it was mentioned in the Brooklyn Club, if not here, that the ichneumon fly had been seen and that in three years there would not be a span-worm left; but when the sparrows were introduced the span-worm disappeared, and they got all the credit, while, in truth, they had nothing at all to do with the disappearance of the worm, that being effected by the ichneumon fly.

Rev. Joshua Weaver—This is a very important subject just now, because the question is being discussed as to whether these birds shall be carried into the country in greater numbers than they have already been. Now, as I said before, it is a fact that in England they have proved a very serious evil, and I think it would be well to warn farmers against them.

The Chairman—The sparrows are bound to extend themselves; they will be everywhere in a short time; they do not want to be imported; they will be in Calfornia in twenty years, and already they have been seen thirty miles from the city.

Irrigation on the Atlantic Slope.

Mr. H. L. Reade—Speaking of dry weather, there has probably been but two years in this country when it has been so dry in the New England States in the month of May and June, and it may be calculated that in Eastern Connecticut farmers are losing from $2,000 to $5,000 a day in their hay crops. If a proper system of irrigation was carried into effect, they could, in the future, laugh the drouth in the face; and I propose that this Club raise a committee of three, and invite correspondence on the subject of irrigation, and that these letters be referred to the same committee, to be raised by this Club, and that some time in the fall there be a paper prepared by this committee embodying all that is known of irrigation, and, perhaps, something may be done this year to counteract this drouth, and, at any rate, in five years from this time things would be materially different. There are plenty of running streams now useless which might be utilized for this purpose.

Mr. J. B. Lyman—The country east of the Alleghany Mountains is so situated, with respect to the slopes of its hills, as to render it perfectly feasible to irrigate it at a moderate expense, but, as yet, it has never been thought of sufficient importance. One year nature gives them water enough, and they go on, having faith that every other year will be the same, but it is well known that drouth is the great drawback of American agriculture. We have more suffering here than in the old country; and all the calculations based on English, Irish or Scotch farming, suffer a great discount because of the abundance of moisture in those countries. There is reason to believe that a great step in advance is to be made, such as is now practiced in places on the western half of this continent, will be common here in the eastern half. The time has come when the Rocky Mountains and the Pacific slope is able to give us a lesson in watering our lands by artificial means.

Mr. H. L. Reade said he lived near the Quinnebaug river, and he hoped he should live to see great wheels lifting up the waters of that stream and distributing it all over the country. He thought the subject an important one, which should be discussed in every farmer's family before they said their prayers.

Dr. J. V. C. Smith spoke of the irrigation of Egypt; that it had made that country, naturally sterile, the greatest producing country in the world.

Mr. A. S. Fuller said, that by this drouth he had lost $1,000 within a month. If he had spent that sum last year he should have been repaid in one season.

The motion to appoint a committee was then carried, and the chair appointed Messrs. H. L. Reade, J. B. Lyman and Dr. J. V. C. Smith as such committee, and earnestly besought all who knew anything on the general subject of irrigation to communicate with the committee. The committee ask for statements from farmers who have streams through or near their places, stating the fall of such streams and the cost of taking the water out and conducting it to different fields. The mode adopted in the west, on the other slope, is to reckon the number of acres moistened by the irrigating canal, and the cost per acre.

Adjourned.

June 13, 1871.

NATHAN C. ELY, Esq., in the Chair; Mr. JOHN W. CHAMBERS, Secretary.

MELON BUGS.

Mr. B. Osgood, Kingston, East Tennessee, stated that, for the last two or three years, he has been unable to grow any early watermelons in consequence of the ravages of bugs. He sprinkled the hills with ashes, soot, sulphur and other substances he had seen recommended, but without effect; so in his extremity he came to the Club.

Dr. Isaac P. Trimble — This is the old story of the striped bug, peculiar to melons and cucumbers. My plan is to put a box around the young plants; a cheese-box answers well. The bugs fly over these, and the plant escapes. At least, I have found it so in my own experience, and I know of others who have been equally fortunate.

Dr. J. Ware Sylvester — I am happy to be able to confirm this statement. Several years since I had some bottomless boxes made, ten inches square and about a foot high, which, used in the way described, proved an absolute protection. At one time I placed glass in the top, but found this unnecessary.

Mr. D. B. Bruen — For many seasons my vines were ravaged by this pest, but this year I escaped. I give credit to the bone flour which I placed in the hills at planting time, and on the plants soon after their appearance above ground.

Dr. Isaac P. Trimble — Our venerable friend should remember that these bugs do not come every summer, and they sometimes pass certain localities, while they are abundant in others. Possibly this may explain his success this year.

Dr. J. V. C. Smith — I recently read somewhere that, by placing a zinc wire and a copper one, of different diameters, about the plant, you protect it from the bugs, which experience a shock when they step from one metal to the other.

The Chairman — The idea of Dr. Trimble is a good one. About a dozen years ago I bought sixty or seventy old cheese-boxes, kicked the bottoms out, and placed them about the plants for protection from cold and winds. They cost a mere trifle, a cent or two each, and endured at least ten successive seasons.

Pasteboard in Domestic Buildings.

Mr. H. A. Leach, Deckertown, N. J., wished "to obtain information in regard to a substance called building paper, and more particularly that kind of building paper termed prepared plastering board, which is said to be a cheap and perfect substitute for lath and plaster, and at less than half their cost." He has doubts as to the utility of the article when used in a kitchen or sitting-room, but how would it answer for bed-rooms, and especially "a spare bed-room?"

Prof. Henry E. Colton — The question of using paper in various departments of building admits of much discussion. There can be no doubt but that it may be made valuable for the interior of dwellings as a substitute for laths and plastering. The cleansing operation through which the paper goes destroys any matter which would have a tendency to decay; hence, it cannot be unhealthy. Painted well, it may be made very ornamental. The substance used is a thick straw pasteboard, which has been sized and pressed. It is fastened to the studs with broad-headed tacks, and dampened a little, so that shrinking will make a tight fit. The strips are put on across the studs in the same direction as lath, and the wall paper is pasted over the pasteboard in the usual way. In mild climates it has been used for the outside of houses, but the paper for this purpose is manilla board, very tough and quite thick. It is not better or more durable than wood and plaster, but it is a great deal cheaper; and summer bed-rooms, kitchens, wood and coal sheds, hen-houses, and the pioneer cabin, can be made of it.

Dr. J. V. C. Smith—I am surprised to hear Professor Colton condemn paper as a building material. He surely cannot have investigated the subject. Why, sir, they make buckets, tubs and water-pipes from it, and in Germany I have seen handsome cottages and churches built from paper.

Prof. Colton—I have investigated it, and that is just why, in my practical view, I do not believe it will be of any great value. It is nearly as costly as sheet-iron, and not so strong. Some fancy men may build a villa out of it, but it would be rather a costly material in this country. There is, however, much to be learned about the uses of paper, and there is a wide field yet to be opened to the straw paper business.

No Advantage in Shallow Milk Pans.

Mr. E. Meeker, Olympia, W. T.—The absence of ice, or at best, irregularity of supply, makes it necessary to look to other plans for equalizing the temperature of milk. Where there is spring-water or well-water of a low temperature, the temperature can be regulated by setting the pans or cans in water. I have adopted the plan of using cans eight inches in diameter, and twenty-eight in height. These held approximately thirty-three pounds of milk, and making about one pound and a half of butter to the can. With well-water at fifty and fifty-three degrees in summer, we have but little difficulty in keeping the temperature down to sixty-three degrees, by adding a few bucketfuls of water at times. Experiments have shown that twenty-two pounds of milk were required to make a pound of butter, where cans were used. Where pans were in use the result varied so much that we could arrive at no definite conclusion, sometimes yielding one pound of butter to twenty and one-half pounds of milk, at other times requiring twenty-four to twenty-five. As we had no place to give the pans a fair test, the experiment proved incomplete. As to quality, we think there is no doubt, as exposing less surface to the atmosphere, is in every way more cleanly, and involves less labor. Here we make butter alone, as the relative price of butter and cheese will not warrant us in making the latter. As this is one of the best of butter-making climates, and also an excellent grass region, with pure, soft water, we are sure that this will develop a first-class dairy region; so give us your counsel and let us get started right.

Dr. J. Ware Sylvester—Some years ago I tried experiments with deep and shallow pans, and the result was in favor of the deep. We got a greater amount of cream in proportion to the milk.

How to Sprout Larch Seed.

Mr. J. J. Teschard, Monroe, Wisconsin, has tried for several years to raise larch trees from seed, which he received direct and fresh from Switzerland, but has failed every time, although he tried in fresh-broken sod, in timber ground and open prairie. This spring he gave some of the seed to a friend, who understands this business, as he keeps a nursery, but not the least sign of a plant comes up yet. The seed seems to be dead, although it is certain that the same was sent fresh and sound, and came here in less than three weeks.

Mr. Thomas Cavanagh—Larch seed don't always come up the same year.

Dr. J. Ware Sylvester—If he will get seed in season, compost it with fine sand, put it out doors where it will freeze and thaw two or three times, I think he will have better luck.

Mr. Thomas Cavanagh—It is a good practice to cover the ground, or shade it with a network of lath, and allow this to remain on all summer.

The Potato Pest and Paris Green.

Rev. H. F. Harrington, St. Louis, Mo., made the statement that, in his section, potatoes are doomed to a total failure. The striped bug covers and destroys the vines all over the country, and no remedies, of which a host are tried, seem to avail against this pest. No change of the land helps any more, and, where no potatoes were last year, for more than eighty rods around, there they come now out of the ground with the plants in millions. It looks dark for this so much beloved household fruit.

Prof. H. E. Colton presented the following paper in regard to Paris green: It is an unfortunate fact that nothing has yet been discovered which will destroy the Colorado potato bug, except Paris green; I think it unfortunate, as that substance is one of the most poisonous known to science, and, consequently, very dangerous to handle. At the same time, it is necessary that farmers, who are troubled with this pest, should get a good article, and be told how to use it; also, that they should be shown how to get it at the lowest prices. It usually sells wholesale at twenty-five cents per pound; now it is forty cents to fifty cents. The high price is caused by the demand and the necessity of making it in summer, when it is very dangerous. I am told by Messrs. C. T. Raynolds & Co., the largest manufacturers in this country, that they would rather make and sell it at twenty-five cents in winter than to make now and sell at forty cents. Men cannot work at it continuously more than a week, and every one in the factory, even to the partner who visits there, is obliged to take an antidote against its effects. You can judge of the amount used, when I tell you that this firm made and sold last week 21,000 pounds entirely to the west. It is made from arsenic, potassa and copper, and is chemically an arsenite of copper. The potash is used merely to aid the solution of the arsenic. It causes sores in the nostrils, in the arm-pits and groin, and, in fact, all the tender parts of the body. If a little gets under the nails, it gives great trouble. No child should ever be allowed to go near it, and the cloth or sieve used in sifting it on the plants should be destroyed as soon as the season for using it is over. In using, the mouth and nose should be covered with a sponge or cloth, the hands with gloves, and the eyes with glasses or goggles. These precautions are necessary, as it is one of the finest powders known. It is to be regretted that no other material will destroy these bugs; but, if care is used, no hurt will result from Paris green. A gentleman in Missouri writes that he has tried everything, and that Paris green alone does the work. The bugs would not touch pure white arsenic or corrosive sublimate. I present you two samples. One is pure Paris green, the other a mixture of lime and copper. The first does the work for the bug; the other is worthless. But large quantities of it have been sold by parties who have not a care for their reputation, and much loss has accrued to the farmers. No Paris green is of any value unless it will show by test its arsenic. Farmers who expect the bug, had best buy in winter, as it must take a considerable quantity, and there is at least fifteen cents difference in the price. I am informed that the bug is traveling eastward, at the rate of 150 miles a year. Perhaps some western man can tell us more as to that. If this be so, it becomes the farmers of New York to find some means of preventing its approach, rather than depend on killing them when they come. One word more, and perhaps the most important one.

The antidote for Paris green poison is hydrated sesquioxyde of iron. Nearly every druggist keeps it always on hand. If it cannot be bought, it may be prepared thus: Dissolve copperas in hot water, keep warm, and add nitric acid until the solution becomes yellow. Then pour in ammonia water, common hartshorn, or a solution of carbonate of ammonia, until a brown precipitate falls. Keep this precipitate moist, and in a tightly corked bottle. A few spoonfulls taken soon after even a bad case of poisoning with Paris green or arsenic is a perfect remedy. Every farmer who uses Paris green for the bugs should keep this medicine always in his house.

Mr. C. V. Riley — What the professor has said about this beetle is true. The poison of Paris green takes hold of some people worse than others. I have been mixing it and sending it out for weeks, but none of the men who handle it complain of its effects. It may be mixed with ten or twenty times its bulk of plaster or wood ashes or common flour, and a very little sifted on each hill will do the work. The army of invasion is marching east. I hear of some in western Pennsylvania. It will be on the Susquehanna and the Delaware in a year or two. Forewarned is forearmed. Let farmers buy ten pounds of this bright green powder while it is cheap, and keep it on some top shelf in a tin case. If the destroyer comes, you can slay him in one day's battle; if he does not come, you can mix your Paris green in oil and give your window-blinds a fresh coating.

The Red Cattle of New England.

Mr. Jesse Harrington, Medina, Ohio — I am an old man, and have had from boyhood some experience in the care of and the different breeds of cows. I was born and brought up in west Vermont, where the red cattle of New England and the parti-colored cattle of the Dutch of the Hudson and Hoosic valleys came in contact, and the dairymen soon found that the Dutch cows were far the best; and why should they not be, as, when the Knickerbockers and Van Twillers brought them to New Netherland, they brought them from the best dairy country in Europe, and they have since been highly improved, as it mattered not whether a cow was brown, white-faced, limebarked or brindled; if she gave a good mess of good milk, and was gentle, she was kept and bred from. After trying the large, improved breed, I learned some things. One was, that two of the improved breed would eat as much as three of the natives; and that two of the natives would give as much milk as three of the improved. Mr. Willard, in his remarks before the Utica Dairymen's Convention, in deploring the decrease of the dairy products in proportion to the number of cows, says: "The improved stock we now have on our farms requires better treatment than our native cows. And a practical dairyman from Herkimer has told me that there was no assurance of more than two out of five heifers making good cows, and as it is customary to try them two seasons before discarding them, I think it is another high recommend for the improved breeds, as among the natives four out of the five could be depended upon. The same state of things exists in Ohio, although our native cows are not so good as were formerly the cows of the Mohawk valley. The Devons make indifferent cows, but, as far as my experience is concerned, a dozen of them wintered at a straw stack will give as much milk as an equal number of Durhams kept at the highest point. Although rather nervous, the Devons make good, hardy oxen, while the Durhams have neither nerve, activity nor power of endurance; and, if any of their admirers think differently, let him turn a Devon native bull with a brigade of Durhams, and see which will rule. In the year '69 we broke in six heifers, four natives, one Durham from a noble Durham cow and sired by a bull that cost eighty dollars when a calf, and one Devon. Five of these were good cows; the other, being full-blooded and just such a milker, and having just such an awkward shaped bag as most of that breed have, is not now on the farm. I don't dispute but that there may be occasionally a first-rate cow among the Durhams. It would be strange if there were not. I have never practiced feeding cattle for beef to any great extent, but I have never had any trouble in selling fat beef at the highest prices. I think it folly to discard a tried and good race of cattle for one that is fit for neither cows nor oxen."

Dairy Cows in Northern Ohio.

Mr. J. J. Jones, Ashtabula county, Ohio, gave it as his opinion that "the Western Reserve is probably as good a dairy country as there is in the world;" and then made the following statements with regard to the management of the cows, most of whose milk goes to the cheese factory: "The cows are wintered on hay alone, if they do well; but, if a cow begins to get reduced in flesh at any time, she is immediately fed grain, beginning gradually, that is, feeding light at first, and increasing; but the main part of them receive nothing but hay until a week or ten days before calving, when they begin feeding light at first, not feeding very much until after coming in, which they prefer to be about the first of April. After this they are fed rather heavy, usually on corn and oats mixed in equal quantities and ground. Some prefer to feed it dry, others to mix it up with cold water. They are fed after this until the first flow of milk is established, which will be some time after they have been out to pasture. Unless there is a great abundance of pasture, a piece of ground is sowed with corn, which is fed green when the pasture gets short; but, if there is an abundance of feed all summer, it is cut and cured for winter feed. In the fall, when the after-swath is well grown, they are turned into the meadows. From this they receive nothing but hay, straw or corn-stalks until the next spring. Cooking the food for cattle has not been tried enough to know whether it pays or not on the Reserve."

Adjourned.

June 20, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Early Potatoes.

Mr. E. Frank Hynes, West Plains, Mo. — At one of the meetings of the Club, Mr. J. C. Thompson, of Rhode Island, exhibited his method of getting early potatoes. He stated he cut his potatoes in halves, and placed them in sand in boxes; after sprouting he cuts apart, and in this manner he expects to obtain new potatoes in sixty days from planting. I obtained from Mr. Gregory, of Marblehead, Mass., the early rose. This year I cut to single eyes; planted, without sprouting, the 22d day of March; on the 10th of May they were in blossom; on the 15th commenced to use, having plenty as large as a good-sized hen's egg, fifty days from planting. The land is new, this being the second year. I manured with partly decomposed stable manure, and thoroughly mixed with soil. The soil thus made acts in some degree as a cold frame or hot bed, and the result is always satisfactory with me. At this writing my potatoes are ripe, vines dead, and the yield is excellent of large sized potatoes, few small ones. I shall dig about the 12th of the month, and plough, manure the patch again, and by the last of August shall harvest my second crop from one seed and from the same land. With the early rose I have always been successful in raising two crops the same year, in this manner For the benefit of all seeking new homes in a healthy climate, with rich soil, where land is cheap, I will say, in this county there are yet subject to homestead or cash entry 200,000 acres of good farming and grazing lands.

To Obtain the Largest Yield of Potatoes per Acre.

Mr. H. M. Robertson, Trenton, N. J.—Select about an acre (for initial experiment) of thoroughly enriched soil, which has been sown with potatoes according to the latest approved method, and at the 1st of June, or when the stems have attained a growth of two or three inches above the ground, having prepared a top-dressing, consisting of two-thirds sulphate and one-third nitrate of soda, finely ground and intimately mixed together, apply a quantity equal to two heaped table spoonsfull of this mixture to each hill of potatoes, incorporating it with the soil. This will cause the stems to grow to the height of from four to six feet, with a proportionate thickness, supporting a redundancy of healthy, deep-green foliage, while the yield of tubers will be from 300 to 600 bushels to the acre. This azotized alkaline mixture furnishes sufficient nutrients for an extraordinary development of stems and foliage, which latter, in its largely increased elaboration of sap over that of plants of ordinary size, suffices to enable the roots to extract from the rich soil the constituents for the production of tubers proportionate in size and numbers to the capacity of plant and soil, while its alkaline character prevents the development of the fungus of the microscopic acari, which causes the blight of the leaves, etc., just as leached wood ashes perform the same office to a certain extent for fruit trees. This refers to an actual yield produced under the most favorable circumstances of climate and soil.

Compost for Hops, Corn and Potatoes.

J. W. Fancher, Broome county, N. Y.—I take twenty bushels of wood ashes, twenty bushels of hen manure, ten bushels of unslaked refuse lime, one barrel of Onondaga plaster, and two bushels of common salt. I use the compound for hops, corn and potatoes. I have always put it on after corn and potatoes were up. Would it be better in the hill, and what quantity of salt can be used in the above compound with benefit? Would you add more plaster?

Professor Nash—When that letter was first read over I thought he was all wrong in mixing his hen dung and lime, for the lime would drive off the ammonia, but as he mixed plaster that effect is prevented. His compost is good, a sound combination of the fertilizing elements in theory, and efficient, no doubt, upon his crops. He will get more direct effect on the first crop by using it in the hill.

Dr. J. V. C. Smith—Speaking of composts, reminds me of the practice of my grandfather, who landed at Plymouth Rock. They found the soil of eastern Massachusetts so poor that our pilgrim fathers saw starvation staring them in the face till a good Indian, Squanto by name, told them to catch herring and plant them with the corn. This they did, and made good crops. Let us take a lesson from Squanto, and dung our corn with dead moss-bunkers.

Mr. D. B. Bruen—I knew a man on Long Island that had a farm too poor to sprout navy beans. So he followed the sea and saved some of his earnings, and came back at length and found his farm in the hands of a stranger. Some tenderness had our mariner toward the old acres, for they held the bones of his sires. So he bought it for $2,000, and instead of plowing it he kept on plowing the sea and hauling in moss-bunkers. He caught millions of them, and when he got ready he spread them thick all over his land, turned them under, and sowed wheat. His crop was forty bushels to the acre on seventy acres, which he sold for $1.50 a bushel, and thus paid for the place twice over with the first crop, and it was the fish that did it.

Dr. J. V. C. Smith—In my travels as a young man I was in Germany and talked with that great luminary of Teutonic science, Herr Pfingster Ehrenburg. One day Herr Pfingster asked me if I knew what made the Nilotic mud so fertile. "Yea," quoth I, "it is vegetable matter brought down from beyond the upper cataract, from the latitude of Senegambia and the Mountains of the Moon." "Nay," quoth he, "not vegetable matter. I have had this marvelous Nilotic mud under my lenses and I have found it full of nameless little fish, reptiles, infusoria. These make the mud of the Nile so rich."

Dr. Israel Jarvis—Now we press the oil from the moss-bunkers, and the fish cake that comes from the press is as good manure as the whole fish; in fact better, for the use of fish only as manure makes the land bake, and no good crop is raised with fish after the fourth application.

The Vanilla Bean as a Vermin Destroyer.

Dr. Lewis Feuchtwanger—It is not generally known that vanilla exercises similar functions as the Caucasian insect powder (Pyrethrum carneum and roseum), which acts very destructively upon insects infesting the person of man and animals, by stupefying first and then killing them. In all tropical climates insects are very annoying, and the inhabitants of the countries where the vanilla grows in abundance, as in Brazil, Mexico, South America, etc., have, for ages, employed the pods of this creeping plant (epidendrum vanilla or vanilla aromatica) in various forms against the attack of the poisonous ant, flea, musquito, fly, etc., by moistening or sponging their bodies with a concentrated tincture of say one ounce of the same steeped in a pint of their aqua callicote or proof spirit. It is a very pleasant perfume for man, used mostly for flavoring ice-cream, chocolate, etc.; but must be quite the reverse to animals or insects; and, as vanilla consists of a resin, wax-fixed oil, brown resinous matter and tannin, it is, therefore, difficult to discover the rationale of its action upon the organs of the insects, nor can we trace any relationship with the action of the insect powder, which has long been extensively used by the people of Western Asia for the destruction of all vermin, the constituents of which remenble that of the German camomile.

HARVESTING HAY EARLY.

Mr. H. L. Reade read the following paper: In 1859, the hay crop in the United States amounted to 19,129,128 tons, worth at least $191,291,280. Eleven years has increased this by at least one-third, so that the crop in 1870 was at least 30,000,000 tons, worth $300,000,000. Making a low estimate, one-sixteenth of the value of this crop is lost by late cutting. And yet the practice, so costly, is surprisingly common. Were argument necessary to convince farmers of their mistake and loss, attention might be called to that wonderful and most suggestive provision of Providence, that in almost if not all sections of the world where cattle depend upon wild grass for winter as well as summer food, sudden and great heat, and a correspondingly dry atmosphere, combine to change the grass into what civilization calls hay, while in the fullness of its growth, and always before its maturity; and thus it is that when for months not a green thing is eaten by the herds of roving animals, they are found to be in better flesh at the end than at the beginning. If the grass reached completeness in its growth, and seeding before being dried, cattle eating it would die of starvation, rather than thrive.

Science, as well as observation, demonstrates the necessity of an early hay harvest. Grass is the natural food of animals, and before the plant reaches its maturity it contains all the elements needed to make a perfect aliment in the best possible combination, and in the best possible proportion. Afterward the nature of the plant changes, and reproduction, not force — if we may put it in this phrase — becomes the ultimate object. If, therefore, farmers would secure the best and most valuable hay crop, grass should be cut while the seed vessels are forming, and never after they are formed. Haying, therefore, should be commenced, on an average, ten days earlier than it is. There may be a little loss at the beginning in the bulk, possibly in the weight, in consequence of the immaturity of the crop; but the loss would be none at the end, by the change in the nature of the plant from a juicy, saccharine combination into something that acts simply as a stiff, horny holder for the vessels containing the matured seed.

Poultry Fountain.

Mr. B. Van Gaasbeck, 12 First street, New York, exhibited a flowing spring poultry fountain, which was highly approved.

Adjourned.

June 27, 1871.

Nathan C. Ely, in the chair; Mr. John W. Chambers, Secretary.

Progress in Dairy Farming.

J. Addison Smith, Collins Center, Erie county, Pa.—We live twenty-five miles south of Buffalo, in the midst of a grazing district. This implies, of course, soiling, composting, underdraining, and subsoiling, and the two first call for a new barn with a new name; a structure simple, cheap, convenient and comfortable, handy not only for storing feed, but also for stabling and composting, and by its merits entitled to have written across its front gable, in letters of gold, compost factory, where each cow, well mulched with dry muck or other dry earth, can turn out annually twenty loads of choice home-made fertilizer, ninety-five per cent of which can be home produced. Now, with this amount of rich compost applied annually to each underdrained and well-tilled acre, how long will it take to realize our motto, and at the same time make it pay as we go along? But who has sufficient faith in soiling, composting, underdraining, and fertilizing, and at the same time sufficient skill to construct a stable so as to secure evenness of temperature, summer and winter, good light, good ventilation, with convenience for drying and storing muck or other absorbents and deodorizers, together with nice facilities for daily composting, and storing up compost, until the best time to apply the same to the hungry soil without waste and loss, and embracing, too, convenient storage for variety of feed, combined with economy of space, and at the same time each kind equally accessible, and all without violating any law of economy, either of time, space, labor, convenience or cost? Thirty-five years' experience as a barn-carpenter, and the same number of years of observation on dairy farming, have given me intense conviction that all of this, and more too, is practical, and along with this conviction is an intense sympathy also for the good of our wide country, and as I know of no body of men so well organized as this Club to work out any problem to improve the material condition of our farmers, I appeal to you to offer some small prize for the best plan of a farm barn and yard, embracing manure-house, hog-pens, and all points going to make up a complete home compost factory, and at the same time a perfect store-house and stable, both practical, scientific and economical. As a leading feature, I would suggest that the stable or basement floor should be a pavement, and that the driving floor should be over the stable, and although I would drive in from the bank, yet there should be no bank against any part of the barn or stable, as it interferes with many important things, not the least among which are light and air.

TRUE PROGRESS IN FARMING.

J. B. Lyman—This session, Mr. Chairman, is our last for a number of weeks. Some of us have farms and gardens and orchards where we wish to practice all that we may know of rural art. Some of us will become tourists, and, speeding across the mountains and the great central valley that lies beyond, we propose to study agriculture as it is practiced in that magnificent plain which feeds and clothes the greater part of this continent and a large part of Europe. We hope to come back in September to these meetings with many important and valuable results of observation with which to enrich our sessions and the reports of what is here said. It is now twenty-eight years since the American Institute Farmers' Club was formed. All have seen great advances made in the mechanism of farm labor. When we began to meet and to talk, the hay and grain of the country were harvested by the toil of human muscle. Now, horses cut nine-tenths of these crops. A few hundred quarts of strawberries were sold by a few of our grocers. Now, New York handles from four to seven million quarts of small fruits. Fifteeen years ago, New York and Pennsylvania gave us our steaks and our roasts. Now, the meat supplies of the great seaboard cities come from beyond the great rivers, from the plains of Colorado and the savannahs of Texas. These important advances are, some of them, the result of greater knowledge and skill and enterprise in our farming community, and they are in part the result of the amazing extent to which railroads have been pushed westward and multiplied. I propose to-day to speak of those defects and difficulties in our farming which may to a great extent be overcome, and thus to vindicate the lines along which a true progress must move toward the farming that is to be.

First. We need a better way of talking about soils. A farmer reports such and such treatment on a sandy loam or on a clay loam. There are twenty sorts of clay loam, and as many kinds or specimens of sandy loams. Some years ago it was believed that analyses of soils would give positive figures by which farmers could always know what they are handling. It is considered, in a rude way, that all soils are grades of clay or of sand. This is a mistake. The earth produced by the breaking up of mica slate and hornblende slate is not a clay; yet it is in no sense a sand. What should it be called? On the Pacific slope they have a very stiff, strong clay, produced by the wearing down of the bastard granite of the sierras and their spurs. This soil is unlike any soil in the east; yet it has no name. So also of the dark, fine mould of the prairie. We have no suitable term for it.

Second. We need to know more of the adaptation of varieties to soils. In the small fruits, we find that some berries are failures on the soil produced by the crushing of the granite rocks. On the red shale of New Jersey they prosper. The Triomphe on sandy land fails. The Romeyn, a berry so similar to the Triomphe that many say it is the same, prospers on sandy loams. The Bartlett pear, of Boston, is unsurpassed. In this latitude it has many rivals, both in productiveness and flavor. A Roxbury russet, grown at Roxbury, is a noble apple. In western New York it is unequal to the Spitzenberg or the Rhode Island Greening. This is especially true of the grape. The vine has its favorite climates and its peculiarly adapted soils. The lake climate for grapes is a remarkable peculiarity, and we do not know enough of its extent or of the sorts of grapes that will fully ripen in those favored spots. The knowledge we have on these subjects needs to be first enlarged, then systematized and mapped down; then it should be made popular and scattered broadcast. Millions of dollars are wasted annually in attempts to grow a variety of wheat, a kind of potato, a sort of berry, in a soil ill adapted to it, but kindly toward another variety of the same plant.

Third. We spread our manures and our seed over too much surface. We get ten bushels of rye from two acres, when we might take it from one. We run over fifty acres for fifty tons of hay, when it could be cut with less labor and of better quality from twenty-five acres. None of our acres but will bring some income, without cultivation, by a growth of wood. East of the mountains, it would be wisdom to give back half the surface now cleared to forest, and concentrate all our pains and manures and seed on the remaining half.

Fourth. The grand defect of all American farming is indifference to the methods by which the manure pile may be increased. East of the mountains we know that we ought to use more manure, yet neglect the sources and the arts by which we are to make our lands productive. West of the mountains a vast spread of soil, naturally productive and cheap, has flattered the western farmer and cut the sinews of his thrift. He has neglected manure, he has despised dung, he has pitied the less fortunate who break their backs and tire their arms forking over compost piles. Meantime the power of his soil has fallen from thirty-five to thirty bushels of wheat, from thirty to twenty-five, from twenty-five to twenty, from twenty to fifteen, in the older States of the west, and the crop is still in the down grade, and will go as low, as poor old Virginia, where five bushels to the acre is a fair crop of wheat. Nothing will arrest this decline in the great staple of bread but the saving of rich manure. We cannot make rich manure without rich food. We cannot use rich, *i. e.*, oily and concentrated food, to advantage except in stall-feeding cattle. Hence the distinction between grain farm and stock farm ought to be unknown. Every grain farm should fatten stock, and every stock farm should produce large crops of grain. The best farmer is he who gives society the greatest number of juicy steaks and roasts, and the materials for the greatest number of wheaten loaves. Him I call the best farmer; he is more, he is the best man in society. The rest of us—talkers, writers, traders—live by our wits; we milk the cow; we suck the public pap; we are *fruges consumere nati.* The creator of food is father of all energies and values; you may call him a mudsill, but the whole fabric and superstructure of society, all pillars of state, the platform, the pulpit, the singers' gallery, the impressiveness of the facade, the streaming glories of the flagstaff, all rest upon that mudsill.

Fifth. We want a science of farming that is an American system. The old world can teach us much, but all examples from England or France or Germany need their constant qualifications. The European climate is much cooler and moister than ours, its winters are milder, and a good square day's work can be bought for twenty-five cents. In all our adaptations of continental example we are to remember that economy of labor and uncertainty in securing laborers are elements which every one of us must take into account.

Sixth. Four years in six our crops are shortened for lack of water in some part of the growing season. The ways by which this difficulty can be mastered are true problems for every farmer. We need cheap and practicable methods of spreading the rainfall of spring through the growing season. It can be done by ponds, cisterns, wind-mills, and irrigating canals. As a general remark, $500 well expended will give one command over ten acres to make them as wet as the greatest prosperity of vegetation requires. This full command of moisture will add over fifty dollars to the value of any cultivated acre. In many cases land would be enhanced fifty dollars per acre in the product of the first year. The American farmer should take a broad view of the importance and nobleness of his work. Hunger has upset the strongest and oldest governments of history. Hunger will not threaten the stability of our Constitution for ages, if our farming is as good as our locomotion; if we apply as good thinking to the solving of problems in agriculture as we do to the problems of medicine or law or mechanics. He who does most to make our farming perfect is working directly to make our Constitution perpetual in time and a model for all the races.

Mr. S. D. Clarke, Oswego, N. Y.—I am a stranger among you, Mr. Chairman. I have come 300 miles mainly to meet with you to-day, and hear you talk, and enjoy your eloquence. Oswego is not such a city as yours, but some of us up there on the shores of old Ontario have drunk the wine of progress that you, Mr. Chairman, speak so well of. It lifts up the spirit, but it does not intoxicate. It has induced us to form an agricultural society, and we have a property worth $10,000, and are increasing in numbers and influence each year. Our main hall is 30x65, and our club-room is 40x30, and we generally have it full. It is one, and only one, of the sprouting seeds scattered all over this land by your hands. You are the parent society. One of your number has said that you have been twenty-eight years in existence. Allow me to say that heaven only has the numeration table that can note the good you have done, the clouds you have scattered, the fire-sides you have enlivened, the doubts you have resolved, the pellets of wisdom you have sown — some on stony ground, and some on good soil.

On motion of Dr. J. V. C. Smith, it was

Resolved, That when we adjourn, we adjourn to meet on Tuesday, September 5.

Adjourned.

September 5, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

A SELF-FILTERING CISTERN.

Mr. William Dyer, of Ashland, Schuylkill county, Pa., "wished to know the best plan for making a self-filtering cistern for domestic use, to receive water from a slate roof twenty by forty feet. What size cistern is best? And most especially do I wish to know how to make the filtering arrangement."

The Chairman—The size of a cistern must depend very much on the size of the family for which it is intended. Some of our friends have many children, and others have no family save themselves. Mr. Lyman has an extensive household, and can, perhaps, throw some light on this subject.

Mr. J. B. Lyman—I have built a circular cistern, the walls converging toward the bottom like an inverted cone. The sides are cemented by placing the cement directly on the gravel. In the middle of the bottom, which is of brick, there is a square filter sunk below the level of the cistern-bottom two feet, being four feet wide, to serve as a filter. This filter is divided by a brick wall, made with very little mortar, so that the water easily passes through it. Above this filter division rises a wall of brick to the top, completely dividing the cistern in two. The filter is filled with fine charcoal and gravel, about half a hogshead of this mixture being used in the filter. Over this mixture about three bushels of pebbles are placed to keep the charcoal and gravel in their place. The water enters on one side of the wall, passes down through the charcoal and gravel, percolates through the unmortared brick wall, and comes up on the other side free from impurities, whence it may be pumped out and drank. When these cisterns are new there is a slight lime taste about them from the mortar, but that soon passes off, not being noticeable the second season. This cistern is built after a plan furnished me by the late Professor Mapes.

Dr. Isaac P. Trimble—Last week I talked with a gentleman who uses cistern water exclusively, and his plan of filtering it is much such as has been described.

Mr. Thomas Cavanagh—It would be better to have the filter on one side, near the top, where it could be cleaned more readily when foul.

Dr. J. V. C. Smith—In the city of New Orleans they use cistern water, which is collected in huge tanks. They use no filters. The sediment collects at the bottom of them.

Mr. J. B. Lyman—They do not drink the water from these large cisterns. They have a drinking-water cistern which is filled in winter, and being kept covered often keeps cool quite into the summer.

The Chairman—Well, here at the north it won't do to have cisterns exposed to the action of the frost, unless you want them to burst. For my part, I should prefer to drink filtered water.

GALLS ON MAPLE LEAVES.

Mr. M. W. Stevens, Swansville, Schoharie county, N. Y.—About twenty years ago I planted street shade trees of the Eup. silver maple (A. dasycarpum); they are now lofty trees and a splendid shade; but for two or three years last past they have been attacked in the month of June by some disease which produces a multitude of small lumps upon the leaves (like the one inclosed). Some of the leaves turn black upon the tree and drop off, while from others a substance falls which produces a stain upon the fence and walk under the trees; this stain is dark green and remains a long time. When the leaves are most covered, and in damp, warm weather, a bitter and disagreeable smell comes from them, and later in the season an insect makes its appearance in colonies of three or four inches diameter upon the trunks of the trees. These insects are half the size of a house fly, brown in color, and very active when disturbed. Between the dropping off, turning black, stains and unpleasant odor, this tree family is very much lessened in value. Can it be prevented?

Mr. A. S. Fuller—There is no connection between the galls on the leaves and the insects on the bark. The galls on the leaves are the work of one of the gall flies, *genus sinox*. They are so small one can hardly see them. A little lime dusted on the leaves might do them some good.

CHINCH BUGS AND CROPS IN IOWA.

Mr. E. Wellington, Riverton, Fremont county, Iowa—Fremont county is the southwest county of the State, and one that has the best soil of any in the State. During May and until the middle of June, the weather was dry and hot, making it quite favorable for killing weeds and ploughing and cultivating corn. It also hatched out an innumerable amount of chinch bugs that destroyed all of the spring wheat in this section of the country, and to some extent damaged the oat and barley crop, and the first rows of corn that were next to wheat. But about the time that they got all of the wheat destroyed, we had some severe storms of hail and rain that to a great extent stopped their ravages. I never saw the corn crop look better here at this time of the year; it averages nine to ten feet in height. In this section of the country, out of every hundred acres in cultivation, eighty acres of it are in corn. There was but little winter wheat sown here last fall, as it has been generally supposed that winter wheat would not do well here on account of its winter killing, but it has not winter killed for the last three years. It ripened this season too early for the chinch bugs to damage it seriously. So far as heard from, the yield is excellent, being from twenty-five to thirty bushels per acre. There will be 200 per cent more sown here this fall than last, and I think that next season there will be a corresponding decrease of the acreage of spring wheat sown. Potatoes also look fine and promise a large yield.

LARGE EARLY CORN.

Mr. C. C. Cooley, of Manchester, Ohio, forwarded two ears of corn with the following letter: I send you by express a sack of meal made from the present season's crop of corn, ground on the 9th of August. This is undoubtedly the earliest large field corn in the United States. I will give you its history. Some fourteen years since I received a small ear of eight-rowed corn (early Minnesota, I think). I planted it, for roasting ears, near a field of large white corn. The large corn intermixed with it. I saved the largest ears for seed; I planted it as before by the side of the large corn. That year I noticed a great difference in the size of the ears, some of the ears having ten to twelve rows. So I again saved the largest and best ears for seed, and have been doing so from year to year, so that I have succeeded in producing a corn that will yield as much to the acre as any variety of large corn. The ears are long, with twelve to eighteen rows. It can be fed to stock by the 1st of August, or can be shelled and made into meal, or sold in the market by the 15th of August, while the common field corn in this neighborhood is not hard enough to grind before the 10th of October, making this corn at least two months earlier than any other variety. I send you two ears of corn planted May 3; they speak for themselves.

I am cultivating this corn on the Manchester island, where it has no chance of mixing with other varieties. This goes to show that, if as much attention was paid to the improvement of corn as there is given to wheat, fruit, hogs, etc., a hundred million bushels might be added to the annual crop. The land on which this corn is raised is good, but has never been manured; it has been in cultivation a great number of years. I plant the corn three by three and a half feet, and allow three to five stocks to the hill.

The great drought that has been prevailing here since the 1st of August has injured the common corn very much, while this corn, being so early, missed the dry season. The corn being white, will command a better price in your market than yellow or mixed corn. A bushel of this corn, when dry, will weigh sixty-one pounds.

So confident am I that this corn is superior to any other large field corn, that I will give a premium of $25 to any person who will produce any other variety that will equal this for earliness and productiveness. I call it "Cooley's early white field corn."

Barren Pear Trees.

Mr. J. E. Greene, of Pomfret, Conn.—What can I do to make several quite large, thrifty pear trees bear well—"Marie Louise" and "Dix" varieties, twenty-eight years old? They bear occasionally a few. They stand in good, deep, black soil, well suited to grow trees or almost anything else. Bartletts and Seckels by the side of them bear well. Also, what can I do to prevent the yellows in peach trees? I am troubled with canker worm on apple trees. What shall I do to prevent their appearance next year?

Mr. A. S. Fuller—The trees are probably growing still; they will bear when they stop spreading. I have known a Dix pear to go twenty-five years before it commenced to bear, but the fruit it bore in abundance was an ample reward for waiting.

The Tennessee Table-lands.

Mr. S. Harrod Bell, of Howard Springs, Tenn., sent the following valuable communication: As this region has been frequently mentioned in the meetings of your Club during the past two years, what I shall say will not be entirely new. Many of the statements contained in former communications were mere opinions in regard to an undeveloped country. They overrated it in some respects, and underrated it in others. This was unavoidable. The country is only partially developed yet, and many questions are still unsettled—at least, in part. I was raised a Northern farmer, am a practical surveyor, and have been here two years. I will state briefly what I have learned, and let inquirers form their own opinions. This table-land is about thirty miles wide. It lies 1,000 feet higher than the surrounding country, and 2,000 feet above the sea. A large part of its surface is nearly level or moderately rolling. The rest is more or less broken. The leveller portions are usually covered with open timber and wild grass; the more broken, with heavier timber and less grass. The difference is mainly owing to the fact that fires could not run so readily in the broken sections, being more hindered by streams, etc. The timber is mainly oak of various kinds; also chestnut, hickory, soft maple, tulip tree, pine and yellow poplar. In some flat, open sections there is considerable "black jack." There are some open natural meadows. The grass is very nutritious. It is only second to Kentucky blue grass. No matter how poor cattle are in the spring, they are quite fat by early fall. The soil is of moderate fertility, and varies considerably. Its quality depends more on the range of former fires than anything else. In some places it is too sandy, but not usually so. It is nearly all underlaid with a yellow clay sub-soil. Under about one-fifth of the area, the rock is too near the surface for agricultural purposes. It crops along the slopes and ravines. The rest of the land is generally free from loose stones. The rock is nearly all pure sandstone, and makes good building material. The effects of barnyard manure are very marked and apparently permanent. A little goes a long way. Lime and ashes vary in their effects. Green soiling would seem to be the thing, but it has not been tried to any extent. This is not a grain-raising country. Wheat and corn yield moderately. The grain is very heavy. Oats and buckwheat do very well some seasons, but occasionally fail. Rye, sorghum and Irish potatoes do well. Sweet potatoes and vegetables generally are of fine quality, and do reasonably well when cared for. The cultivated grasses have done well when properly set. Clover, timothy and red top have been sown; the latter grows wild in some places. The little blue grass I have seen was growing finely. White clover springs up wherever a seed is dropped. Horses, mules, cattle and swine will pay well for their raising. Sheep are the best to start with. By having inclosed winter pastures, but little feeding is necessary. There is about a week of snow each winter; not much mud. Apples are nearly a sure crop; the yield is large, and fruit sound and well flavored. Peaches yield largely, when they escape frost. Pears, cherries, quinces and all small fruits have done well as far as tried. Grape vines are healthy and the fruit sound. Their prospects are very promising. Dairying and bee-keeping are doing well, and promise to do better.

No murrain, hog cholera, foot rot or regular potato rot has originated here. No chinch bugs or potato bugs, and few musquitos. The summers are comparatively cool. The mercury seldom gets to ninety-five degrees. The days are breezy and nights cool. The air and water are very pure. There are numerous springs and small streams. Some of the former are permanent, and some fail in dry weather. Where wells are dug, water is usually found near the surface. There are several chalybeate, or iron, and other mineral springs. One of these resembles those at Saratoga, N. Y. For healthfulness I have not found this region equalled in any of a dozen States that I have visited. Not one case of either bilious or typhoid fever, ague or chills has originated here during the past two years. Several invalids have been benefited or cured by our climate and mineral water. The refusal of Kentucky to grant a charter to the Cincinnati Southern railroad has delayed settlement here. I have reason to believe that this charter will be granted early next winter. It will make a great change. There are not over 200 Northern families in this county. They represent nearly all of the New England, Middle and Western States. Among them are persons of worth, intelligence and culture. Schools, Sunday schools and religious societies are being organized. This country is thinly settled. The natives are friendly, and a strong union sentiment prevails. Scarcely any negroes, and no Ku-Klux here. So strong is the Northern influence, that one would scarcely know he was in "Dixie." The difference between this and other sections must be felt to be fully appreciated. This table-land is on the line of the Tennessee and Pacific railroad, which shortens the route between Knoxville and Nashville ninety miles. It is completed as far as Lebanon. Persons coming here to settle should not put all their money into land because it is cheap. That mistake has been made by some, to their cost. They should save half to pay for stock, fruit trees, tools and improvements. Prices of land are very low, ranging from one dollar to five dollars for wild, and from two dollars to fifteen dollars for partly inproved tracts, owing to size, quality, location and value of improvements. There are many bad titles, but plenty of good ones. Colonists will find it necessary to exercise care, and not spare pains in examination; they will be well repaid for their trouble. Those who desire further information will do well to preserve this article for reference. This country is underlaid with coal, which crops out occasionally. Iron ore is found on the surface in some places.

September 12, 1871.

NATHAN C. ELY in the chair; Mr. JOHN W. CHAMBERS, Secretary.

HUBBARD SQUASHES.

Franklin Brown, Choconut Centre, N. Y., wrote under date of July 12 that he has "two acres of Hubbard squashes, and they are growing and setting finely. The laterals are coming out thickly on the best of them. My experience in this line is limited; hence I ask you for advice on the following point: Will it be better to let them have their way and nature take its course, or to allow them to get as many sets as I think they will mature, and then clip the extremities of the vines and thus keep them subdued? Some say let nature take its course, but I think it not practicable in all cases."

Dr. Trimble—This is a very good subject for investigation, and I would be pleased to have the opinion of several of these learned gentlemen.

Mr. Bragdon—I always grow the best Hubbards by clipping the vines.

Mr. Nash—If the vines are permitted to run, there will be many sets, but only part of them will mature. Clip them and there will be a smaller crop, but better specimens.

MANURE IN HILLS OR BROADCAST.

A. K. Rothers, Round Top, Texas, desired to be informed whether it would be the part of wisdom to scatter his compost or put it in hills.

Mr. Lyman—As a general rule, I think it best to use little manure in hills on land which one wishes to bring up and keep fertile. The chief crops require manure on all portions of the soil. But if he is following trucking as a business, there may be exceptions.

Mr. Curtis—The effects of manure put into the hills are more immediate and marked, and if a rapid and stimulated growth is desired for the plant, this is the best way; but if the object is to improve the soil generally, then a broadcast manuring is preferable.

LANDS IN KANSAS.

Among the visitors at this session was Mr. Jason Yurann, of Blue river, Kansas. He was asked to speak of his country, and in reply mentioned that he had found Kansas a healthful State and had never regretted that he went there ten years ago. Stock growing he considered the most profitable business for farmers in the west. Sheep are free from foot rot, and no scab is seen in Kansas. They require close shelter from the rain and winds of winter. Prairie hay makes a very rich feed for them, and they keep fat on it during cold weather. But this grass should be cut before it is frost-bitten, better in July than later. In newer neighborhoods it is necessary to herd the fold every night, in consequence of prairie wolves. Dairying would also pay well in Kansas, and first-class butter sells readily at thirty or forty cents. The prevailing grass is the blue-joint, and early in the season no other is so fat-producing. Later it dries up, and Kentucky blue is being introduced to take its place as autumn forage.

Mr. F. D. Curtis—The facts are, that a man with proper notions of life, and with a disposition to be industrious and frugal, can better himself by going west. He can go to Ellsworth county, about 238 miles west of Kansas city, and for five dollars an acre buy a farm of the Kansas Pacific railroad, or for three dollars an acre in Russell county, just beyond, locate himself on a farm anywhere within twenty miles of the railroad, with six years to pay for it in annual payments of one-fifth at a time. I consider the climate there as good as anywhere in our whole country. It is a buffalo region, and covered with a rich carpet of this luxuriant grass, and well adapted to grazing, and not unfitted for butter and cheese making, as there is already established there, near Hilton's Station, a dairy of thirty-two cows, where this industry is a success. At this point I saw recently the largest growth of trees from the seeds I ever saw, and so said Mr. Douglas, of Wakegon, Ill., an experienced nurseryman. Land can be secured under the Homestead act with an expense of only fourteen dollars, and five years' occupation, to the amount of eighty acres, within the limits of the railroad grant, for any citizen, and 160 acres for soldiers. While it is true that the thermometer rises high in this section, there is always a breeze, and one does not feel the heat as much here as in New York, at least such was my experience during one of the hottest days of the season. Kansas is modeled after Massachusetts, and contains a superior class of people, who are determined to lift theirs to the top notch among States.

Farming in Oregon.

Mr. Charles Barrett, Wester, Oregon, sends the following communication: The locality of the point of which I write is in latitude 46° 16′, and 210 miles east of Portland, bordering the Blue Mountains skirting the basin made by the Columbia river. This basin is about 100 miles wide at this point. Near the center rolls the Columbia, from which the rise of the mountains commences, gradually at first, but increases as you approach the summit of each. Two-thirds or three-fourths of this distance is covered with grass (bunch grass), sparse at first, mixed with sage, grease-wood, and sand. The soil is light and ashy, strongly impregnated with alkali, which in many places is incrusted on the surface from one-half to two inches in thickness. As you approach the mountains, the soil grows darker, the grass increases in quantity, the sage disappears at the "Foot Hills," thirty miles from the Columbia. The soil is well adapted to the growth of small grain, yielding from thirty to fifty bushels of wheat, and fifty to eighty of oats and barley. Here is a luxuriant growth of bunch grass mixed with the sun-flower and variety of other herbage. Corn yields well in the narrow bottoms of the streams that flow from the mountains, which are small and numerous. This place is well adapted to stock raising, for in no place in America does stock do better than in the valley of the Columbia, and is the only business that will succeed; the climate, the soil, the locality, all point out this business as the one fitted to succeed, and farming should be made subsidiary to stock-raising—to raise feed to keep them through a cold winter. When this business is fully developed and all its advantages made available, then will this region turn out large quantities of beef, mutton and wool. Strictly speaking, we have but the wet and dry seasons. The former sets in in April or part of May, when the wind becomes settled in the north, and from this time till November we have but few cloudy days and but little rain. In November, the wind changes to the south, which blows from the equatorial regions to the poles; which comes loaded with moisture which it deposits along the northern coast in the shape of rain, hail, or snow. A large share of this falls west of the Cascade Mountains or in the mountains. This sets free a large quantity of heat, which modifies this climate, and gives us the same winter temperature as the southern States. But when the wind changes to the north it universally brings cold, and if it continues long it is very cold, often bringing the thermometer below zero, carrying the cold into Mexico; but this is the exception, not the rule. This winter we have had only two weeks of winter in which it froze hard, but we had no snow. This closed up at Christmas. Since then we have had but little frost. The grass is growing slowly; grain coming up. Sparrows are singing. Farmers are ploughing, and vegetation begins to show the signs of spring. All through January, west of the Cascades, was constant rains. We had but little rain, a good deal of cloudy weather, with some sunshine, during which the south wind prevailed. This modification of climate gives the peach, the grape, the melon in perfection; whilst the apple, the pear, plum, cherry, and all the small fruits cannot be "beat." Three winters out of four our stock get their own living. You will see by this that here is a field inviting to enterprise and thrift, where success is sure if energetically followed; and to crown this comes the Northern Pacific Railroad through the valley to open us to the world, and soon we expect to hear the snort of the iron horse. I wish to report some of the experiments in the introduction of the improved grain. Irrigation is indispensable to secure a great yield in this climate, though in ordinary seasons a good crop is secured if put in early. My experience begins with oats. I procured eight pounds of white Probastier oats and the same quantity of Norway, and took the pains to drill them. I took about one square rod of each and irrigated at the proper time. The Probastier oat was noted for its numerous branches of shoots, which were tall and strong, with a large head well branched and heavy, many of the stools reaching as high as forty stalks; one I counted reached fifty, and many of the heads of each stalk had 100 balls each, the most of them with three oats in each ball, making the greatest yield of oats that I ever saw. Taking the average yield of the ground that I irrigate, it was fully 4,000 fold. The oats drew the praise and admiration of all who saw them. The oats that I did not irrigate were cut short by the hot weather that set in just as the heads were forming, hurrying them so fast that they did not mature, and shortened the straw. These stools had from fifteen to thirty straws each, well set, and, if planted in February or March, would have given a great yield, but enough was shown by the trial to prove them a superior oats, and prove valuable to the farmer. From the eight pounds I harvested fifteen bushels. I got about the same results from the Norway oats, they confirming their reputation for yied and adaptedness to the soil, etc. Some of them had magnificent sets. I am confident that the Probastier oats will be a success, for its heavy grain and thin hull, and the straw will make excellent feed for stock. My trial with corn proved satisfactory, the Olcott sugar corn yielding fully at the rate of seventy-five bushels. With irrigation, with a rich luscious grain that cannot be equaled by any other corn, and from a patch of ground fifty feet long by twenty feet wide, I harvested three bushels of shelled corn, making at the rate of 120 bushels per acre; and from one vine I got 200 pounds of pumpkin of the mammoth variety, and sixty pounds of sweet pumpkins—planted on first day of July, from one vine. Adjourned.

September 19, 1871.

NATHAN C. ELY in the chair; Mr. JOHN W. CHAMBERS, Secretary.

DRAINING.

Mr. A. Elmar Cory, Palatine Bridge, N. Y.—The subject of drainage is of such importance that it cannot be discussed too often. The great drawback to this kind of improvement is the expense, which farmers hesitate to assume.

Surface-drainage can be done much cheaper than underground. I do not know of any machine specially adapted to this purpose. So far as my knowledge extends, ditching machines and dirt-scrapers are like potato-diggers, lacking in something.

If your Club can shed any light on this subject, and reduce the expense of moving dirt and making ditches, you will do me a favor, and thousands of others who are desirous to "wade in" this kind of improvement.

Mr. F. D. Curtis—I think our correspondent is mistaken about the expense of draining in connection with the great benefits to be derived. I have in my mind a field situated in Charlton village, which, as long as I can remember, and probably for nearly 100 years, as this is an old settled country, has been very moist—in fact a swamp—and produced nothing but bog grass, almost worthless. Last year the owner ran a number of narrow, deep drains through the field, and this year he has a crop of corn growing on it, which I am sure will pay for all the cost of drainage. There is a machine for ditching now on exhibition at the fair of the American Institute, but I have not examined it, and cannot speak of its merits. When I was in Leavenworth, among other good things seen was a new dirt-scraper, made at Maywood, Ill., so constructed that the draft is near the ground, and the balance so perfect that it can be held with two fingers, and it will readily carry a great load. Those of us who have ever held the old-fashioned road-scraper need not be told what a task it is, and how straining it is upon the holder; but with this machine there is no strain at all, and two horses will handle it easily. I was more impressed with the new scraper because of its cheapness, and because I saw in it an escape from the tortures of the old ones, which I have had the honor to endure when trying to "mend my ways."

Prof. J. A. Whitney—Excavating machines, such as are used in railway work and other departments of civil engineering, have been brought to a high degree of perfection; but, so far as I know, there is no machine in existence fitted for excavating a ditch for drain-tile, pump-logs or lead pipe. Such an apparatus should be capable of being drawn by two stout horses, and handled like a plough; but there are mechanical difficulties in the way of this, that scores of inventions that have been made have failed to overcome. The earth must be pulverized for removal, and afterward raised and thrown out at the sides of the ditch. The pulverizing may be done with a device like a ploughshare, but for lifting and depositing the earth there are only two or three ways, and each is defective. We can cause the earth to slide up an inclined plane from the share, and out through lateral chutes or spouts at the rear; but it has been found by experiment that the dirt will clog and stop if the incline is more than twenty-three degrees, and, if we make the incline as low as this, it becomes so long before the material is raised to the desired height that the whole machine is unwieldly and unmanageable. In place of the inclined plane we can use an endless belt at a steeper incline, but this is apt to clog where the dirt leaves the short for the belt, and also complicates the apparatus so as to render it both expensive and liable to get out of order. Another plan is to carry the earth upward by means of a wheel, like a water wheel, with scooped buckets, mounted upon a wheeled frame and rotated by gearing, something like that of a mower. This principle has been adopted with success for large excavators operated by steam power, but it will not work in a small ditcher. On the whole, if any man will get up a machine for making farm ditches that can be used by one man with an ordinary team, he will do a good thing for the public and for himself.

Preparing Sumac.

Mr. F. A. Richmond, Lehigh, Farmony, Penn.—We have hundreds of acres covered with sumac, the most of it this season's growth, very fine and thrifty, and would like to turn it to some use. We are on the line of the L. V. R. R., 145 miles from New York. Do you think we could make it pay to gather it and send to New York for a market?

Professor H. A. Colton—The sumac which grows in the gentleman's section, and in fact throughout the northern States, from some climatic cause, has not so much tannin as that from the south; hence it is not so valuable. Some claim that that from Missouri and other western States has as much, but in the absence of any analysis we may assume the price indicates the fact that it does not. The southern has improved so much in quality that some of it has sold at $100 per ton, within ten dollars of the best Sicilian. The northern and western is worth only about forty dollars to fifty dollars per ton. A cause of this may also be in bad preparation. The leaves only should be picked, no twigs or limbs. Then the leaves should be dried by sun heat, and so arranged that they can be run under a shelter. They must not be allowed to get wet or damp in process of drying. They should be picked before the berries are fully ripe. This industry has become a very great one in the south, and enabled many persons to make a comfortable living from an article heretofore wasted. The demand is not lessening, but really increasing, and there is room for a much larger production. The morocco manufacturers prefer the article fine-ground and from the leaves only. Thus made and carrying a good per centage of tannin, seventy-five dollars to ninety dollars per ton of 2,000 pounds can certainly be calculated on.

Professor J. A. Whitney—All the published accounts agree that Sicily sumac comprises not only the leaves, but the small twigs and their bark. As far as concerns the mere value of the material for tanning, the addition of the bark, which has considerable tannic acid, will somewhat add to its value. But it is quite possible that there may be some coloring matter in the bark that would be objectionable in making first-rate morocco leather, and hence dealers and manufacturers prefer the leaves alone. There is one matter, that of avoiding any wetting or fermentation of the material, that should be pressed upon the attention of sumac-pickers. The virtue of sumac lies in its tannic acid. If we ferment or decompose the material some or all of this is converted into what is known as gallic acid. This has no tanning power, and, moreover, exerts an injurious action by opening the pores of the leather, loosening its texture, and of course deteriorating its quality. Adjourned.

September 26, 1871.

NATHAN C. ELY, Esq., in the chair.

ASHES AS A FERTILIZER.

Mr. N. Bennett, Jefferson, Wis., asked whether it will pay to haul leached ashes half a mile to put on an upland sandy loam, which, in heavy rains, is inclined to wash.

Mr. H. L. Reade—It will pay to cart them four times the distance. Speaking of ashes, I have here two ears of corn, the product of a single stalk which overgrew fourfold its near neighbors, in consequence of being planted where a heap of ashes had lain for three months a little more than twenty years ago. This shows that ashes, besides being good, are good for a long time.

Mr. Hobbs—Are anthracite ashes valuable for manure?

Mr. A. S. Fuller—Good to thicken a sandy soil.

The Chairman—Also worth something on heavy land as a disintegrator.

Mr. C. D. Bragdon—And an excellent absorbent.

Pruning Plants.

Mr. G. T. Pratt, Homer, N. Y., asked if there would be any harm in cutting off the tops of strawberries in an old bed.

Mr. A. S. Fuller said he didn't see what good it would do. If the tops of two-thirds of them are clipped away at the time of transplanting, the plants will be all the better for it. This is true of celery, turnips, and in fact of all the vegetables that are transplanted, and it is the secret of success.

Filtering Cisterns.

Mr. F. W. Coe, Vergennes, Vt., who stated that he has used filtered cistern water constantly for drinking and culinary purposes more than twenty years, gave these further ideas upon a subject which the Club considered at some length a few weeks ago: "My first filter was a box about four feet square, with a partition down through the center, with openings at the bottom of the partition for the water to pass through. Both compartments were filled with charcoal, pebbles and gravel. The water came direct from the conductor into one side of the box, passing down through the filtering material through the openings in the partition; then up through the same material on the other side, over it into the cistern, which was connected with the filtering box on that side, which was, of course, a little lower than the side of the filter where the water enters. The water in this cistern sometimes smelt a little in very hot, dry weather, but was generally pretty good. About six years ago, I sold my home, and built anew. In one corner of my cellar I built a large, square stone cistern. Across one corner of this cistern I laid a four-inch brick partition in cement (one brick laid upon another, with cement between, but none on sides.)

"The brick are what the masons call salmon brick, not the hardest or softest kinds. The water is conducted direct from a slate roof into the main cistern, and passes through the pores of the brick partition in the corner, rising to a level with the water in the cistern within a few hours after a heavy rain, and, as it comes from the conductor with considerable fall and force, it agitates the whole body of water, helping to keep it pure and sweet. In this corner apartment is a block-tin inch pipe leading to the pump. If a quart of water is pumped from this corner, another quart finds its way through the pores of the brick to supply its place, and thus through the day, as water is hourly being used or taken from this corner apartment, there is a constant circulation or movement of the water passing through the brick to supply the consumption, thereby tending to free it from all impurities. I have used this brick partition for a filter over five years, and give it a decided preference. The water has always been clear, and apparently pure, being made so in part by its almost constant motion in connection with the filtering. The bricks appear to be as sound to-day as when first laid."

Mr. John L. Bridger, Tarboro, N. C., asks the following: In very solid and firm clay, can the walls, other than partition, be constructed without brick? Can the external water be kept from the cistern water by cement, or by cement and gravel laid upon solid clay walls?

The Chairman—I plastered cement directly upon the gravel and it worked well till I left the place, some twelve years after.

Professor H. C. Colton—This matter is one of much moment to the people in the section where this gentleman lives. A great deal of the spring water there comes through marl, and hence contains lime. I would further remark, Mr. Chairman, that the people of that county (Edgecombe) are probably the best agriculturists in the south. They do more work and use more manure to good purpose than any other section of the south, and much of the credit for it is due to this gentleman and his brother. They make heavy crops of cotton on land where others seldom raise more than 150 or 200 pounds of lint. The superiority of Edgecombe farming is notorious in that section. Much of it is due to this very marl, which makes bad water, but the farmers deserve the credit for using it. He can make his cistern, as Chairman Ely says, by making good hydraulic cement and gravel. Pure white sand is the best filter. My experience in Mississippi and elsewhere south leads me to advise that the first runnings from the roofs be not run into the cistern, but off into the yard, or thrown away in any other manner. After the water has run clear, then turn it into the cistern. A good, cheap filter is a tight box half filled with sand. Keep the cistern-top tight, and draw the water from it by a pump. It will keep sweet a great length of time, but it is best to keep a few clean fish in it, such as perch or trout.

Mr. Robert J. Dodge—The suggestion of Professor Colton, that the first runnings be conveyed away and not permitted to enter the cistern, is a good one. It might also be well to sweep the roof once in a while, and keep it clear of leaves and other rubbish.

Moss in Meadows.

Mr. G. Korn, New London, Conn., said that ridding pastures or meadows of moss, means nothing more than strengthening the growth of grass. Every meadow, every pasture, is a battle-field where plants of different kinds are fighting for their chances. Supply your friends with what they want freely, and they will overpower its concurrents without further assistance. The washing down by rain, from hilly, stony pastures, of soluble mineral substances, takes the subsistence from the plants we desire to encourage. Spread rich soil, guano, wood ashes, upon a peaty, swampy turf, where you never before saw white clover or useful grasses, and suddenly they will make their appearance without even being sown. They have been there before, waiting only for a better chance; but you could not see them, for they were overrun by coarser plants, and powerless by starvation. Supply your pastures with a good choice of plant food—fresh, rich soil mixed with wood ashes, compost, marl, night soil, guano, kalisalto, soluble phosphates. Let them have a light top-dressing every spring, better than a heavy one at once, and help them before they are entirely worn out, as this is the cheaper way. Roadside washing contains many useful ingredients, and liquid manures also. Lime may be useful where plants and soil are in want of it, but useless for only killing moss. Plaster helps mostly the clover. If you cannot afford more, haul the washings down on any good soil from the lower part of your pasture, by and by again to the top, and thinly spread it over the grass, and, if you are able, give a mulching of straw, brushwood, salt hay during winter and early spring. Mulching, even in summer time, shows useful effects, preventing the blowing off, perhaps, of moisture and carbonic acid by the winds; and two lots of pasture alternately mulched, while the cattle are kept off, produce a good deal more of food than the same area run over the whole season, by the same number of animals. Another correspondent, writing of moss in meadows, said the best application is plaster. "There are," he added, "knolls in our pasture where nothing but moss grew a few years ago, which are now covered thick with white clover. Nothing but plenty of plaster has been used to effect this change."

Adjourned.

October 3, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

ANILINE DYES.

It was said by Professor H. E. Colton, in answer to an inquiry, that the colors made from aniline embrace every known shade, and are brilliant and beautiful. They may be bought ready prepared for home dying of any first-class druggist. In this connection, the professor called attention to what he pronounced the splendid collection of aniline dyes exhibited at the Institute fair by the School of Mines of Columbia College. Aniline dyes, he further explained, are made from coal tar; and in the case on exhibition, the original tar, the crude aniline, and every other product or residuum is shown, so that one there has the whole product before him. And not only is this color shown, but iron, lead, zinc and copper ores, and all the details of the process by which these metals are produced; then in the department of drawings are well executed pictures of all the furnaces and machinery which are used. The professor said he considered this one of the most interesting parts of the exhibition, and reflected credit upon our city as well as the college by which they are exhibited. We are indebted to the great German chemist, Hoffmann, for the discovery of these colors, and the process of making them was for a long time a secret; but with such instruction as this exhibit shows our young chemists are receiving, we shall not long be indebted to Europe for anything in that line. Young, when he first made oil from coal, claimed, enthusiastically, that he had revealed the pent up sunlight of ages gone. In these colors, one might say, were brought to light the pent up rainbows of many centuries.

BUTTER FACTORIES.

Mr. Thomas Slater, Slatersville, N. Y., stated, in answer to a former correspondent, that one of the best butter factories is probably that located in Speedsville, N. Y. The proprietors manufacture butter from the milk of 600 cows, and it is sold in the New York market for from five to ten per cent more than the best State dairies. The churning is done by steam. At Caroline, four miles from Speedsville, is another factory, where they manufacture both butter and cheese. They take about three-fourths of the cream from the milk, from the balance they make what is termed skim cheese. The cheese is not improved any by skimming the milk, but it is sold for about half the price of good cheese. This factory say they make it profitable to manufacture both butter and cheese at the same time.

WILD STRAWBERRIES.

Mr. J. J. Van Kirk, Ramsaybirg, N. J., wrote to say that he has a fine strawberry bed, which yields abundantly, and all from a few wild plants that were growing on uncultivated ground. Four years ago he planted three of them in his garden, and by a little attention, and transplanting the old ones and new, spring and fall, he had them in fine bearing condition in two years from setting. Last summer, and this, the first picking averaged in size two and a half inches in circumference; many were much larger. His friends all pronounced them excellent. They are of fine shape, rich, sweet, solid and juicy; the best, he thinks, he ever tasted. "What is the use," he inquires, "of buying plants with big names, when we can get better ones from wild plants for nothing?"

PRAIRIE HOMES FOR THE POOR.

Mr. D. W. Mott, of Franklin county, Iowa, forwarded the following advice, which cannot but prove helpful to many persons who are looking westward, but whose capital will scarcely more than pay their passage thither; I wish to say to every one who thinks of coming west, that if your capital is limited, do not think of going on to your own land the first year. If you have land already bought, go as near it as you can find improved land for rent, buy you a good span of horses, and rent at least eighty acres of tilled land. The last of March or first part of April, sow thirty acres to wheat, and ten with oats; plough your forty acres, and mark off for corn. Plant your corn, then harrow it, and now buy a good two-horse corn plough, and plough it well twice each way. You can do all of this, and find time to break twenty acres on your own land. Now, if you have $50 about you, hire some man to break twenty acres more — see that your breaking is all done in May and June. By the first of July your corn is laid by, and you are ready for harvesting. If you have done all of this well that you have done, don't buy any reaper, for you can easily find some one who is ready to cut your grain if you will bind for him, and, in this way, cut, bind and stock your grain. You will now have something to live on, for the two-thirds of all you have raised is yours. You can now cut your hay on your own land, and stack it there, dig your well, and make a stable for your horses and a cow, for you ought to have one by this time. The money from your wheat will buy you a house. By this time you will ask very few questions of any one, for you will see what is to be done, and know how to do it. Don't take any stock in subsoiling your prairie sod; men have done it, and have raised fifty bushels of corn to the acre. Men have raised steers that weighed 3,000 pounds, but you don't want to until you can afford it, and a poor man cannot. I have seen folks buy farms and prairie land, and make farms for fifteen years; and four-fifths of all who go right on to their own raw prairie, build their house, dig their well, build their stable, buy their team, break their prairie, and the next year put in their crop, and have to buy all they live on all this time, will find their money all gone, and their pluck too. You may ask how much money a man ought to have to do as I have suggested; $500, but $350 will do. Suppose he has not got that, what can he do? I will tell you. We will suppose that every man at the age of twenty-five, who has a wife, can, after paying all he owes, buy two tickets to Iowa. If he has, and they are both willing to work, he is all right. Thousands of us farmers are glad to see him. One came out just that way one year ago last spring. He hired out for twenty dollars per month, and his wife, at the same place, at two dollars and fifty cents per week. Last winter he bought a span of four-year-old horses, one-half cash, the balance this fall, one good cow and one hog. He has worked 110 acres of corn, oats, and wheat this summer, and yesterday asked me about this 160 acre lot up between me and town, saying he would like to buy it. A few words to men with money: if you have $15,000 to fool away, go and buy a steam plough. If he wants to plough his land at a cost not to exceed fifty cents per acre, I will tell you how. I have three gang-ploughs, and nine yoke of oxen and three drivers. The ploughs cost about ninety dollars each, the oxen $125 per yoke, the driver's labor and board one dollar per day. They can average four acres per day each. My oxen are good for the money at any time; I have only to calculate the wear and tear on plough, yoke and chain, and feed to the oxen, and the one dollar per day for the man, and find, by actual experience, that fifty cents per acre covers the cost of ploughing. With this way of ploughing, mark one way, and plant with the two-horse corn-planter, then harrow, then plough twice each way, and my corn is laid by at a cost of two dollars and fifty cents per acre, and I hire everything done.

Osage Orange Hedges.

Mr. E. W. Brown, Cambridge, Ill., stated that he had set more or less osage orange each season for a dozen years past, and he gave the following observations as the result of this extended experience: I think osage will grow anywhere that apple trees will, but here it must be mulched for the first winter or two, and then it will kill down after it is half a dozen years old, sometimes, but will shoot out in the spring, making six or eight feet growth generally. The plants one foot apart are near enough; too near, they smother out. About the fourth spring slash them, leaving here and there a stump to weave in. If you get them too flat they will die; made that way they will hold anything from a chicken to a bull; for after it has grown one year it will be so that a bird cannot go through it, and the wind may blow and the flood come, still you have a good fence. If it is allowed to grow too high it will shade some; but around all fields there is about twelve feet that you cannot cultivate, and generally grows up to weeds; but after the hedge gets four or five years old, I seed down to timothy next to the hedge, and that is not hurt by the shade of the hedge, for generally it will grow two tons to the acre right up as close as you can run a mower. One piece I have had into corn, and have turned around on the strip, cultivating as usual; still the mower would cut clean, so you do not lose any ground in a meadow or cultivated field. In a pasture, stock will eat the young sprouts so much that it will furnish more feed than the same ground in grass. The most of the trimming is done in March, when we cannot do anything else. The brush we use to patch up other fence, or to weave into a wire fence, so that a wire fence thus fortified will hold any cattle, and brush at the bottom will make it hog tight. I made some cheap fence this way: I had hedge two years old, then I set posts in it, say a rod a part, and put on a pole; then put hedge in the bottom and nailed some on the posts; then took hedge and straddled it over the poles. It has held hogs, horses and cattle, and I would rather have it than a fine board fence, as long as it lasts. For a permanent fence it is the best thing I know of.

Adjourned.

October 10, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Potatoes.

Mr. Aaron Wright, Penn's Grove, N. J.: I will give the readers of the Club proceedings the result of an experiment made with potatoes. I planted about the middle of April, in rows two and a half feet apart, putting them about one foot apart in the row, using hog-pen manure. A portion I put manure under the potato, and a portion the manure was put on the top of the potato. The former yielded 350 bushels per acre, and the latter 200 bushels per acre. The kind planted, the Peerless.

Dr. Isaac P. Trimble.—The potato crop in Salem county, and in most parts of New Jersey, was never so fine as this fall.

COLORADO BUG.

Mr. J. W. Hawkins, Plymouth, Mich., writes that the farmers in his neighborhood have enjoyed the society of the Colorado bug for three years, and the prospect is "that they will tarry for another season, as the ground is full of them." As the pest is sure to turn up at the east, Mr. Hawkins gave the following hints regarding the reception it would be proper to extend: There is but one thing I have tried which is sure death to these bugs. This is no guesswork, but obtained by experience. I would not send to my native State that which I could not recommend. It is said the bugs feed on nothing but potatoes, but I have learned they are very fond of flour. Take one pound of Paris green; mix with ten pounds of wheat flour; take a tin dish, oyster can, or any dish with a cover; punch the bottom full of holes like a pepperbox, and sift it over the vines while the dew is on. This forms a paste, and it adheres to the vine. If the vines are small this will go over half an acre; if large it will require more, and the bugs will leave the leaf on which they are feeding and go to eating the flour, and in about two hours you will find them on their backs on the ground. Care should be taken to put it on all the leaves that have got bugs on, and what is left go over with a tin pail, and hold the pail one side of the hill, and with the hand give the tops a quick slap over into the pail; this will knock them all off into the pail; if they crawl out of the pail, scour it bright and smooth around the top of the pail, and a good plan is to put about half a teacupful of kerosene in the pail, and, when through, touch a match to it, and they will trouble you no more. If this receipt should fail, you may know your Paris green is not good; there is a bogus article in market. I planted one-fourth of an acre of potatoes last spring, from which I dug eighty bushels of potatoes (early rose). Adjoining farm there was a patch they ate up entirely; not a stalk to be seen. Last spring they were crawling over the ground searching for a potato to poke his nose out, and they would pounce on it and devour it. They were so numerous I could pick from ten to twenty full-grown bugs off a hill. When the potatoes were about two inches high, I had boys picking them off, but could not keep them down. By the time they were in bloom they had increased to such an extent that the vines looked from the road like currant bushes with the leaves all off and hanging full of ripe currants. I was about giving them up as lost, when I applied this remedy, and before night there was scarcely a bug to be seen. I followed right up with the hoe and picked off what few were left. I would find two or three in a row that had been where the green had not reached them. I have read a great deal about the fatal effects of their bite, but it is all nothing. We handle them here; even small children will pick the old bugs off by handfuls, and I have never heard of an instance where one has been bitten.

In applying the Paris green, keep on the windward side, so you do not inhale it, and if no sores are on my hands I apply it with my hand; I find I can do it faster.

Churning.

Mr. J. D. Minniss, Athens, Pa., forwarded the following report of results of experiments in churning: A quantity sufficient for a churning of one cow's milk and cream, half and half, was churned in eight minutes. Another churning was taken in the same proportion, the products of another cow, and churned in exactly nine and one-half minutes. Still another churning was taken from a different cow, mixed in the same way, and churned in just eleven minutes. The churning in each experiment was done with the cream and milk at a temperature of sixty-two degrees. After the above experiments the milk and cream from each cow was taken in equal quantities, mixed and churned in the same churn under the same temperature, in ten minutes' time.

Colorado.

General Cameron, of the Greeley colony, in answer to a call, spoke with sensible brevity of Colorado. He considered it destined to become a stock-growing country of considerable importance. Wool can be produced for ten cents a pound, and a four-year-old steer for ten dollars. Agriculture will be limited by the capabilities of irrigation. Irrigation has not been a failure, but it makes farming more expensive than in a rainy country. But the silver mines are almost inexhaustible, and those who work them furnish a good market. For those who have asthmatic complaints and consumptive inclinations, the atmosphere is beneficial. General C. described the mountain scenery, the sunlight, the varied colors, the clear air of Colorado. Those whose homes are amid these delightful scenes cannot grow old rapidly, and the aged may find returning unexpectedly something of the bouyancy of youth.

FENCES AND FENCING.

A correspondent, C. R. Smith, expressed the opinion that of no one thing pertaining to their art are farmers so generally ignorant as of the cost and relative value of fences. Men of good judgment in other matters build board fences, with three boards a foot or more in width, while four, six inches wide, of good thickness, would make a fence more sightly, less likely to be injured by high winds, and in every respect a better fence, with a saving of about 5,000 feet of lumber to the mile, which, at Western prices, twenty-five dollars per 1,000, would amount to $125. They build the zig-zag, every rod of which puts nearly 200 feet of land beyond the reach of the plow; amounting to one and a half acres per mile. Mr. Greeley's wall fence costs him five dollars per rod, making $1,600 per mile. They are probably about four feet wide, and cover half an acre of land to the mile, which, at fifty dollars per acre, amounts to twenty-five dollars for land. Fence and land amounts to $1,625 per mile. Straight board or wire fences occupy but little land. Board fences with iron posts, costing about ten dollars, as proposed by Prof. Colton, come in competition with wooden ones, costing from twenty-five cents to seventy-five cents each. Those of wood will last about ten years, while the iron ones ought to hold out from forty to fifty years, and then what is left will be about one-quarter the first cost for recasting. One of the worst features of the wooden post business is the destruction of young trees. A large part of the fence posts and the sleepers for our 50,000 miles of railroad is taken from young and thrifty growing trees. We may as well expect our flocks and herds to increase while we slaughter a large portion of the young, as that our forests will improve while we do this. A country without forests is poor indeed. Better part with our coal fields and gold mines than with them. The arts of peace and the necessities of war require their preservation. Our springs and streams of water and climate depend upon them. They furnish us not only fuel, but material for our almost infinite variety of wooden manufactures, from a wooden spoon and lucifer matches to the mast of a ship. Long trains of cars and heavy-laden ships are constantly carrying their products to distant places. The ax of the lumberman may be heard not only on our plains, but far up the sides of our mountains, and their beautiful green is being transformed into bare and rugged rocks. There are large sections of our country where valuable farms have not only a scanty supply of fuel, but are nearly destitute of a single tree suitable for repairs of fences or buildings, where rocky woodland would command a higher price per acre than the rich lands of the Connecticut or Schuylkill, and where a single pine tree that has survived the destruction of its fellows would more than pay for an acre of our best land. A late United States commissioner of agriculture stated that, at the present rate of destruction, our forests east of the Mississippi would not hold out thirty years. The annexation of the Canadas will not save us, for the Canadian press already warns its people that they will soon deplore the destruction of theirs. The use of young trees for posts and larger ones for zig-zag fences has done its share to produce this state of things. Zig-zag in fencing is about the worst sort, except that produced by strong drink. On account of its snaky course, it requires eighty rods more of fence than a straight one, three or four times as much lumber, and one and a half acre of land to the mile for the hideous thing to wriggle upon; and yet men are to be found who will continue to zig-zag while whisky and fence rails are to be had. President Lincoln showed his good sense in abandoning rail-splitting soon after he came to years of discretion. Iron and stone must come into use as the foundation of our fences. The west is full of iron, and the time is not far distant, certainly not long after the steam plow shall have come into use to turn the soil of her magnificent prairies, when her broad fields and lines of railroad will be inclosed with fences, the foundations of which shall be sure for half a century.

Adjourned.

October 17, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Preserving Pears.

Mr. Samuel M. Furman, Astoria, L. I., exhibited some fine Duchesse d'Angoleme pears, and asked how he should keep them.

Mr. P. T. Quinn—They should be picked with great care, laid in the basket without the slightest bruising, and kept apart in an atmosphere dark, cool and dry.

FENCING PRAIRIE FARMS.

Mr. James Hull, Girard, Kansas—Fencing is the great item of expense in making a prairie farm, and retards its cultivation more than all other causes. Wire makes the cheapest fence, but is nearly worthless, as I have learned by dear experience. Two stands of iron and one board will stop peaceable cattle, and only such. It costs sixty-five cents per rod. A good substantial fence of boards, such as will stop hogs and all cattle, will cost two and a half times that amount. It is a matter of the first importance to a settler in selecting a farm to do so when the soil and climate are suitable for growing live fences, and also where, until such fences are grown, the owner of stock is required to keep it from trespassing on his neighboring crops. These will save him half of the expense in opening a farm. Dr. Smith, in comment, alluded to the disadvantage of fencing at all, and expressed the opinion that in the good time coming a better system will be adopted. Dr. Jarvis made, in this connection, the startling statement that tender plants cannot succeed well in windy places, and he advocated setting rows of trees for protection. Colonel Curtis urged the advantage of soiling as likely to be the distinguishing characteristic of the coming system of stock growing.

A WELL CONSTRUCTED CISTERN.

Mr. W. H. Fernald, York, Me., who said he had supervised the building of a great many cisterns, gave the following in regard to the sort that has given the best satisfaction: First excavate by the side of the house or other building (not underneath it) eight, ten, or twelve feet, according to the capacity desired, and from seven to nine feet in diameter (circular to a level bottom). Where the pipes are to come down go down eighteen inches deeper. When this is done, clear out all the loose earth, and cement the bottom and sides up to within two and a half feet of the surface. Then break back the earth, and commence with brick and arch over, leaving a waste-way at the side, and an aperture at the top twenty inches in diameter. Having done this, bring down your pipes within three inches of the bottom. Then commence with brick, laying them an inch and a half apart (edgewise) in the first course, on the arc of the circle eighteen inches from the side of the cistern. Carry them up about two feet, and arch over to the side, inclosing the pump-pipe or pipes, giving the whole a thorough coat of cement, leaving open only the apertures in first course. Then place carefully some small pebbles to protect the openings, and fill up to the level of the bottom of the cistern with equal parts of washed sand and charcoal. Then, outside of this, on the main bottom of the cistern, commence a brick partition of pale brick. Carry it up, and arch it over so as to leave a space sufficient to contain three, four or five hogsheads of water, as the owner may wish. This is to be jointed with cement, but not plastered, for a filter. This mode is superior to the common charcoal filter, as in the latter the charcoal becomes coated with sediment in a short time, and has to be renewed. In the common brick filter, we only get the water filtered from the sediment brought in from the roof and gutter, and are still liable to catch rats, mice, cockroaches and spiders in our filtered water. In my mode of construction all of these difficulties are removed. More than this, the water being filtered through the brick partition has all dirt and other foreign substances removed, and then, in passing through the charcoal and gravel, is purified from ammonia and other gases the charcoal has an affinity to, giving you as pure water as you can get without distillation. I use plain iron pipe in preference to all others, for it is always perfectly safe.

The Chairman—I am now constructing a cistern upon my country place at Norwalk, after a plan which I have proved to be as good as the best in use. A wall of stone is laid up six feet high, upon this is placed a wall of brick, arched over; across the middle of the cistern is a dividing wall of pale brick; the water is let in on one side and passes through the wall to the other side, from whence it is drawn. It is always sweet and clean, being filtered by its passage through the brick.

The Worth Farm.

Dr. Isaac P. Trimble brought tufts of sod and ears of corn from the Worth farm, which he said he visited last week, and discoursed as follows of what he saw: It will be remembered it was stated in a report last winter that a large field on the Worth farm had produced 110 shelled bushels to the acre. This result was ascertained by measuring the size of the field, and the contents of the cribs in which the crop was stored. Some members of the Club and a few of our correspondents seemed to doubt, and supposed some error in the measurement.

Lime is used freely in all this section of the country with most satisfactory results, and the Worths generally apply it to the corn crop; they use thirty or forty bushels of stone lime to the acre at one dressing. The ashes made on the farm is generally sprinkled on the hills of the growing corn. Sometimes plaster is applied, but with hardly any perceptible effect. The commercial fertilizers are not used on this farm. For two generations the feeding of beef cattle has been the leading interest here, and during all that time it has been a principle never to pasture close. This old sod accounts for the corn crop; and it was said by one of the laborers who had worked on this farm for forty years, that, in all his experience, the corn crop was uniformly good, even the driest seasons scarcely diminishing it.

Osage Orange Hedges for the Prairies.

A gentleman living at Cambridge, Ill., forwarded the subjoined statements in the hope that they may serve as at least partial answers to the various questions which are being asked nowadays about Osage hedging on the prairies. Our soil here is black loam, from one to two feet deep, with a clay subsoil; it freezes from eighteen inches to three feet of winters. Most every farmer has from one to ten miles of hedge, some of it twenty years old. Twelve years ago a hedge was set near here, and four years ago it was lapped down, and after it was done it looked like a fence of poles two inches in diameter, woven in the bottom; was cut about half off down close to the ground, except one every four feet for a post; and the others were laid in with the tops about three feet from the ground; sprouts grew up from the poles every few inches, and it has been trimmed the last of June and September with a corn knife, making a strong, handsome fence about a foot wide; we have trimmed most every way, but think this is the best; here and there one bush was left to grow, and this year part of them had oranges which are four or five inches in diameter, spongy, and on the outside warts, and of a light green color, containing five or six hundred seeds. We throw them in our back rooms and let them freeze and thaw, and in the spring rub out the seeds in a tub of water. Plant in drills two and a half or three inches apart (some use a wheat drill with part of the holes stopped up), three or four seeds to the inch, on rich, clean ground. They are very slow about coming up; if they could be cultivated before they were up it would be better, for the easiest time to kill weeds is before you see them. A little white grub makes sad havoc with them just as they are coming up sometimes. They are generally taken up late in the fall by using a plough without a mould board, to cut the roots, and pull with gloves, counting as you go, leaving a hundred in a bunch; or plough them out with a common plough, keeping the row in the middle of the furrow, and using a fork to knock some of the dirt off from the roots;

put 500 in a bunch, tie with a tarred string, haul in by ploughing a furrow and covering with a plough. Five hands ought to get out 75,000 in a day, and the price is from two dollars to two dollars and a half per thousand. These are the main points—the rest they can learn from experience. Now, I wish every farmer would try a little, at least; for wherever it will grow, I think it will be the main fence.

Butter Making.

Mr. J. B. Lyman—When at the State fair, I procured the following statement from the person who took the first prize for butter, regarding his conveniences, and the various steps of the process which brought such results: The milking is done in tin pails, and immediately strained in tin pans containing about six quarts each. The pans are set on a rack made of slats about eight inches apart. The temperature is kept from fifty-five to sixty degrees by our thick walls, by the flow of the cold water, and by the use of ice. The milk is allowed to stand thirty-six hours before skimming. Great care is taken to cream the milk before it is thick or lappered through. Our milk-room is a basement under a wing of the house, the walls seven feet high, the sides two feet above ground; the end or entrance of the room is four feet above the surface, and three feet beneath; the opposite end joins the cellar under the main part of the house. The bottom is laid with cement three inches thick; the walls are three feet thick, laid with stone and cement, and the surface inside plastered with cement, lathed and plastered overhead. There is a well of pure cold water in the room, a cistern on the outside, with lead pipe conducting the water into the room for washing purposes. Under the pipe is a sink for creaming the milk. At one end of the counter is a hopper or box for the skimmed milk, which is conveyed to the hog-pen through pump logs under ground. The churning is done by dash churns, driven by endless chain horse-power, two churns running at the same time; fifty to sixty pounds are made at one churning, which occupies about thirty minutes. Great care is taken not to churn too long, as it injures the grain. The butter is taken from the churn with a ladle, and washed with cold well water until it is entirely free from milk. In hot weather the ice-water is used; then we cure with Ashton salt at the rate of one ounce of salt to two pounds of butter. It is then left until the next morning, when it is again worked with a butter-worker; care is taken not to work too much, as it injures the grain. It is packed in white-oak pails, holding fifty-two or fifty-three pounds. A cloth is put over the top of the butter, and a thin laying of salt on the cloth. It is then put in the store-room, where it is kept until shipped. Our milk-room is kept well ventilated with pure fresh air. It is impossible to make good butter in a close room; the animal heat should be removed from the milk as soon as possible after straining. In summer the windows are open through the night and morning; in cold weather at mid-day, and the temperature kept up with fire. We churn three or four times a week, making an average of 200 pounds a week during ten months of the year.

Adjourned.

October 24, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

DITCHES AND DITCHING.

A visitor asked for information on this subject, especially, as he said, with a view of ascertaining the most expeditious and profitable way of opening ditches in land having a clay subsoil.

Mr. C. D. Bragdon—I have made miles of ditches, and found no practice better than that of following the surface plough with a subsoiler.

Mr. F. D. Curtis—The plan is a good one.

Professor Whitney—The use of the plough to loosen the soil for the shovel is the only way to make a good ditch. At all events, among many inventions for ditching, I know of none that will work successfully in our strong eastern soils. If made simple and cheap they will not work, and if complicated they are costly and soon get out of order.

FEEDING MEAT SCRAPS TO FOWLS.

A member desired information from his colleagues as to the propriety or otherwise of giving poultry meat scraps, such as are pressed and for sale at the agricultural warehouses. He has heard that these cakes are carelessly made up; contain refuse matter not only of no value often, but even poisonous.

Dr. J. V. C. Smith—It has been demonstrated that fowls require animal food of some sort to keep them in condition and supply albumen for their eggs. During spring and summer they feast on insects, and supplying them with the scraps in question is equivalent to giving them animal substances out of season.

Mr D. B. Bruen—I have used these scraps for many years, always cooking them with the feed. By the way, it is a saving of forty per cent to cook the feed given to poultry.

The Chairman—If the pork scraps are known to be, or suspected of being, made up of deleterious substances, buy beef scraps, which are as cheap and better. I use the latter, keeping the cake, which is a large one, and pressed solid, on a raised platform or box, and always where the fowls can reach it.

LIMING LAND.

The question, which is the best lime for agricultural purposes, being under consideration, Professor Whitney said that depends upon the character of the soil. On heavy, wet land, lately drained, stone lime, evenly distributed, will be best. On low-lying, sandy alluvials I would recommend air-slaked and pulverized. On dry uplands, chalks or calcareous marls, if he has them. As a rule, the weaker and less caustic limes should be applied to land having the least humus or organic matter, and the caustic and freshly slaked to that containing the most. The kind of other manures used must also be taken into consideration. I would not apply strong barnyard manure simultaneously with caustic lime, but would put on the lime say early in the fall, and the ammoniated manure in the spring. There is a curious discordance between the teachings of some leading chemists as to whether lime containing magnesia is hurtful to the growth of plants. The older chemists say that it is, and give a very plausible reason to account for it, while some of the more recent, Professor Johnson among them, take the opposite course. The matter is of much real importance to tillage in many parts of Pennsylvania, where magnesian limestone abounds. And if some farmer will try two fields with the same crop and under the same conditions, only one manured with common and the other with magnesian limestone, and report the result, it will be very useful to agriculturists in many places.

PRESERVING SWEET POTATOES.

Mr. Bryan Tyson, Washington, D. C.—I saw in a recent report of your Club that Mr. Fuller, in response to an inquiry as to the best method of preserving sweet potatoes, recommended dry sand. I have, as I consider, thoroughly tested this plan, and will briefly give a portion of my experience therein, believing that under some circumstances potatoes thus treated will keep well, and, under others, not at all. In the first place, I would suggest that the potatoes remain in the ground until the weather turns cool. They should, however, be dug before the ground freezes. The ends of such potatoes as are exposed to frost should be protected, until dug, by throwing on dirt. I have had the best success with kiln-dried sand. This can be very easily done by building a platform of dry wood, with an open space, under the bottom, of a foot or so. Throw the sand on the top, and fire the wood. As the wood burns the sand will run down into the open space. After the sand has cooled, pour among the potatoes. This plan does equally well in hills and cellars, care being taken not to place too many in a bulk, say not more than thirty bushels. The ashes from the wood will do no harm, especially if pine wood be used. I have used sand for four crops of potatoes. Two of the crops were dug early, and treated with sand that had been spread on a floor until it was supposed to be dry. The potatoes soon heated, and many of them rotted, one of the crops being nearly a complete loss. Whether this was attributable to the potatoes being dug too early, the warm weather, or to the sand not being thoroughly dry, I am not now able to tell. In both cases the sand was applied to the potatoes in a dry state, soon after they were dug. The other two crops remained in the ground about as long as it was safe for them, there being, in one case, a considerable freeze soon after the potatoes were dug. The potatoes were all treated with kiln-dried sand, and kept as well as could be desired. I selected two hills, and applied the sand to one soon after the potatoes had been bulked. The other hill was aired some two or three weeks by having three or four air-holes at the bottom of the hill, and one at top, when the sand was applied. In the spring it could not be told which plan was best, there not being, that I now recollect of, a single rotten potato in either hill. For edible purposes, however, it would, probably, be best to partially cure the potatoes before the sand is applied, as the potatoes appear to undergo but little change after the sand is applied. I have seen them, where they had been accidentally broken in putting away, look about as fresh when opened the following spring as if it had just been done.

Therefore, where they are put up in a green state they will be in about the same condition when opened the following spring, not having sweetened any by time. I also believe that the potatoes are less liable to heat if they be first partially cured before the sand is applied.

VIRGINIA LANDS.

Mr. S. L. Baldwin, Guineys, Carolina county—The development of Virginia has been much delayed by the droughts of the last two summers. The bountiful rainfall this summer will do much toward dispelling the fear that droughts were annual in this country, but will not heal all discontent among northern settlers. There are too many instances of discontent having their foundation partially in other causes; as, for instance, too many came here and bought more acres than were of any use to them, and more than they could pay for; men inexperienced in the art of farming, who thought old farmers were fools beside them, and who imagined the touch of their masterly genius all that was necessary to make old tobacco fields give forth in abundance. This class of immigrants are full of unrest. But the thinking, reasoning man, whether he was formerly a farmer or a business man (and the most successful and hopeful are the business men who are carrying business principles into farming) is full of hope of the development of Virginia and the success of their undertaking. Our three summers' experience has proven beyond a peradventure that these lands are easily recuperated. It has shown that the slightest possible sprinkling of manure insures a stand of clover, and some land on every farm will bring it without the aid of manure. The fear of continued droughts are no longer felt. California has had her three, in succession, to two to be scored against Virginia. The doubt about successfully growing clover is dispelled. The solution of the query as to how the people would treat us, is made by our learning that northerners should settle in neighborhoods convenient to one another; not because of any violence nor positive ill-treatment, but for reasons that soon become obvious to the immigrant. He who comes here in the hope of making money, by raising ordinary farm crops, is destined to disappointment. Prices are so low, and transportation is so high, as to preclude it. And now, while prices of grain are low, is the proper time to improve impoverished lands. More money may be made by thus enhancing the value of your farm than by raising grain. The recent advance in the price of wool will tend to increase its production, and, in a few years, the northern and western shepherd will be found killing his sheep to save the expense of continuing the flock. Such a state of affairs will never be known in Virginia, for the reason that a flock of sheep are absolutely no expense at all to the owner. I speak from positive knowledge when I say that numerous large flocks of sheep are kept here, year succeeding year, costing nothing but the salt they are given. Spring lambs I have never known to bring lower than four dollars, and from that to seven dollars, in the Richmond market. I have known a number of small flocks, this season, whose wool was sold before the advance, yet their owners realized sixty and eighty per cent on their value from wool and lambs sold. This is the product for the year in money; sixty to eighty per cent on every dollar invested in sheep. The country abounds in worthless hounds; if they ever kill sheep it has not come to my notice. And there is still another advantage in keeping sheep. It has been found that by keeping a flock a year or two, even on the poorest of these lands, they will come into white clover, which in due time will improve the land to a degree that a stand of red clover may be obtained. Some attention is being given in this valley to grape raising. Several persons have put out from 1,000 to 8,000 vines, which are now one and two years old, and, without an exception, give promise of success. The few vines planted in gardens years ago bear bountifully every year. Cedar posts and rails abound, so that we may trellis cheaply, and we believe that at two cents per pound grapes will prove the most profitable crop we can cultivate. All other fruits yield abundantly. My peaches were especially fine this year, and the trees bent under their excessive loads, notwithstanding they were so full last year that many broke down. The cause of this bountiful yield I attribute to a free use of wood ashes about the roots and trunk, and thrown into the crotches of the trees. My early harvest apples yielded so bountifully last year that I hoped for but few this; but I was happily disappointed by getting even more than before. The trees were treated to ashes the same as the peach trees. We have promises from many sections of the north of a renewal of immigration. The several hundred northern families settled in the edge of this and Spottsylvania counties make this a rallying point for those seeking a home in this beautiful climate.

B. B. Dunville, Suffolk, Nansemond county—I remember to have heard Dr. Trimble give a description of this section, or rather eastern Virginia. He said he would turn it into one vast poultry yard, but there was a drawback. Possibly there he would not be able to raise feed enough, as the land was so much worn out. Now, let me say, my first year here I was almost converted to the doctor's side, but, as you may remember, we had several months and no rain; but this year I am convinced he was mistaken. Twenty-five barrels of Irish potatoes have been made from one of seed, in many instances; moreover, I can show the doctor several large fields of corn that will yield from fifty to sixty bushels to the acre, that have been ploughed for years; and there are several young apple orchards well worth visiting, that bear fine fruit, and have done every year since they came into bearing. You can all vouch for our Wilson strawberries, and also our grapes and pears. To sum up: where can land be bought so cheap in the States that will do as well, with all the facilities we have for marketing our produce—Washington, Baltimore, Philadelphia, New York and Boston giving us our choice, and at reasonable rates of freight? My family consists of five children, myself and wife. I have lived here two years. My doctor's bill has been less than fifteen dollars, and probably half the amount for medicine. During sixteen years in New York city it would average fifty, and one year, I remember, it was nearly $300. Now, my experience so far is that the health of my family is better than when I lived in New York city. I have no doubt that Kansas, Nebraska, Minnesota and other places, are healthy, and possibly clear of chills and fevers, but there will be something else, and men will die even in these healthy places; and here in our town I will show as many men and women over sixty years as can be found in any town of its size in my native State of New York.

Adjourned.

October 31, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Planting Corn.

Mr. D. B. Bruen — I always reject the kernels from the tips and plant only those which are perfect. I believe that wrinkled corn comes from wrinkled kernels.

Mr. Curtis — Every careful farmer rejects the tips and buts of ears, and plants nothing but the plump and perfect kernels, upon the principle that they will produce strong and vigorous plants. Furthermore, I am of the opinion that the crooked and twisted kernels are apt to produce knotted and imperfect ears. Dr. Trimble made a very sensible suggestion on this subject, when he recommended to a correspondent to get the best seed corn he could in his own neighborhood, and not send away to another State. I have a string of seed corn now hanging in my corn-crib, of superior quality, which is the same kind of corn raised by a neighbor as long as I can remember. Now, sir, I believe there is no use of changing seed corn if the best ears are carefully selected every year. If plant food is supplied sufficient, there will be no deterioration, but rather an improvement; hence, to send away to remote places for seed which is not natural to the climate and soil is generally a loss, and the idea is absurd that by a change of seed a good crop will be produced. This itching uneasiness may gratify a curiosity, but it will not of itself insure a crop. Soil and cultivation are the essential requisites, and the farmer should build his hopes on these more than on a flaming advertisement.

Mr. D. B. Bruen — I have planted beans and corn for a good many years now, and invariably use the seed descended from that which used to be grown in my father's garden, and I have as good crops as ever. Of course, I am always careful to select the seed, and use none which is imperfect.

Lard and Sulphur for Lice.

Hiram H. Barton, South Shaftsbury, Vt., stated that two years since his fowls were affected with lice, so much so that it was unsafe to step in the poultry house. He "applied lard upon the top of the poles on which the fowls roosted, and sifted freely on the lard sulphur. The pest was soon gone and has not again appeared. The remedy is so easy and simple that every person keeping one hen should be compelled by good sense to use it."

Dr. L. Bradley — Rubbing a little lard under the wings would probably have the same effect.

Mr. D. B. Bruen — Fumigation with sulphur is better still.

Lightning-rods.

Mr. W. P. Porter, Hartstown, Pa. — Are lightning-rods of any use whatever, and if so, what material is most suitable, iron or copper, or is the old fashioned rod good as the best?

The Chairman — I have before expressed the opinion here that these rods are of utility, if for no other reason than that they make the women folks and the children comfortable. But there is a gentleman present who knows all about the subject, and who can give other reasons if such exist. I allude to Professor John Phin, editor of the Technologist, and shall be glad if he will favor us with his views, and thus answer the question once for all, and save people the trouble of coming to us week after week, burdened with the same song.

Prof. John Phin — Whatever differences of opinion may exist in regard to the authorship of the discovery of the identity of lightning and electricity, there can be none in regard to the fact that Franklin, and Franklin alone, invented the lightning-rod; and, strange to say, when it left his hands it was nearly as perfect as it is to-day. Notwithstanding the many patents that have been issued for alleged improvement in lightning-rods, we would as soon trust our property to a rod constructed after the directions given by the inventor, as to one made according to the latest devices, covered by the broad seal of the United States patent office. It is true that during the last half century we have learned something about rods and their mode of action, and have acquired a more perfect knowledge of the special points which demand attention, in the effort to secure perfect safety. But it will be found on examination that Franklin's old rod embodies all the points necessary for a perfect conductor, and that consequently we are not at the mercy of any patent right monopoly in this matter. *Lightning-rods are useful.* There are many instances on record where buildings furnished with rods have been struck and injured. But this is not to be wondered at when we reflect that fully one-half—nay, perhaps three-fourths—of all the rods now actually erected violate the fundamental principles upon which their efficiency depends. Besides serious errors in regard to arrangement and continuity, it will in general be found that it is only by the merest accident that a good ground connection is ever secured. The cathedral of St. Peter in Geneva, although so elevated as to be above all other buildings in the neighborhood, has for three centuries enjoyed perfect immunity from damage by lightning, while the tower of St. Gervaise, although much lower, has been frequently struck. This doubtless arises from the fact that all the towers of St. Peter are accidentally furnished with very perfect conductors. The great column of London, known as the Monument, erected in 1677 in commemoration of the great fire, although over 200 feet in height, has never been struck, while much lower buildings in the vicinity have not escaped. A still more striking instance of the value of lightning-rods is afforded by a church on the estate of Count Orsini in Carinthia. This building was placed upon an eminence, and had been so often struck by lightning that it was deemed no longer safe to celebrate divine service within its walls. In 1730 a single stroke of lightning destroyed the entire steeple; after it had been rebuilt it was struck on an average four or five times a year, without counting extraordinary storms, during which it was struck from five to ten times in a single day. In 1778 the building was reconstructed and furnished with a conductor; and, according to Lichtenberg, up to 1783—that is to say, during the space of five years—the steeple had been struck only once, and this stroke had fallen upon the metallic point without producing any damage.

Lightning-rods should be made of the very best conducting material, and of a size sufficient to carry off the heaviest discharge that is ever likely to fall upon them. Of all the well-known substances, metals are the best conductors; and even among metals there are great differences in this respect; some metals, according to Becquerel, conducting nearly seventy-five times better than some others. There are, however, but two metals whose claims are worth considering—copper and iron. The others are too costly.

Mr. J. B. Lyman — Would there be any advantage in combining the two metals, iron and copper?

Mr. Phin — None whatever. We speak now of the *size of the rod.* Great differences of opinion exist in regard to the size of rods necessary to insure safety. The old directions by the French Academy of Sciences named a rod of from one-half inch to one inch square as a safe conductor. The following extract from the last report gives their latest views upon this point: "A discharge of our electric batteries is capable of melting several yards of very fine wire. A flash of lightning is capable of volatilizing more than 100 yards of bell-wire, or of the wire that is usually employed in connection with the hammers of public clocks. In 1827, upon the packet-boat New York, a surveyor's chain forty yards long, made of iron wire a quarter of an inch in diameter, which served as a lightning-rod on the vessel, was melted by a flash of lightning and dispersed in red-hot fragments. No instance has ever occurred in which lightning has raised to a red heat a bar of iron some yards long, and four-tenths of an inch square, or having a section of one-sixth of an inch square. Hence a square rod of iron, the sides being four-tenths of an inch, has been adopted in the construction of lightning-rods." This shows that the enormous conductors recommended by Professor Henry and others are unnecessarily expensive and clumsy. When copper is used the size may be proportionately reduced. If iron is used, the rod should, if square, be four-tenths of an inch on the side; if copper, one-fourth of an inch is sufficient.

Mr. F. D. Curtis — Would there be any harm if the measurements were greater?

Prof. Phin — None; nor would there be any advantage; besides, the rods would be unsightly and harder to handle. The different forms which have been patented are not of the slightest consequence. A flat rod is more convenient than any other form. If we examine the rods ordinarily found in market, and puffed by those who have invented them, we shall find that, instead of being solid bars of a square, round or merely flattened form, they are tubes, twisted ribbons, or bars whose cross section has the form of a star. And if we ask why these complicated and expensive forms have been adopted, we shall be told that it is for the purpose of obtaining the greatest amount of surface with the least amount of metal, and this is done because electricity always resides on the surface. Those who reason in this way, however, prove clearly that they have never studied the subject, else they would be aware of the fact that, while static electricity at rest always disposes itself on the surface of bodies charged with it, electricity in motion pervades the entire substance of the bar through which it passes, and consequently the power of such a bar to convey electricity is measured by the quantity of metal that it contains, and not by the extent of surface that it presents. Pouillet showed this in a very clear and decisive manner. He measured the conducting power of a fine wire of cylindrical form (the form that presents the least possible surface in proportion to its cubic contents), and then, having flattened and annealed it, he tested it again. Its surface was enormously increased, but its power to conduct electricity was lessened rather than otherwise; this diminution being probably due to the fact that the wire was increased in length, and, consequently, its cross-section was somewhat diminished.

We come now to consider the best method of attaching the rod to the building. It is a very prevalent opinion that lightning-rods should be carefully insulated from the buildings to which they are attached, and hence most rods are made to pass through glass tubes or insulators, the avowed object being to prevent the electricity from passing into the building. The extreme worthlessness of any such arrangements ought to be obvious to any person that ever observed a flash of lightning, and the positively dangerous character of the insulators will be apparent to every one that carefully studies the principles which govern conduction and induction. That a flash of lightning which will pass through a hundred feet of air should be unable to pass from the lightning-rod to any other object, merely because an inch or two of glass is in the way, is a proposition too absurd to find favor with any sensible man. In the first place, then, lightning-rods should be connected with all large masses of metal which may exist in or upon the house, such as metallic or tin gutters or pipes, iron railings, etc. In the second place, the rod should be attached to the house in the neatest and least obtrusive method possible. If the rod be flat, it may be pierced with small holes and tacked directly to the building; but a better way, both for round, square and flat rods, is to employ properly shaped staples of stout wire. These staples may be driven into the studding of wooden houses or into the joints of brick walls, and when properly painted will not present an unsightly appearance.

The Chairman — They may be pinned the same as conductors — drawing strips of tin over and tacking at both ends.

Prof. John Phin — Yes, that plan would be as good as any. Upon the perfection of the ground termination the value of the lightning-rod chiefly depends. If this be defective, no other good features can possibly make up for it. And yet, so little is it understood, that a careful examination of a very large number of rods leads us to believe that fully one-half the lightning-rods in existence are defective in this respect, and consequently furnish but an insufficient protection. The rules to be observed are: 1. The end of the rod ought to be made to terminate in a layer of soil that is permanently wet; and, 2. The end of the rod ought to expose to this soil as large a surface as possible. Permanently moist earth is to be attained only at considerable depth — say at the level of the water in the wells in the vicinity. Unless we reach this point, we can never be sure that our rod does not terminate in dry or but slightly moist soil.

The Chairman —Would it not be well to bury pig iron at the terminus of the rod? In reconstructing my country house, I found my predecessor had thus disposed of fully two cart loads of odds and ends.

Prof. Phin — The idea is a good one, or coke from the gas-houses would answer equally well.

Mr. Slipper —What area of surface is protected by a single rod?

Prof. Phin —The French Academy sets it down that a rod protects a circle having a radius twice the length of the rod above the building. But that idea is exploded. It makes no difference how far the rod extends skyward. It is only necessary to have one connection with the earth, but it is indispensible that this connection be a perfect one. I would run rods along the ridge-pole up each chimney, but let them all connect with the main.

Mr. J. B. Lyman —What is meant by having the rod end in permanent moisture? Suppose I am on a hill where I have to dig forty feet for water; must I carry the rod to the same depth?

Prof. Phin — Not necessarily; the sand may make a good enough material for the rod to end in.

Mr. R. J. Dodge — How about galvanized rods?

Prof. Phin —They are no better than painted ones.

The Chairman — We are certainly greatly obliged to the gentleman for the information he has imparted. I have got some new notions. For instance, I formerly supposed that a painted rod was worse than useless. Our readers will get helpful ideas, I dare say. They will avoid the lightning-rod peddlers, purchase their own rods, and put them up themselves, as they can easily do with the help of the instructions given.

Improving a Worn Plantation.

Mr. Thos. Barnes, Ellicottville City, Md., asked attention to an experiment of his with two acres of exhausted land, and gave the following synopsis of outlay and income:

1,200 pounds of fertilizer, at two cents		$24 00
Once ploughing and twice harrowing		4 00
Clover and timothy seed		5 00
Three bushels of seed rye		4 50
Cutting and thrashing rye		7 50
Total		$45 00
Mowing and housing clover		15 00
Total		$60 00
Thirty bushels rye at 95 cents, 1870	$28 50	
Straw sold	25 00	
Clover and stubble	7 00	
		60 50
First crop clover, 1871, four tons, $20	$80 00	
Second crop clover, three tons, $15	45 00	
Third crop clover, two tons, $15	30 00	
		155 00
Total		$215 50
Subtracting outlay		60 00
Total		$155 50
Gain per acre		77 00

He expressed the opinion that it is not objectionable to buy manure when it pays as these two acres have done, especially as the land is likely to be productive for years to come. The fertilizer was composed of one-half of finely ground bone and one-half double-refined poudrette.

Adjourned.

November 7, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

THE "YANKEPIN PLANT."

C. W. Spencer, M. D., Fillmore, Mo., sent a seed pod with a few extra seeds of what is known in his section as "Yankepins." The nuts taste like oak acorns. "The plant grows in a shallow lake near here; the flowers are double; color creamy white or pale buff; petals fleshy; flower very fragrant; blossoms June to September. I think it would be a fine ornament for the shallow (one and a half to two and a half feet deep) ponds in your parks. To get the plants, throw the seeds into the water and they will take care of themselves. What is the botanical name of it? If Horace Greeley is present, hand him one of the nuts and get him to tell what it is. I think he will call it an oak acorn. They are much sought after by the children, hogs and geese for food."

Mr. A. S. Fuller—That plant belongs to the *nymphæceæ* or water lily family. The scientific name of this particular species is *nelumbium luteum* or yellow *nelumbium*. It is rarely found in the eastern States, there being but three localities yet discovered where it appears to be a native, viz.: Sodus Bay, N. Y., Lyme, Conn., and in one pond below Philadelphia. At the west and south it is quite common, where it is known as water chinquapin, probably because the seed resemble the dwarf chestnut or chinquapin (*castanea pumila*) of the southern States. The large fleshy roots or tubers send up long leaf and flower stalks, their length depending entirely upon the depth of the water in which they grow. The leaves are one to two feet broad and slightly turned up at the edges. Flowers yellow, fragrant, five or more inches broad; sepals and petals many, gradually passing into each other. Stamens numerous on the receptacle, which enlarges into a top-shaped body, bearing ten or more ovaries (seed), which are each separately immersed in as many hollows. The seed resemble small acorns, and are composed of a fleshy, farinaceous substance. The tubers or root stocks are also edible. As soon as the ovaries are fertilized, the seed vessel bends over and sinks below the surface, where the seeds mature and then fall to the bottom. *Nelumbium speciosum* is the celebrated lotus or sacred bean of India, so frequently referred to by historians and travelers in the east. Near to the *nelumbium* are the *nymphæa* or common pond lilies, of which we have two or three native species. They are beautiful plants, similar in habit to the *nelumbiums*. *Nymphæa cœrulea* is the well known blue water lily of Egypt.

Another closely related genus deserves a notice in this connection; it is the *nuphars* or spatter dock. Of these we have four or five species. They are excellent decoys for enthusiastic young men who desire to show their gallantry and risk wetting their boots in gathering water lilies for lady friends. The *nuphars* are quite showy, but their flowers possess a fetid odor more pronounced than agreeable.

Dr. J. C. V. Smith — It is a little curious that this lotus plant should be found in this country and to have disappeared from Egypt, where it used to grow abundantly.

Pumpkin Seeds Bad for Poultry.

Mr. Washington Hills, Jr., of Long Island, wrote as follows in relation to an inquiry in last week's Club report regarding the reason of lameness in turkeys and other fowls: One cause of the disease complained of is allowing turkeys to eat the seed of pumpkins. Now is about the time farmers take in their corn and gather the pumpkins. Almost invariably the cattle are treated with a meal of pumpkins, and if the turkeys are around the barnyard they also have a meal of the seeds, and, so sure as they do, so sure will they be lame. Sometimes it kills them. At any rate they do not get over it. They will stay lean all the season. Nothing will fatten them. In fact, I have known a whole flock affected in this way to be almost worthless, and nothing else caused it but pumpkin seeds. Again, pumpkins are not fit for cattle; they will dry up the milk.

Pears for Preserving.

Mr. S. G. Wright, Detroit, Mich., desired to be informed which is the best variety or varieties of pears to be put up in cans. He has several trees in his garden which he wishes to graft with the kind most suitable.

Mr. A. S. Fuller — A difficult question to answer, inasmuch as there are many excellent sorts in cultivation. For canning purposes the pear should have a fine-grained, white flesh. Among the early varieties I would name the Bartlett, and for late Beurre d'Anjou and Vicar of Winkfield. The latter is not considered a first-class pear in quality, but the flesh is very fine and clear white, and retains this appearance when preserved. Another good recommendation for this variety is that the trees thrive almost everywhere, and bear prodigious crops. For preserving and cooking it has long been my favorite sort.

Mr. H. T. Williams — The Lawrence is the pear most popular with canners in Delaware. It grows in the southern and in the lower portion of the middle States twice as fast as in a colder climate. When this business of canning gets fairly under way, canners will take all the pears we can grow.

Mr. A. S. Fuller—I didn't mention the Lawrence, for the reason that it is a slow grower in cold localities. The Vicar does well almost anywhere.

Dr. E. Ware Sylvester—I grow over forty varieties, and regard the Louise Bonne de Jersey as the very best for that use. First, because it does not ripen quite so early as the Bartlett, and there is not so much danger of fermentation on account of warm weather; second, it is entirely free from the muskiness that characterizes the Bartlett, and which is very objectionable to some persons; third, it is handsomely shaped, so it looks nice when canned; fourth, it is just tart enough to give a fine flavor to the canned fruit; fifth, the Louise Bonne de Jersey is much larger in size when grown on the quince, and comes earlier into bearing; sixth, the tree is very healthy and hardy, bearing abundant crops at the west and north; a single tree, or a very few at most, of this variety, would supply a large family with abundant pear material for canning.

Professor James A. Whitney remarked that, in reading a large number of English, French and American scientific exchanges, he frequently found items like the following, that seemed of general agricultural interest.

COTTON-SEED OIL.

It is eighty-six years since it was first proposed in England to extract oil from cotton-seed, but it is only about fifteen since this has been done to any extent in this country. It has been used for many purposes in its original state, and, when purified both by itself, as a salad oil and as an adulterant of olive oil. The latest suggestion for its use is to make it a substitute for ordinary shortening in cooking. It is designed to do this by boiling it in water with a little chlorate of potash and nitre, and then passing a stream of oxygen gas through it to oxydize or burn out the impurities and remove the odor. In the process a temperature of four hundred degrees (about enough to scorch pine shavings) is necessary; and this is obtained, without danger of burning the oil, by driving a jet of steam into the liquid. The process may not be good for anything, but, if it should prove successful, it can doubtless be used for fitting other oils for culinary purposes.

OIL OF SUNFLOWER SEED

Is made in large quantities in Russia, and which is exported from St. Petersburg at about eighteen or twenty cents à gallon, gold, by wholesale. The cultivation of this plant for oil in this country has been recommended time and again, but for some reason has never been extensively undertaken. Four years ago the returns showed that in Russia the annual product of sunflower seed was 33,500,000 pounds. A light, rich soil, not shaded by trees, is required. About five pounds of seed is needed to the acre, drilled in rows eighteen inches apart. The young plants are thinned to thirty inches apart. The average yield is stated at fifty bushels to the acre. There can be no doubt that a large portion of the Western country is peculiarly adapted to the growth of the sunflower.

SELF-RAISING FLOUR.

Making self-raising flour, which has been invented in England, and which can be used by any dusty miller who chooses to be careful about his work: Pure hop yeast-cakes are thoroughly dried and then reduced to powder; half a pound of this prepared material is mixed with sixty pounds of clean wheat, and the grain is then ground in the usual manner, except that care is required to prevent the flour in grinding from being heated above blood heat. Precaution should also be taken to prevent this flour becoming moist, as it will ferment much more readily than the ordinary kind. From yeast we may turn to hops, which every grower knows lose half their value if kept one year, and become nearly worthless at the end of the second. In such connection an agricultural use for coal oil is proposed as follows:

HOP EXTRACT.

An extract of hops which can be kept for any length of time can, it is stated, be prepared by dissolving out the "hop-dust" and better principle by digestion in coal oil, naphtha and other light products of petroleum. It is preferred to use a solvent that will boil at 100 degrees Fahrenheit. The concentrated extract is of course obtained by evaporating the solvent, and for all we know to the contrary may smell bad even if it does keep well. As this, if it succeeds, will probably benefit the speculator more than the farmer, perhaps the latter would like a recipe for applying petroleum to some more every-day use, and here is one that should be put in practice on every bit of iron-work on farm implements before they are stored away for the winter. It is recommended by Dr. Puscher, a German pandit, who tells how to accomplish a very desirable thing, viz.:

TO PREVENT RUST.

The protection of polished metal from rust, which is done by dissolving one part by weight of paraffine in three parts of petroleum, and using it as a varnish on the surfaces to be protected. Paraffine is a white solid, which may be obtained through almost any druggist or storekeeper, and is very cheap. This is one step ahead of using mutton tallow, just as the next thing mentioned is ahead of the old method of coloring butter with carrot juice or annatto.

TO COLOR BUTTER.

Dr. Quesneville, a Frenchman, describes a new yellow coloring substance, which he states to be especially useful in coloring butter. The carrots were shred, dried and pounded to powder, then digested in bi-sulphide of carbon, a volatile liquid obtained by the action of ignited charcoal on sulphur in a retort of peculiar construction. The coloring matter is dissolved out from the carrots, and the rapid evaporation of the bi-sulphide leaves it behind in a fine powder.

PINE-LEAF HATS.

And now for variety we close with mention of a new use for pine leaves or straw, namely, pine-straw hats, which the writer saw last summer in the fair of the Mechanics' Institute in San Francisco. The straw was braided into flat strips about an eighth of an inch wide, and these were sown together to form a brown and not unsightly headgear with a narrow brim. The best were made of the leaves, six or seven inches long, of the digger pine of California, but one or two were from the shorter straw of South Carolina pines. This is a mechanical item, but it may be noted that pine-straw has been the subject of much chemical treatment. Some years since a foreign chemist succeeded in extracting a loose white fibre from it which was mixed with cotton and linen in the fabrication of cloth. Some have also suggested that pine leaves contain resinous matter enough to make them available in the manufacture of illuminating gas, but, so far as the writer knows, this has never been practically tested.

ORANGE CULTURE.

Mr. W. Day, Jr., Daytona, Florida—Nearly all authorities ascribe the nativity of the orange (*citrus aurautium*) to Asia, but any one visiting the immense wild groves of Florida, some of which may be reckoned by the square mile, will find it difficult to arrive at any other conclusion than that it is also indigenous to the soil of our

American States. The orange is the most beautiful of all fruit trees. It grows with a round, symmetrical head to the height of thirty feet, has a bright, glossy green leaf with an apron or wing upon the stem. The bark is of an ash or steel-gray color, and the twigs, which are of a dark green, are profusely bestudded with the most aggravating thorns. The sweet and mild trees may readily be distinguished by the leaf. The sweet leaf is of a darker green, and the apron upon the stem is larger in proportion to the main leaf. The tree flowers in January and February; the fruit begins to change its color in September, but cannot be said to have fully ripened until the following spring. It clings to the tree with great tenacity for many months, improving as it hangs, until during the following season it becomes perfectly delicious. One who has not gathered directly from the tree an orange thus ripened, knows little of its true flavor. Upon the wild trees the flowers, the gum fruit, and the ripe oranges, one and two years old, may often be found.

It is stoutly affirmed in Florida that the orange seed will always be true to its kind, but in the Hearth and Home, of Nov. 4th, I find the remark that "there is no certainty that the varieties of the orange will reproduce themselves from the seed. If a particular variety is desired it must be budded." I cannot agree with the writer. I have seen, in the vicinity of Daytona, seed lingorange trees in full bearing eight years old, the fruit the exact counterpart of that in Mr. Sutton's grove, whence the seedling were taken. But the wild groves found in the true orange belt show most conclusively to my mind the seed is true to its variety. At Daytona we have very large groves of bitter, sweet and sour oranges. Now, if the seed is not true, and, as is affirmed, the sweet orange is an accidental offshoot from the wild orange, we should find in these groves an endless variety of oranges. There should be sweet and sour, bitter sweet, bitter sour, and bitter pure and simple, with every conceivable variation of form, color and flavor. I admit all that is done in the way of improving fruits by budding and crossing in various ways, but when "in the beginning the earth brought forth grass and herd yielding seed after his kind and the tree yielding fruit whose seed was in itself after his kind, and God saw it was good," I think it was part of the divine plan that every seed should be true to its variety.

In selecting a location for an orange grove, I think regard must be had to climate. North of about latitude twenty-nine and one-half degrees, the winters are too severe, and render the crops unreliable. Last winter, orange trees were killed at Jacksonville and in

Northern Florida, while on the Halifax they escaped, and the trees are this year more heavily laden then ever. The orange will grow upon almost any soil, but if planted upon pine lands fertilizers are necessary. Burned shells, ashes, bones, etc., should be freely supplied. The advantage of planting upon hummock land is that it is exceedingly fertile, and is often supplied with the needed alkali in its shells and shell-marl. This is the case along the coast. From St. Augustine south, the coast soil is based upon immense beds of shells and coral. Sometimes the shells have been broken up by the action of the waves of the sea when the land was forming, and concreted into what is known as coquina rock, while the hummock lands — the lands which were last reclaimed from the waters — are filled with microscopic shells, constituting with its admixture of sand and vegetable matter, what we call shell-marl. Oftentimes the surface of the ground is mainly an immense mass of oyster-shells, harder to spade than a gravel-pit. Mr. Sutton's grove, near Daytona, stands upon such a bed, and his grove of 1,000 trees, with that of Captain Burnham's, has made the reputation of the Indian River orange. The cluster of twenty-eight oranges upon a single twig twelve inches in length, brought to this city by Dr. P. A. Gordon, of Daytona, a few days since, came from Mr. Sutton's grove.

Orange groves are brought forward by one of the following three methods: First, by budding or grafting wild trees where they stand; second, by transplanting the wild stocks and afterwards budding them; and, third, by planting sweet seedlings. In the first method cut off the wild tree one foot from the ground during the winter or spring, cut with a bevel, coat with wax, and allow a single shoot to grow from the stump. By June this will be ready to bud, or it may be grafted at any time when the bark is free. Clear away the forest shade gradually until the orange has become accustomed to the warm sun. Train but one bud or graft, because, first, it will use all the sap and make as much top in a given time as a dozen; second, two shoots will envelop the decayed end of the stump, and, inclosing a mass of infectious matter in the very heart of the tree, will affect the trunk clear to the roots. Sickly trees in old groves are almost all of this class. A single shoot will crowd the decayed portion to one side and heal it under, while the heart of the stump and the heart of the sweet sprout will unite and make one continuous healthy trunk from the ground up. Nip the terminal bud at the desired height for making the top, and thenceforward allow the tree to assume its own form. When it is desired to transplant the wild stocks, select about four inches in circumference; cut them off about one foot from the ground and pull them up carefully, so as to lose none of the roots. This may be done by taking a hitch on the stump, close to the ground, with a bight of untwisted hemp rope. With a stiff lever thrust through the bight; a man can easily lift a stump two inches in diameter. Larger and refractory stumps should have the soil worked from under the main roots and a more powerful lever applied. The rays of the sun should never be allowed to strike the roots, nor should they be drenched with buckets of water, as this will wash off all the alumina. Sprinkle them carefully with a bush, and keep cool, damp and well ventilated until they are heeled in. Select a moist, not wet, spot convenient to soft water, excavate a pit four feet wide, one foot deep, and of such length as required by the number of trees. Dig a trench eighteen inches deep for the top roots, which should be cut off to thirty inches, then set in the trees, filling back the earth taken from the next trench as well as from the sides of the pit till all are heeled in, when the whole mass of loose earth must be completely saturated with water and the soil perfectly settled around the roots; first providing, however, for a speedy drainage, so the water will not stand in the pit. Erect a temporary shelter to exclude the sun at first. Remove this gradually until the tree so suddenly brought from the dense shades of the hummock will be enabled to endure the light and rejoice in the genial rays of a Florida sun. In a few weeks, with an occasional watering, the trees will begin to sprout, when they must be carefully removed to their respective places. They may be budded at any time when the bark is free, but no sprouts should be removed until the following year. The tree has new roots to make, and it will only strike root in proportion to the amount of foliage. Let a tree make all the wild top possible the first year; it, at the same time, makes feeders, and, when you have secured a good flow of sap, you may consistently expect to force the sweet bud by pruning off all others. Mr. McDonald claims the healing process to be original with him, as applied to the orange, and to be the grand secret of his success. Setting out a grove of sweet seedling trees is exactly like setting out an apple orchard. Trees should be planted about twenty feet apart, or about one hundred to the acre; nor should they be set deeper than nature put them. In transplanting, mark the north side of each tree, that it may be reset exactly as it originally stood. Do not cultivate any crop which will overshadow the orange, but the grove is greatly benefited by the culture of low crops. Do not plough too close to the roots; stirring with a light harrow is better. Keep the trees mulched with cane-tops or grass. Many place a bushel of oyster-shells around the foot of each tree, every two or three years. The tree is an evergreen, and may be transplanted at any time, regardless of the moon's phases. Experienced nurserymen will secure a show of fruit in eighteen months or two years. A safe rule is never to touch a sweet tree with the pruning-knife. Plant a seed, feed it, and let it alone, says Mr. McDonald, and the tree will assume a more perfect and well-balanced shape than any meddler can give it. The sweet seedling will bear in six or seven years, and live many centuries, bearing thousands of oranges every year. The orange grove has three enemies—lazy owners, the "scale insect," or *coccus hisperidum*, and frost. The first ought to die, the second may be routed by nourishing and cultivating the grove, and the third can be avoided by going far enough south.

There is much wild speculation upon the profits of orange culture. Under favorable circumstances, the yield is very great. I have seen trees laden with from 2,000 to 5,000 oranges; while at Mellonville stands an old tree which has borne its 10,000 oranges. It is safe to assume 2,000 oranges as a fair average for a grove fifteen years old. These are worth, upon the tree, the buyer to pick them, two cents each, or forty dollars per tree. This is equal to $4,000 per acre. But assuming that, for some cause, the product is but half that, what other crop affords so great and so reliable a profit? Opposite Pilatka, stands Mr. Hart's grove of 500 trees, of, as yet, only medium size. I have seen the statement in print, that his oranges, in 1870, brought him $17,000, having sold over 400,000 oranges at prices ranging from three to six cents. I saw the grove one month since, and it was in most admirable condition. Orange culture in Florida is yet in its infancy, and not enough are grown to supply the home demand so suddenly created by the influx of northern people, and the demand in our more southern cities. Hence, none find their way to New York. Where the Indian river, or Smyrna oranges, as those on the eastern coast are called, are known, they always command double the price of the Sicily orange, and I have seen them sold in Atlanta, Ga., side by side, the former at one dollar, and the latter at only forty cents per dozen. For any one, especially an invalid, desiring a pleasant, profitable and healthful employment, in the most salubrious of all climates, where he can, with impunity, labor in the open air every day in the year, there is nothing more satisfactory than orange growing on the eastern coast of Florida, and nowhere can he maintain himelf so easily upon limited means until the grove begins to pay; for, from the orange land, he can realize two, three, and sometimes four crops of vegetables a year. These, with the game, fish and oyster crop, make living cheap. When the orange grove does come on, the reward of his labor is great, and he is, thenceforth, independent.

Dr. J. V. C. Smith—The paper is an exhaustive and excellent one on a topic that is exciting considerable interest.

Mr. A. S. Fuller—The question is, will it pay for us to go down there, and with our improved systems and implements make a business of orange culture? I question if I shall ever decide for myself, but I may. There is one point in Mr. Day's discourse which I wish to notice. I do not wonder that orange growers in Florida consider grafted or budded trees usually unhealthy, nor that they have poor success in transplanting trees from the forests. We would never think of going into the woods and selecting old seedling apple trees for stocks; and should we do so our apple orchards would fail as quickly as the orange tree transplanted in the manner described by Mr. Day.

Mr. H. T. Williams—Mr. Parsons, of Flushing, who went to Florida himself, expressed to me the opinion that it was risky, to say the least, for a northern man to undertake the culture of oranges there with expectation of making much money.

The Chairman—It is within three days that I saw the statement that Mrs. Stowe had made $13,000 this year from her orange grove.

November 14, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Turning Butchers' Offal into Manure.

Mr. E. Thompson, Louisville, Ky., asks the value of offal as a fertilizer. Our pork-packers throw away hundreds of loads every year. How is the best way to use them?

Dr. J. V. C. Smith—Any animal matter introduced into the soil is the best possible fertilizer for plants. It is especially good for trees, and may be buried among the roots.

Mr. C. D. Bragdon—I have seen, perhaps, twenty experiments in the use of animal refuse as applied directly in quantity to plants and vines, and never witnessed any profitable results. It gives great growth, but it weakens the plant and makes it more liable to winter-kill. It is like compelling a man to eat more than his stomach can bear.

Mr. F. D. Curtis—Decaying animal matter acts best as a manure when composted with barn manure and loam, with plenty of plaster to absorb escaping gases. When muck and plaster are used in sufficient quantity, lime may be mixed in to hasten decomposition. Let him dig a shallow pit shaped like a saucer, and throw the offal into it in layers, using rotten straw and weeds or rotten turf, with some plaster; if the odor is rank, and cover all in with three or four inches of garden earth or forest mold. The principle is that vegetable decay and animal decay neutralize each other, and convert matters noisome and offensive into the choicest plant food.

THE JAPAN CLOVER IN GEORGIA.

Prof. H. E. Colton forwarded a specimen of grass, and wrote as follows from Macon: "I inclose you a sample of a grass which is destined to occupy a large part in the regeneration of the old fields of the South. It is called here Japan clover and Georgia clover. Mr. C. W. Howard says it is botanically *lespedeza striata*. It was first called to my attention on the line of the Alabama and Chattanooga Railroad near Elyton. The people there believe it was brought here by the Chinese. Not being disposed to give much weight to their assertion that it never was known here before the war, I have since asked hundreds of persons, and all say it was not known previous to 1865. It is a rich, succulent grass, with firm roots. As fast as eaten down it comes up again. It roots out the old broom-sedge and takes its place, thus making a rich green sward, where before reigned supreme the dingy yellow of the sedge. I have seen cattle and sheep eat it with the greatest eagerness, and I am told hogs will also eat it; that they will leave clover for it."

Mr. A. S. Fuller—The plant to which the gentleman refers is not a grass, but a near relative of our common clover. It was introduced in some unknown way from Japan about twenty-five years ago, and has rapidly spread over the southern States. It is known as Japan clover or *lespedeza striata*. The plant seems to have become naturalized in many portions of southern Atlantic States, and is certainly a blessing to southern farmers.

JUTE.

Mr. T. F. Scott forwarded from Mississippi a sample of what he supposed to be jute. He found it growing on his plantation, and said:

I am satisfied it would flourish in low, wet and rich lands of our country, and the yield would be enormous. I am satisfied it would pay, as this plant grows like a cane-brake and would require no cultivation. It might be expensive to get it set, but once established I am satisfied no tedious labor would be required to render it merchantable. A mowing machine would cut it and the balance would be easy.

Mr. A. S. Fuller—The plant is the so-called American jute and one of the many native species of hibiscus. About ten years ago N. S. Contelo patented a process for separating the fiber, but I have never heard whether it was successful or otherwise. This jute plant belongs to the great mallow family, where we also find the okra, cotton, shrubby althea of our gardens, and hundreds of other plants cultivated either for ornament or some more useful purpose. The bark of all contains fibrous material in large or small quantities, and there is no good reason why some of our native species should not be largely cultivated for their fiber. The most common species is the one known as musk or swamp mallows (*hibiscus moscheutos*), and may be found in great abundance in the salt marshes near the sea shore. It also grows in low grounds as far west as the Mississippi. The flowers are rose color, but occasionally pure white. At the west there is one called the halberd-leaved; another which is known as the large flowering or grandiflorus. At the south they have the prickly-leaved and the great red flowering, but the fiber in the stems is nearly the same in all. I have cultivated the different species in my garden for the past fifteen years, and found that they thrive equally as well in dry as in wet soils. Seed is produced in great abundance, and there would be no difficulty in raising plants enough to supply the world. The root is perennial, and when a plant is once established it will take care of itself.

Mr. J. B. Lyman—It is doubtful whether we have a better jute-plant that prospers more in this country, and is more valuable for other purposes than cotton. If a cotton stalk is taken at the right time, before frost and rains have rotted the bark, an excellent tough jute can be made from it. The practical difficulty, in this and a score of similar instances, is that labor is too dear for the American farmer or planter to think of utilizing all the useful things that grow around him. In going into the jute business he would put himself in competition with half-naked East Indians, who will work contentedly all day for ten cents' worth of rice.

HAWTHORN HEDGING.

Mr. C. W. S. Anderson, Waterford, Pennsylvania, asked how to treat the seed in order to secure plants.

Mr. A. S. Fuller—Hawthorn seeds seldom germinate until the second year after planting. The fruit should be gathered as soon as ripe, and placed in a barrel or other vessel where it can be kept moist until the pulp decays; then wash out the seed, mix with soil, and bury in the ground where it will freeze in winter and remain moist in summer. When they have been in this position one year, take out and sow in drills, covering the seeds three inches deep. If the seeds are good and no accident has befallen them, they will germinate the following spring. The reason why so few wild seedlings are found is because the seed becomes dry the next season after they fall, and this destroys their vitality.

Adjourned.

November 21, 1871.

NATHAN C. ELY in the chair; Mr JOHN W. CHAMBERS, Secretary.

HAND CULTIVATORS.

Mr. Ezekiel Snider, Rockville, Canada—I would be pleased to learn something of the practical workings of any of the hand cultivators now in use for such drilled crops as onions, beets, etc. Are they in any way superior to the hoe and rake?

Mr. A. S. Fuller—I have found them to work very successfully and save labor in light soil, free from stones or other obstructions; but they pull heavy in hard lands, and few hired men are willing or able to use them.

Mr. J. B. Lyman—They are a novelty, and seem to be an improvement; but my experience is that they tire a man faster than a light hand hoe or fine-toothed rake; you cannot get quite as close to the row. In onions there is no substitute for the thumb and forefinger, and in beets and bagas the drills should be far enough apart to allow the use of a small one-horse cultivator.

PASTURING ON CLOVER.

Mr. T. L. Shepard, Lowell, Ohio—As I have been puzzled by conflicting testimony in regard to turning cattle into clover, part of which I thought good, and part decidedly bad, I determined to give some rules so plain that the wayfaring man need not err therein, and here they are:

1st. Never put any beast into fresh clover pasture on an empty stomach.

2d. Never when the grass is wet.

3d. Never put them in when the weather is changing from warm to cold.

4th. Do not give any salt for at least twenty-four hours before they are put in for the first time, nor until the evening of the second day.

5th. Do not let them remain in more than about twenty minutes the first time, after which they may run wet or dry with perfect safety.

Without such precaution there is danger of swelling from bloat, and valuable animals are often lost in this way.

Keeping Round Potatoes.

D. A. Buckley, Williamstown, Mass.—I want the potatoes fully ripe, so the skin will not rub off, and dug with potato-hooks or forks, and care taken not to cut or bruise them. The digging should be done in fair sunny weather. I have them picked up immediately, the pickers following the diggers, so that they shall not be in the light and air longer than necessary. Never allow them to be thrown hard into the basket or wagon. They should be handled as carefully as winter apples. I never have any more light or air circulating in the cellar than is necessary, while putting them in, and close up as soon as I am done, and keep them so till they go out to plant or to market. Those who use but a small quantity should get them from some one that they know gathers them with care, and then put them in tight barrels, cover them over the top with dry dirt, or, what is cleaner, sawdust, and then dig them out as they want to use them. Never let them come to the light or air, for they will spoil as quick as lime. I usually put mine on the cellar bottom, as I have from 3,000 to 6,000 bushels in one place, and keep them covered, and that is the reason that my potatoes are always good the year round, retaining their crispy brittleness. Every farmer can have them the same if he selects good ripe potatoes that have been carefully handled, and then takes care of them as I have described.

Difference Between Dairy Cheese and Factory Cheese.

Mr. C. N. Payne, Conneaut, Ohio — My father and myself own each a separate farm separately stocked with cows; employ all the fixtures and skill necessary for making "factory cheese." At our fair we competed with other factories, and by competent and impartial judges we received the first premium for factory cheese. After the fair the other competitors objected to the decision and were sustained by the board, on the ground that our cheeses were not "factory," as they were made from the milk of only two dairies — 60 cows. We received no milk hauled any distance over the road. If we are not making "factory cheese" we would like to know it, as we sell to buyers as such and our manufacture so stands in market. We certainly wish to do right in the matter, and come to your Club for counsel.

The question was referred to Mr. X. A. Willard, the highest authority, and this is his reply:

After reading the papers, giving the facts concerning the cheese-manufacturing establishment of the Messrs. Payne, I see no reason why it should not be named a factory, and be entitled to all the benefits pertaining thereto. A cheese factory, as we understand it here, is a building furnished with all needful appliances for making cheese, and where the milk from two or more farms is received and made into cheese. When two persons associate together and have the milk from their herds made into cheese at one place, we recognize it as a factory. We have several such in this and the adjoining counties. In some instances, where a farmer has a large number of cows (say 100), and fits up a building with approved appliances, and employs skilled cheese-makers, giving a name to his establishment, and marking that name on his packages, we give him the benefit of a factory name, and so report him in the market. And why not, if his cheese is similar in shape and quality to factory made, and can compete with other factories as to prices? We have no such narrow views here as would exclude the highest grade of cheese as factory, if the maker choose to give it that name, and compete with best factories in quality and prices. There are, however, comparatively few farm factories. Those most noted in this immediate vicinity are the William Peck's and William J. Skinner's. The William Peck takes the milk of about 130 cows, from two farms owned by father and son. The Brochett & Feter factory takes the milk of about 100 cows from two adjoining farms. The cheese from these establishments is bought and sold in New York as factory, and they regularly go into the several market reports, that are made up for the leading papers, as factories.

ENGLISH TREATMENT OF GRASS LANDS.

Mr. Henry Taylor, who has had large experience in England, on the estate of the Duke of Bedford, gave us his method of managing a meadow.

Grass land in England is becoming more valuable every year in consequence of the various kinds of like stock being so much improved; the produce of the dairy also is daily increasing in value. Some of the permanent grass farms command a rental of from £4 to £10 per acre. The first step toward improving the grass farms in England is to make drains, which should be quite five feet in depth, and sixty-six feet apart, except in very tenacious soils, where the drains should be thirty-three feet apart. The next operation is to dress the lands with about fifteen loads per acre of a portion of well-rotted farm-yard manure, soil of any description, road-scrapings, ashes, lime, etc. Thoroughly mix the whole together in a large heap, then allow the mass to remain six or eight months previous to carting it on the fields, which should be done in autumn or fall. This manure should be at once equally distributed over the grass, and as soon as the weather in the spring will allow you to operate, the grass should be first thoroughly harrowed with a pair of heavy iron-toothed harrows in various directions across the field, which operation will thoroughly mix the manure with the surface of the grass. Then all kinds of rubbish, such as stones, sticks, or any other matter that will be objectionable to have in contact with the mowing-machine, should be carefully picked off by lads, and carted away to repair the roads near to frequented gateways on the farm, and then the last but most important operation should be done — that is to thoroughly roll, twice in a place, the whole of the grass. This operation is considered by the English farmer to be of the most and greatest importance, for it is generally admitted that it is impossible to consolidate too much the soil about the roots of all grasses. These operations encourage the grass to spring up more thickly, and produce a better quality of herbage, both for grazing and for hay. The comparison between grass-land, thus managed, as I have feebly described, and that which is paid less attention to, is very remarkable, and the apparent difference in the weight of grain per acre, also the difference in the thrift of the cattle, is so glaring that no sensible farmer would hesitate to treat his meadows in the manner I have described; for it is a well-known fact that land not only in England, but in every country, will only remunerate occupiers by paying every attention and farming it well and thoroughly; and I feel that there must be thousands of acres in this fine country that would pay thoroughly well if it was sown down to a permanent pasture, where the farmer would have a better opportunity to improve his breed of cattle and sheep.

THE GRASSES OF THE GREAT PLAINS.

Mr. E. Marshall, Crystal Lake, Iowa—There is an important difference between the growth of the black prairies and of the dry rolling lands west of the prairies. It is true that the blue joint of other prairie grasses do not furnish good grazing more than five months in the year, but in the great pastoral belt alluded to, the case is different. There the grass is short and hair-like in texture with heavily seeded heads, never green, but of a somber gray color, and retains its nutriment throughout the year. To such an extent is this true, that an animal will prefer to graze where the last year's grass is unburned to the fresh new grass grown on burned ground, even in the months of June and July. This grass is very short, and covers not more than one-third of the ground, grows slowly, and consequently its capacity for supporting very large herds is limited. Two years' experience and observation in the extreme northern part of this belt has convinced me of the truth of the above statements.

FERTILIZING WITH LIME AND MUCK.

Mr. H. H. Wickham, Big Run, Ohio, wishes to prepare wheat and oat stubble this fall for next spring's crop. Shall he lime before or after ploughing? Which is the cheapest, lime at four cents per bushel, or loam and muck? The former on the land in a pile, the latter on three sides of it on the line.

Mr. Frank D. Curtis—Lime should be spread on the surface after the ground is plowed for the crop. It would be better to mix the muck with the lime this winter, and spread the compost on the surface just before planting in the spring. The loam could be mixed with stable manure with advantage, to absorb the juices and escaping ammonia. This is the best way to use the loam. Muck will answer for the same purpose, but is better mixed with lime to sweeten and decompose the vegetable matter, which is generally sour and unfitted for immediate benefit.

CLOVER AS MANURE FOR TURNIPS.

Mr. J. W. Wagener, Holtsville, L. I., brought for the inspection of the Club several large turnips, grown by him on lands which had been sown with clover, the clover turned under with a slight dressing of sea-weed from the bay. The crop grown by this treatment was claimed to be from 400 to 600 bushels per acre.

REASONS FOR SURFACE MANURING.

Mr. F. Grenwitz, Starkville, Herkimer county, N. Y.—After years of trial, I have decided to lose no more time and toil in burying my yard manure. To spread manure on the surface is to apply liquid manure, for the first rain will wash out the substance and drench the land. Then you have the coat for protection. This is a guard against the sun or the severity of the frost on grass lands. In the soil, manure will only fertilize what it comes in contact with, and that is comparatively a small portion of the land, as it cannot be as equally distributed, possibly, as liquid manure, or the juice of the surface covering does it. Here the soil is soaked as far as the liquid extends, every particle of it. The smallest root cannot penetrate without not only a contact, but a constant contact, with the strength of the manure. This is the case with grass roots; hence the remarkable growth. So if a piece of land has manure spread on it in the fall and is plowed in the spring, there is always an increased growth, showing a most gratifying result. But if the land is plowed before the manure is put on, and then cultivated in the spring, the effect will be still more gratifying. This only in cases where the manure is applied evenly so as to cover all the land, and is worked down in close contact with the ground. This by a roller, heavy brush or light harrow. Then the soil will hold the strength—the gases—as they are formed, and the manure thus applied will be a part of the soil, never lost unless washed off on a hillside. It is the best way to apply manure, whether long or short—the short or rotten the best. But the longest manure will do well, as it will the better protect the surface both winter and summer. Even pure straw has an effect here that is surprising to those who for the first time try it, and in some places it is always applied on wheat fields in the fall. Let us save all our manure of all kinds and apply as soon as possible; the sooner it gets on to the ground the better, as its strength and protection will at once benefit the land, instead of the strength going off as it does in the barn and in the heap as we find it heaped up. It is an excellent plan to cart on the meadows or fields as soon as the fall manure begins to be made, and spread at once, close and fine, and equally on all places. Continue this during the winter. Be sure to cover all, and spread evenly as you go. If you have a field plowed in the fall, nothing is better, if the soil needs it, than to spread directly on this surface. In the spring, you will find a sight that will do you good to look at. Instead of being frozen in heaps, the manure will soon thaw up, and the ground under it will be dark, and soft, and mellow, and rich, of course. Here you have something for a crop that will not fail. Your seed — clover or grass — will be sure to catch, and be a success for years. This, not because the manure is applied, but because it is applied properly. Here is one great error, though we do not consider it so: manure spread unevenly and in lumps — the usual way — will be of little benefit. We have seen this in hundreds of cases; we never knew one that was successful. The air and the ground, in spots, get the strength, while most of the land is without it. To get the benefit of the manure, all of it, or nearly all, *must be spread evenly over the whole land, and closely to it.* This may seem very unimportant — it does to most farmers — but it is the secret of success. Manure lumps are an abomination on a farm; the same, pulverized, and spread evenly and close to the land, acts at once. There is nothing new in this letter, but the facts are of such great importance, and so generally neglected, that it becomes necessary to repeat and enforce their observance. Such waste as takes place constantly is not pleasant to behold. The substance is not *seen to go*, therefore, it loses its force upon the mind and is permitted to escape. Our land suffers in consequence, when just this substance that escapes is what is wanted; it is the best part, and often the essence of the manure.

The Chairman — I like these views of our friend from Herkimer, and I know of but one exception to the mode he urges. When I have a rank, concentrated manure, as slaughter-house offal, to apply to a crop, and want a lively, strong growth, as in cabbages or French beets, or tobacco (but I don't plant tobacco), I am sure it is best to harrow or plow in that manure. Perhaps the harrow is just as good as the plow. But when a field gives off a rank odor, I am sure I am losing virtue from that manure; then, a light sprinkling of loam will lock it up in the surface, and hold it till the crop eats it.

Mr. A. Pratt, Prattsburgh, N. Y.—Mr. Grenwitz has the right idea about keeping manures on the top of the field. Twenty years ago, the opinion was that manure should be plowed under. This practice was enjoined by agricultural writers. They taught that manure would otherwise waste. Influenced by their counsel, farmers used to carefully lodge their manure in snug heaps in their fields, and spread it only as the plow was ready immediately to bury it. They were sure its virtues would dry up and blow away should it lay exposed even for a day. Oftentimes a damp or cloudy time would be chosen for these operations, in the belief that there would be less loss by evaporation than there would be in clear weather. But there has been a great and gratifying change in theory and practice since that time. It has long seemed to us that the process of nature amply justified surface manuring. We know of no contrivance in nature for turning manure under. A worn-out field, if planted in forest, will, in time, regain its original fertility through the operation of natural causes. The rains of heaven and its own dead foliage falling upon and decaying on the surface is all that is necessary. Land in pasture always improves in the elements of fertility; yet the droppings of animals and the dead weeds and grasses, through the agency of which the improvement is effected, touch the surface of the ground only. If there is waste in these cases, as was once held, it would seem as if field and forest would deteriorate when left to the operation of natural laws, but the fact is otherwise. And such results would also impeach the wisdom of nature's Great Author. We have sometimes thought that an argument could be drawn from another source in support of our position. To make a barren fig tree fruitful, it was once advised to dig about it and dung it. Twenty years ago, men grew wise beyond what is written. They said: Spread on the manure and plow it under; that is, dung about it and then dig. But, latterly, they are finding out their mistake; that the old order (named in the Testament) is exactly right, to wit: Dig about it, then dung. A weighty reason in favor of emptying barn-yards on our ground after it has been plowed is, that it not only makes a good yield of corn, and puts the soil in fine conditioned for subsequent crops, but proves destructive to foul seed. What does not germinate and get killed by the preliminary working of the surface preparatory to planting is sure to be annihilated by the after cultivation of the crop, if thorough culture is given. But when plowed under deep, such seed will lie dormant till turned up the succeeding year to grow and ripen in that year's crop. We have put on coarse manure, straw, long corn-stock buts, dry cobs, chip dirt, anything on the premises that we wanted to get out of the way, and what had not manurial properties immediately available as plant food we found to serve advantageously as a mulch in dry weather, and ultimately to increase the fertility of the soil.

Dr. Isaac P. Trimble — The remarks are well calculated to do good. Nature does not plow under nature's fertilizer. Last summer I paid a visit to a friend in Columbia county, N. Y., where the selling of hay is common. He is a farmer, and was then gathering his crop. He invited me to see a new mowing machine at work. The work for the horses was light for two-thirds of the way round the meadow, the other third very heavy. I asked the reason of the difference. His reply was: "Last fall this part was top-dressed." The difference in the crop was three or four to one. The timothy on the manured part was like wheat, the heads turning over with their weight, and would make two tons to the acre; the other part not more than half a ton. I asked why he did not manure all alike. Because he had not enough of it. Do not your neighbors sell hay? Yes. Then buy it and feed it till you make your whole farm produce two tons to the acre. A farmer cannot afford to grow hay at half a ton to the acre any more than he can afford to spend his life in making ten or fifteen bushels of corn to the acre. Such crops will keep him poor forever. With two tons of hay or sixty bushels of corn he may grow rich, and the sooner he begins to make his lands produce such crops the better. Meadows are often plowed because the grass has run out. Plowing makes them no richer, and they soon run out again. A top-dressing with barn-yard manure would save both time and trouble.

Rev. Joshua Weaver — To make the proper comparison it would be necessary to put the manure on two fields and turn it under on one. I believe that the proper way is to mix the manure with the soil. Lay a board on the surface and you improve the soil. A surface application of manure, of course, has some more advantage in the same way. It acts as a mulch.

Prof. Nash — I go for putting the manure on or but little under the surface; not deep underground, for there it either lies dormant a long time and does no good, or if it decomposes it goes into compounds which are poisonous to plants; whereas if left on or little below the surface, where it feels the influence of the sun, air and rains, it is speedily decomposed, and its elements pass into such compounds as are genial to plants, restoring their growth at once. But do not leave manure above the surface. If so left in great lumps, hardly touching the soil, it dries up; its value is but partially attracted into the soil, while the most of it is wasted on the desert air. On meadow land, therefore, I would spread it as evenly as possible, and then roll down into actual contact with the surface soil. If applied on plowed land I would cover it but shallow, not more than four inches at most, and then harrow till it should be fairly mixed in and composted with the soil.

Mr. John Crane — Manure should be fine when it is applied. My experience is that more benefit is received, and for a longer time, when the manure is plowed in. When left on the surface I think some of the best parts are lost in the atmosphere. One of the most profitable crops of wheat I ever raised was from seed which went into the ground together with manure. That field showed the benefit for five or six years. My experience with top-dressing is that it gives a large return the first year; but that a slight plowing in makes the crops good for a longer time.

Prof. Nash — If you get a good crop every time you can afford to apply the manure each season. Speaking of plowing in manure, it is possible to go too far. If time served I might tell in detail the story of a farmer who put $200 worth of manure per acre on a large field and plowed it in from one to two feet deep. The consequence was he never received the slightest benefit from it. On the other hand, he believed that ten years later his land was worse off than it would have been without any manure.

Mr. Henry Stewart — The question of manuring offers so many varied conditions that no one system will answer for all circumstances. For meadows, of course, manure must go on as top-dressings; for wheat and grain crops it should go where the seed is, or as near it as possible. For root crops it is best spread on the ground and harrowed in. Then, again, the variety of manure would affect the question. Nitrogenous manure should be covered to prevent waste of the ammonia, which so readily passes off, but it would not be advisable to plow it under deeper than where the sprouting seed can reach it.

Mr. F. D. Curtis — Coarse or unrotted manure should be plowed under; well-rotted or fine manure is better utilized by being harrowed in with the seed. An excellent system is to spread the manure, if not too coarse, on the surface of sod in the fall, and plow it under in the spring. In this way the manure is worked into the soil and is absorbed ready to feed the young plant when required. If spread upon the surface too early, the heat of the sun will evaporate much that is valuable, and it is better to do this work when the winter solstice is approaching and thus avoid the danger.

Mr. J. B. Lyman — Some years ago in the Connecticut Valley I had an opportunity of noting an experiment exactly in point. Two farmers, whose lands were side by side, ran a race in raising tobacco. The soil was the same, the previous treatment had been about the same, the plowing and pulverizing were thorough on both tracts. One farmer plowed in his stable manure with a shallow furrow, and harrowed after turning so as to blend the compost with the two or three inches of mellow tilth at the surface. The other put on a very heavy dressing or rank fertilizer from a slaughter-pen, and by harrowing mixed it partially with the surface, but many clumps and bones and heads were left on the top, and the odor of the decaying animal matter could be smelled half a mile. The plants were set out at the same time, the cultivation in both cases was clean, and the season was good for tobacco. The field where the manure was turned and mixed with the surface soil gave a third more tobacco than the other, and the leaf was finer and cured better, making a more marketable article, which commanded two or three cents more per pound.

Mr. Henry E. Colton—The sum of this matter may be stated as follows: Manures which contain nitrogen likely to evaporate should be covered with earth; those which are slightly soluble may be spread on the surface; very soluble manures it would be best to plow in, as they would be likely to run off in the wash. I have seen the richness of barn-yard manure thus running away on a somewhat clayey soil. Another point is that when plowed in, the manure should not be put much deeper than the seed. I have seen fish manure or offal used on the Albemarle and the Potomac, and there the best results are gotten by plowing in the offal. In manuring for grain, and especially for wheat, it is best always to mix the fertilizer with the three inches of top-soil in which the seed sprout and through which most of the roots are spread.

Adjourned.

November 28. 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

EXPERIMENTS WITH POTATOES.

Mr. Gerard C. Brown, Croton Falls, N. Y.—I herewith send schedule of my experiments with various varieties of potatoes this summer, specimens of which were at your fair on exhibition. If the results of this experience of mine are in some slight degree beneficial to my brother farmers I shall not count the cost on my part.

Figures, like facts, speak for themselves, but I wish to call particular attention to two or three varieties. The Peerless certainly has earned its name, as the yield of 160 barrels to the acre in such a dry and unfavorable season amply testifies. I have heard some grumbling in certain quarters as to its quality, but I can't complain of it; and I think, can convince any gentleman who has not lost his taste entirely that the Number Six is, with me at least, a first class table potato. The White-eye Peachblow, a new variety, originating with our worthy friend, Dr. Hexamer, is an improvement even on its excellent progenitor, the old White Peachblow, and must supplant it as fast as it becomes known. The Excelsior makes a bold push for the first place also, and its name is not its only claim. An early potato, with the excellent points of the Peachblow and enormously productive—I have failed to see a weak spot in it—it must become very popular. The Early Rose—well, it won't do to talk Rose to the farmers of of many parts of the country after this season's experience. It does not smell "sweet as a rose" to them now, though many of them were almost ready to swear by it last spring. Some whom I know are much to blame themselves. They ran all over the country, like mad, for seed, which they planted all over their farms with little manure and less care, and spent some hot days in August "cussing" the potatoes, which were not worth digging. I guess this experience will be worth something to them. They will learn one thing—that it won't do to slight the Rose, while it will repay real attention. The Late Rose is undoubtedly an off-shoot of the Rose. I have noticed it carefully for two years, have planted it separately, and am not convinced that it will continue to maintain itself as a distinct variety. Its principal characteristic seems to be its coarse grain and its lateness, which may arise from some accidental weakness or degeneration of the seed. This seems the more probable, as I find it each season scattered through the field, while all the stock of Rose on the farm came originally from one potato. Every practical grower knows that not all his potatoes of any one kind will be of the same quality. Some Peachblows will be poorer on the table than others in the next hill; some will rot sooner than others; and some here and there by their curled and stunted tops will show their waning vigor. I guess "this is what ails" the Late Rose. I will recommend the "King of the Earlies" as entitled to his rank; at all events, he got himself ready soon enough for me to get seven dollars per barrel for him the last week in June, in the New York market. Let Long Island hark to that, and if she will plant enough Number Fours next spring, I can't do that again from "Old Putnam."

Potato Exhibit, 1871.

Order of maturing.	KIND.	No. of barrels seed to acre.	Yield to acre in barrels.	Yield in barrels to one of seed.	No. hills to barrel.	Per centage rotten.	Quality.			Price per barrel.	No. of kinds.
							First.	Second.	Third.		
1..	New Hampshire	3⅓	21	6½	192	....	....	....	3	$5 00	1
2..	King of Earlies (No. 4)	3	44	14⅔	90	....	1	....	....	7 00	2
3..	Early Rose	2½	40	16	100	.01	1	....	....	2 50	3
4..	Early London White	3	34	11⅓	120	....	1	....	....	3 50	4
5..	Early Snowball	3	21	7	180	....	....	1	....	2 00	5
6..	Early Mohawk	4	50	12½	80	....	....	1	....	2 50	6
7..	Ketchum Seedling	3	26½	9	150	....	....	1	....	2 00	7
8..	Early Queen	3	31	10⅓	132	....	....	1	...	2 00	8
9..	Excelsior	3	60	20	66	....	1	....	....	5 00	9
10..	White Sprouts	3⅓	36	11	110	.05	....	....	1	1 25	10
11..	Sebec	3	20	6⅔	200	.20	....	....	1	1 25	11
12..	Dyckman	3⅓	28	8½	144	....	....	1	....	1 50	12
13..	Goodrich	3⅓	36½	11¾	108	....	....	....	1	1 50	13
14..	Garneo Chili	3⅓	52	16	75	....	1	....	....	2 00	14
15..	Willard	3	66	22	60	....	....	1	....	2 50	15
16..	Monitor	4	50	12½	80	.15	....	....	1	1 25	16
17..	Buckeye	3½	23	7	175	.10	....	....	1	1 25	17
18..	Climan	3	39	13	102	....	....	...	1	1 50	18
19..	Samaritan	3⅓	44	14	90	.... ..	...	....	1	1 50	19
20..	Breezees Prolific (No. 2)	3⅓	44	14	90	....	....	1	...	2 50	20
21..	Forfarshire Red	3⅓	47	15	84	....	....	...	1	1 50	21
22..	Jackson White	3	30⅓	9⅔	130	.07	....	1	....	1 50	22
23..	White Mercer	3	14	4⅔	288	.10	....	....	1	2 00	23
24..	Black Mercer	3⅓	47	15	84	....	....	....	1	1 50	24
25..	Skerry Blue	3	28	9⅓	144	....	....	....	1	1 25	25
26..	Holbrook	3⅓	34	11	120	.12	....	...	1	1 50	26
27..	Harrison	3⅓	66	21	60	....	....	....	1	1 25	27
28 .	English Kidney	3⅓	32	10½	125	....	1	....	....	2 00	28
29..	Orono	3⅓	47½	15	85	....	....	....	1	1 50	29
30..	Noblow	3⅓	80	6	200	.05	....	...	1	1 50	30
31..	I. X. L.	2	100	50	40	....	1	....	....	......	31
32..	Peerless (No. 6)	2	160	80	25	.001	1	....	....	5 00	32
33..	Prince	4	29	7¼	140	....	1	....	....	... ..	33
34..	Darien	4	20	5	200	.30	....	....	1	1 25	34
35..	Dyrite	3	53	17⅔	72	....	....	1	....	1 25	35
36..	Prince Albert	3⅓	30⅓	9⅔	130	.05	....	1	....	1 50	36
37..	Strawberry	4	28 4-7	7 1-7	140	.12	....	...	1	1 25	37
38..	Vandeveer	3⅓	35½	11⅔	111	....	....	1	...	2 00	38
39..	Copper Mine	3½	34	11⅓	120	....	...	....	1	1 50	39
40..	White-eye Rusty-coat	3⅓	41½	13½	96	.30	...	....	1	1 25	40
41..	Pink-eye Rusty-coat	3⅓	40	13	100	....	....	....	1	1 25	41
42..	Calico	3	71	23⅔	56	....	1	....	....	2 50	42
43.	Andes	3⅓	41	13⅓	94	....	....	....	1	1 50	43
44..	White Peachblow	4	45½	11½	88	....	1	...	....	2 00	44
45..	White-eye Peachblow	3	47	15⅔	85	....	1	...	....	3 00	45
46..	Red Peachblow	3⅓	44	10¾	90	....	....	1	....	1 75	46
47..	Gleason	3	44	10¾	90	....	....	1	....	2 00	47
48..	Casco White	4	90	22½	44	.02	....	....	1	1 00	48
49..	Chili White	4	88	22	48	....	....	1	....	2 00	49
2..	Imported Leathercoat	3	20	6⅔	200	....	....	....	1	......	50
1..	" Greentop	3	25½	8⅔	170	....	....	....	1	.. ..	51
3..	" South Am., No. 1,	2	18	9	220	....	....	....	1	......	52
4..	" South Am., No. 2,	2	5½	2½	700	....	....	....	1	......	53
	New varieties from seed planted April 3, 1870:										
3..	Fenian, or ...... No. 1..	2⅔	26	10½	165	....	....	....	1	... ..	54
2..	Carmelite ...... No. 2..	2⅔	98	36	42	....	1	....	....	......	55
9..	Bismarck ...... No. 3..	2⅔	57	21	70	....	....	1	....	......	56
16..	Gravelotte ...... No. 4..	2⅔	100	37	40	....	....	1	....	......	57
	Sedan ...... No. 5..	2⅔	100	37	40	....	1	....	...	......	58
17..	Crown Prince ... No. 6..	2⅔	80	29	50	....	....	....	1	......	59
8..	McMahon ...... No. 7..	2⅔	90	33	45	....	....	....	1	.....	60
15..	Drew ...... No. 8..	2⅔	72½	26½	55	....	....	....	1	... ..	61
7..	Gregory ...... No. 9..	2⅔	72	26½	56	.... ..	....	....	1	......	62
10..	Mt. Gilead ...... No. 10..	2⅔	73	27	54	....	....	....	1	......	63
14..	Glenida ...... No. 11..	2⅔	66	24	60	... .	....	....	1	......	64
	Putnam ...... No. 12..	2⅔	66	24	60	....	....	1	....	......	65
	Our Fritz ...... No. 13..	2⅔	66⅔	24	65	....	...	....	1	......	66
11..	Mahopac ...... No. 14..	2⅔	40½	14½	99	....	...	....	1	......	67
18..	Uhlan ...... No. 15..	2⅔	40	14½	100	....	....	....	1	......	68

POTATO EXHIBIT, 1871—(*Continued*).

Order of maturing.	KIND.	No. of barrels seed to acre.	Yield to acre in barrels.	Yield in barrels to one of seed.	No. of hills to barrel.	Per centage rotten.	QUALITY.			Price per barrel.	No. of kinds.
							First.	Second.	Third.		
	Conover......... No. 16..	2⅔	90	33	45	....	....	1	....	......	69
	Gerard .... No. 17..	2⅔	66	24	60	....	1	....	....	......	70
	Hexamer........ No. 18..	2⅔	40½	14½	99	....	....	1	....	......	71
4..	Croton .... No. 19..	2⅔	30⅓	10⅔	132	....	...	1	...	......	72
6..	Brownite........ No. 20..	2⅔	34	11⅓	120	....	....	1	....	......	73
	Standard .... No. 22..	2⅔	44	16⅓	90	....	....	....	1	.....	75
	Carolina .... No. 21..	2⅜	153 11-13	57	26	....	1	...	....	......	74
14..	No. 23....................	2⅔	102	38	39	....	1	....	...	......	76
	No. 24....	2⅔	29	10¼	135	....	....	....	1	......	77
1..	No. 25....................	2⅔	100	37	40	....	1	....	....	......	78
20..	No. 26....................	2⅔	72½	26½	55	....	....	...	1	......	79
	No. 27....................	2⅔	38	14	105	....	....	....	1	......	80
	No. 28...	2⅔	31½	11⅓	126	....	....	....	1	.....	81
13..	No. 29....................	2⅔	26½	9½	150	....	....	....	1	......	82
12..	No. 30....................	2⅔	34½	12⅔	115	....	....	....	1	......	83
	No. 31.......	2⅔	47	17½	85	....	....	1	....	......	84
	No. 32.	2⅔	63½	23	63	.. ....	....	....	1	......	85
21..	No. 33.	2⅔	16½	6	246	....	....	....	1	......	86
	No. 34....................	2⅔	20	7	200	....	....	...	1	......	87
	No. 35....................	2⅔	48	17¼	82	....	...	....	1	......	88
	No. 36	2⅔	14½	5⅓	270	....	....	....	1	......	89
	No. 37....................	2⅔	60	22	66	1	....	....	....	......	90
	No. 38.......	2⅔	53⅓	20	75	....	....	....	1	......	91
5..	No. 39	2⅔	28½	10¼	140	... .	...	....	1	......	92
		3⅓	43½	12⅔	92	1-10,000	....	....	....	$2.50	

AGRICULTURE IN ENGLAND.

The Chairman announced that, pursuant to the resolution of the session of three weeks ago, the Professor of Agriculture in Rutgers College and the State Geologist of New Jersey, Geo. H. Cook, would address the Club on "The Lessons of English Agriculture."

Prof. Geo. H. Cook—Gentlemen of the Club: Your chairman has referred, in the remarks with which he has so kindly introduced me, to the fact that I have been connected with the geological survey of my State. While this is true, I come before you not as a geologist but as a farmer, to talk in a way entirely practical, I hope, and pertinent about what I saw in Europe that gave me important ideas and lessons of value. There isn't a farmer anywhere that cannot learn something by looking up from his plow and seeing how his neighbor is managing his estate. So, in a larger way, England can show us the path to a better and truer and more profitable tillage than any European country; and though I saw the continent, the most of what I may say this afternoon relates to the methods and the skill of English and Scotch husbandmen. In going ourselves, as in the summer of last year, I had three main lines of observation before me. 1. I wished to study farm methods. I knew that English practices were old and well proven by generations of experience, and also that the English agriculturists comprise in their number many of the best informed, the most sagacious, and the most accurate and conscientious workers on those islands; and from their established system of science, teaching by example, I believed that much could be derived of lasting interest to us; nor was I mistaken. 2. I wished to see all the noted instances where bogs and sea marshes had been reclaimed and added to the tillage area of the countries. 3. Connected, as I am, with our Jersey school of science, I could not but feel a great interest in all the establishments where the youth of that kingdom are taught agriculture. During the five months of my visit, I was able to pay pretty close attention to each of these heads; but this afternoon I can only give you the benefit of certain conclusions to which I was led.

PLOUGHING BY STEAM POWER.

1. In cultivating by steam power Soon after I landed I was so fortunate as to meet the son of Mr. Fowler, the inventor of the English steam plow, and he, with a civility which I do not forget, went with me to many farms, and took much pains to let me see the working of the steam system, and the effects it has on the ideas and practices of farmers. They do not call it a steam plow half so often as they do a cultivator. Steam is used to invert the surface of their fields; but its chief application is in pulverizing the earth to a great depth. This is done by what may be described as a heavy and powerful harrow. That I saw was about seven feet across, and the teeth were as big and as long as my arm, bent a little forward like the prong of a dung-fork. It tears up the ground to the depth of twelve or fifteen inches and makes a hard clay loam as mellow and friable as an onion bed. I was surprised at the speed with which it was dragged back and forth from one stationary engine to the other by the stout wire rope. I tried to keep up with it, but found it was making away from me unless I walked at the top of my speed. The rate of progress was five miles an hour, and its day's work was twenty acres. The plowmen told me they had found speed of great importance in pulverizing. A tool that would leave the clay in lumps if running at three miles an hour breaks all before it fine when going five miles an hour. The ground was very dry and hard where I saw this first cultivator working, a heavy loam with flint gravel; it had been in wheat, and the farmer was making this deep, mellow tilth with steam power that he might have the best seed bed for roots. Speaking of the depth

in tillage, a subject which has been often before you, the English have established and harmonious views on this point. They say it is very important, once in four or five years, to go away down and tear up the soil below the cut of any common plow, as deep as fifteen or twenty inches. Mr. Campbell, one of the most successful of their tillers, has a steam cultivator, the prongs of which will go thirty inches deep, and it takes two thirty-horse engines to pull it to and fro. They do not want such tillage for every crop; but for roots the deeper the better. It is this power of making a deep, mellow field, without turning the top soil under, for which steam is chiefly valued as a motive power in room of horses. Steam has taught them that if a farmer can keep his surface clean, so he will not need to turn under weeds; he can use not a plow but a big drag in tillage with better results than if he depended wholly on the plow. Another advantage which steam gives is the great rapidity. I saw a fine field of wheat ready for the reaper Monday morning. On Wednesday night the wheat was off, the stubble was torn fine and deep, and the root crop was in. If a farmer gets a little behind hand in the pressing season, which there comes in August, he can clear out all arrears and bring everything sharp up in two or three days with one of those twenty-horse engines. For common depth, say seven to nine inches, they could not say that steam was cheaper than horses. It is not proposed to replace horses with steam, but steam gives them a practicable and efficient method for rapid and deep tillage, and for this the English farmer employs the engine. Between 2,000 and 3,000 of them are in use.

Culture of White Grains.

The first peculiarity that impresses an American farmer when stepping on an English estate is the absence of maize. They call wheat, barley and oats by the general name of corn; but our Indian corn I did not see at all. Hence corn harvest with them means August work on small grain. Their wheat, barley and oats ripen all alike, and harvest with the English farmer is a time of stress and push, and of critical days. If the weather is good all is well. His hands get good pay, and all goes merry. But bad weather is a serious disaster. Sometimes a week of shower and fog just then will throw a man into the hands of the sheriff.

In oats I could not see that they were greatly in advance of us. In fact, they admit that they do not know more about oats than their grandsires did. Nor could I observe anything remarkable about their barley harvests; but in wheat I was surprised. The English farmer may justly pride himself on his knowledge of this kingly cereal.

Their wheat straw is stiffer than ours and stands up better. The head is large and the color bright and clear. The uniformity of their fields is remarkable; no bare or thin places; no wet places; no winter-kills. Some fields that I saw would average thirty, some thirty-six, others forty bushels per acre; sixty and even sixty-four are often reported. One large field that I saw gave an average of forty-four, and I heard of an average of sixty-eight bushels per acre. That wheat I did not see. But I am well satisfied that the yield is from fifty to 100 per cent beyond our American average. Now, how is this done? 1. The English farmer does not expect good wheat except on excellent land well manured. 2. He pulverizes thoroughly and makes the best possible seed-bed for wheat. He plows, cross-plows, then rolls then harrows with a fine-toothed pulverizer; then he sows broadcast or drills in the seed, and covers from an inch to two inches deep, and if the soil is sandy he rolls lightly again. Often, on poorer spots, he sows a few hundred weight of nitrate of soda, and this special fertilizer brings up the thin places and makes the crop even from side to side of the field. 3. He considers the folding of sheep on a field fits it in the best manner for wheat. They all keep great flocks of sheep and feed them on turnips. Of this root an average crop is twenty tons per acre, and the sheep often eat them as they are found in the earth, biting them down below the surface, and with their sharp, hard feet treading the earth till it looks like a road-bed. In this way weeds have no chance, and the droppings are kept in the upper two inches of soil. In order to secure this compactness from the treading of the sheep's hoof they confine the flock to a small area, as a half acre, feeding them there till the roots are all gnawed away; then by moving the hurdle, a light fence, the flock is penned on another strip, and so on all the fall and winter. The manuring, plowing, cross-plowing, rolling and pulverizing are done at intervals from March till seeding time. Turnips are preferred as the crop to go before wheat; if not turnips, a clover lay.

Their General Policy in Farming.

The difference between renovating crops and exhausting crops is well understood in England, and the proportion that should always exist between them. Turnips, beets, clover and grass they rank as renovating, or flesh and dung making; wheat, oats, barley, hops and rape they call exhausters. The rental papers generally provide that fertilizing crops shall occupy a certain area of the whole tillage every year. For example, I made a study of the system of Robert Leeds, a well known and able farmer, on 1,160 acres, 1,000 under active tillage in rotation, and 160 in pasture and permanent meadow. He divides and rotates as follows: 250 acres in roots, 250 acres in wheat, 250 acres in barley and oats, 250 acres in clover and timothy. If either of the crops goes beyond the quarter part, it is roots. Last year, he had 300 acres in beets, ruta-bagas and turnips. I saw him taking thirty-five large cart-loads of red beets from each acre. There must have been thirty tons, 900 bushels, and the growth was alike all over those 300 acres. These 9,000 tons of roots were all eaten on the place. His stock is 2,000 sheep, 150 fed cattle, besides pigs, calves and horses. His sheep are all large and growthy, fine animals — he finds no profit in any others — mostly Southdowns. His fed cattle were all Durhams, and looked like the choice pens at a Kentucky cattle show. He calculates to add from thirty to eighty dollars to the value of a steer in eight or nine months. His sales are 200 to 250 bullocks and about 500 sheep annually. There I saw the admirable system of box-feeding, which I wish our farmers could be induced to adopt. These boxes are 10x10, I judge, and quite high, made substantially of inch or inch and a quarter stuff. The bullock goes in and stays there till he is ready for the knife. They are sheltered and well ventilated, ample to allow him to turn around, and lie or stand as he pleases. The water and feed boxes are movable, up and down. In a month after going in they may need to come up a foot to clear the bedding. One box has oil meal, another cut roots, another hay, and the fourth water. He can help himself at any time, and such generous bedding of clean straw is thrown to him that he eats some of it, and the rest he tramples and converts with his droppings into the best of manure. When he comes out, fat, he leaves say ten cubic yards of this compost below him. The richness of this manure may be judged from the fact that Mr. Leeds buys 300 tons of oil cake annually. The grand secret of British farm success is heavy stocking and high feeding. In no other way can they stand up to rents that would appall one of us. If an English renter like Mr. Leeds were to manage an American farm of the average cost per acre as he does the one I visited, he would make the land pay its first cost in two years, and perhaps in one. The lowest rental I heard mentioned was about eight dollars an acre a year, and the highest about thirty dollars. They all calculate to pay out as much for work as the rent amounts to. Thus, on a great number of places, fifteen dollars per acre rent and fifteen dollars in labor are the regular figures; an acre must yield thirty dollars worth before it begins to return a farthing of profit, to say nothing of bought fertilizers. To illustrate the amazing difference in the stocking of our farms compared with theirs, take New York State. In natural capacity, I think the average of your lands is equal to that of England. She has 50,000,000 square miles; New York, 47,000,000; she keeps 35,000,000 sheep, and New York something over 2,000,000; she has fifteen sheep, feeding and fertilizing her surface, where we have one.

The pride of the best English farmers is not in speaking of their exhaustive crops; they do not speak of 1,000 bushels of wheat, but of so many tons of meat. The average product of meat is 138 pounds a year to the acre. Holland is a little above this; but Flanders, a country renowned for model farming, reports but ninety-eight pounds per acre.

Mr. J. B. Lyman — You speak of so much labor per acre; what did you learn to be the average wages per day or week paid the farm hands?

Prof. Cook — Two shillings a day is about the lowest earned in harvest and ten shillings the highest. Fifty cents a day, or $3.50 a week, the laborer boarding himself, is the earning of the greatest number in the driving season, and half a pound a week — ten dollars a month — in dull times.

A word about fertilizers. They have been through the same mill that is grinding us now in the matter of bought manures. They have been swindled so often that many of the larger farmers, as Mr. Leeds for instance, buy their bones and have an interest in a bone mill. Then they can be sure that they are not buying dirt or plaster at £7 or £8 a ton.

Mr. J. B. Lyman — On what crops do they mainly apply their bone and phosphate?

Prof. Cook — Chiefly on roots.

I found one remarkable fact about the application of the manures rich in ammonia to black, peaty lands. They have a great many drained fens, where the soil is black to the depth of several feet. Ammoniacal manures do no good on such lands. But mineral manures, as the phosphates, work wonders. The reason is this. Peat and muck are very rich in the elements of ammonia, more so than the average of yard manure. The different forms of lime do such lands most good. I wish I had time to-day to speak fully of all I saw at Mr. Lawes'. He and Dr. Gilbert are the oldest, the most skillful, cautious and accurate agricultural experimenters in the world. Whenever you see any report from their farm you may know it is bullion. Their experiments extend over a space of twenty-five years; and they are so careful and conscientious. Mr. Lawes showed me the park where he has tried different top-dressings for grass on a sod that has not been broken for a century. One manure and only one is applied to each half acre. The effect of nitrate of soda, for instance, has been to root out the weeds more effectually than any other dressing. But the clovers do not come in. On the plot dressed with phosphate of lime, all the leguminous plants show a tendency to increase. Another strip he has dressed with sulphate of soda, with carefully noted results. When he scatters these fertilizers he hangs up a curtain, so not a pinch will go over the line, and he cuts and weighs the grass with the same nice fidelity. But I should consume another of your hours were I to describe all the painstaking of these admirable men, that has been kept up now for a quarter of a century. I have said enough to show how the noble art of agriculture in England rests on two strong pillars, a settled farm system, approved by centuries of experience and pushed to the highest thrift by the high price of lands, and precise knowledge, made strong by accurate science, and made trustworthy by the most conscientious care.

On motion of Mr. F. D. Curtis, the unanimous thanks of the Club were given to Prof. Cook, and the chairman said: Little that we can say will add to the consciousness that he must have of such stores of valuable knowledge as he has given us a taste of. At any and all times we shall be most happy to welcome him to our meetings.

Osage Hedges.

Mr. W. C. Hurst, Laytons, Sussex county, N. J.—I send to you for information regarding the osage thorn hedge. We planted nearly 3,000 plants early last spring around our burying-ground. They are planted in light sandy soil, with clay under, and have not grown well at all. I presume there are members of your Club who are acquainted with this plant. Will you be so kind as to inform us what we should do to save it and make it grow, as we know nothing about its care or treatment.

Mr. J. B. Lyman—That soil is not rich enough to make a thrifty osage hedge; it demands a strong, dark soil, like a prairie loam. The successful osage fences are on land that will make eighty shelled bushels of corn without manure.

Adjourned.

December 5, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

FARMING AS IT MAKES CHARACTER.

Dr. J. V. C. Smith read the following paper:—During the summer and autumn past, in travels through northern and western New York and in Massachusetts, I have noticed many hundreds of farms, and had opportunities of observing the leading traits of that great class of workers by whose industry all the rest live. As a race of men, the eastern farmers are industrious, intelligent and aspiring, far beyond the average of the American people. The desire and the resolution are almost universal among them to grow in fortune, to grow in knowledge and in social position. These aspirations extend to the family; and if a farmer has made up his mind to remain and die in the station in which it has pleased God to place him, he always hopes that his children will have better advantages, and stand higher in the scale of social life. This aspiration has impressed me as quite remarkable, and it explains the fact that so many of our ablest and strongest men in all departments of life have come from behind the plow. But in order that this admirable succession may be continued, our farms should be places where the conditions of high health are all complied with. A farm affords the means of making the soundest constitutions, the best possible illustration of the old Latin maxim—*mens sana in corpore sano*. But to secure this, the farmer's table should be supplied not only with an abundance, but with a variety of the most wholesome food. Too many of the craft seem to be ambitious to sell all they gather, and put themselves and dependents on a course of regimen that would not be satisfactory were it imposed upon them by others. To glean the land and deprive one's self of the luxuries that constitute the pride of a market is voluntarily exchanging what their stomachs require for money, which, when that is a governing principle, is gathered for others to enjoy who neither know nor care from what source it was accumulated. Prudence is a virtue, and should be encouraged both by precept and example; but avarice is a vice, when a disposition to hoard discards the comforts and conveniences of a well-ordered home. Farmers should live generously, on the best products of their domain. If their tables are served with what will not sell, their minds will never develop to a standard of intelligence on which the success of farming positively depends, and their children will have transmitted to them an incapacity for attaining distinction in any of the higher relations of life. There is but a feeble exhibition of brain power where the stomach has been restricted habitually to inappropriate diet. Nutrition must be constantly varied and abundant to supply the various organs of the body with elements necessary to the full perfection of their functions. The farmer, therefore, who mainly subsists on a few articles of food—because he imagines he cannot afford to consume anything that would sell for a profit—loses far more than he can ever gain by that policy.

It is said, that one reason why farming is not looked upon with more interest in Ireland, but perhaps unjustly, is because those engaged in it are not remarkable for intelligence. Certain it is that field laborers there are fed principally on potatoes; but when they reach other countries, and especially the United States, where it is customary to have a variety of condiments and a mixed diet of meats and vegetables, instead of an exclusive diet of potatoes and salt, they change entirely in mind and body, and exhibit traits of character, enterprise and bold determination quite beyond what would have been their social, political or intellectual status had they remained in their own oppressed native land. In order that a farmer may advance the interest of society, he must possess those qualifications which command respect. His knowledge of the business to which he is devoted is regarded with attention by those who wish to improve their own condition by following his example. Next, with a reputation for being discreet, a safe counselor in whatever appertains to the management of his property, makes him a man among men, whose acquirements give stability to institutions with which he may be connected, and thus a moral force accompanies all his acts, and his moral influence is a rich investment for his posterity.

During my autumn rambles, I visited the homestead of one of our number, who often gives us, in these meetings, the benefit of his experience. I was desirous to learn whether he practices the arts and the virtues which he so often recommends, and I was greatly pleased at learning how admirably his farm business is conducted. Order reigns there. Cheerfulness, refinement, good taste and economy are visible in all the appointments of the place. A convenient dwelling, in which comfort has not been sacrificed to empty show, is a pleasant feature for contemplation. A fine collection of books, especially on the favorite pursuit of the proprietor, various objects of virtu, musical apparatus, and, above all, a wide range of vision, on which every eye may feast from any part of the mansion, might be cited as an evidence of a love of nature in those who first fixed upon that particular location for a dwelling. Large barns and out-houses, neatly painted, a vast extent of stone-wall fencing, orchards, choice fruit inclosures; broad fields in the distance, in which choice breeds of cattle and other animals were grazing, pets of the proprietor, were evidences of enlightened husbandry. Besides an unusual degree of attention given to the rearing of swine, he has not been unmindful of minor matters that contribute to the development of the resouces of land on which the best efforts of his active mind are bestowed. To so have improved the essential properties of swine as to have young pigs eagerly purchased, by those competent to estimate their value, at ten, fifteen and twenty dollars a piece, shows, unmistakably, he has rendered an important service to the community by furnishing a better article of food, both in quality and amount, than was common in pork before this gentleman gave to the subject that consideration which has been crowned with acknowledged success. There was another feature in the landscape groupings from the front door of the inviting farm to which these observations refer, not to be overlooked in the contemplation of larger and more striking objects, which give a rural finish to a charming picture. I refer particularly to splendid broods of poultry, which everywhere are the necessary adjuncts of country life, and without which there is a defect in the economy which should characterize agricultural pursuits. It is a sign of a good master when hired men and maids have remained a long while in the same service. When the farm hand is trusted with entire confidence to carry out the plans of the proprietor of an extensive domain in his absence, and it is always accomplished to his perfect satisfaction, it indicates there is a mutual kindness and sterling integrity on both sides. Our friend has a colored man who has become so identified with the establishment, that, were he to leave, it would be regarded as a serious misfortune. While seated by his side on the box, the coach being full, I inquired of him what sort of a man the colonel was, in respect to his treatment of those in his employment. "Why," said the honest fellow, "he's the best man in the world. He'll do anything for everybody if they do right. I've been with him some years, and I shan't go away no how." Subsequently, on asking the proprietor what sort of a man his coachman and man-of-all-work was: "Why, he is invaluable," was the answer. "He is, as you must have discovered, intelligent, and as honest and faithful as he is discreet and active. He has endeared himself so completely to us, I have just commenced building him a convenient house." I cite this case not for laudatory purposes, but to illustrate the true and proper relations that should exist between the farmer and his head man, especially when that owner is absent a large share of the time. It should be said, however, in explanation of the ease with which these results are brought about, that the real head man is the accomplished and energetic lady that our friend leaves at the homestead. No part of the place is too remote to escape her frequent visits, and no animal is so small or feeble as to miss her constant and fostering care. It would be an excellent usage if the best farms, and farmers and farmers' wives, could be known through prizes issued by our State Boards of Agriculture, and then farmers would know where to go to see the best examples of high success in their art. It would immensely redound to their advantage to visit farming districts at a distance, for the purpose of seeing how other people fare, and learn by observation their processes and modes. No better investments could be made than to improve one's self by studying those means which others have pursued for the attainment of comfort, intelligence and independence. Although Dr. Franklin asserted that

> "He who by the plow would thrive,
> Himself must either hold or drive,"

driving and plowing are not all. If knowledge is power, let no opportunity be omitted for garnering in the suggestions, the thoughts and the experience of those who have better opportunities than ourselves. We shall then be qualified for exercising a moral force in connection with our ordinary pursuits, which is recognized in the annals of modern Christain civilization as a high and dignified mission. A well-informed farmer is qualified for almost any position, since he cannot be otherwise than a gentleman; and in the United States, as it must be eventually recognized everywhere, moral worth is more precious than hereditary titles or wealth without sterling integrity. A good farmer is generally a good man, and when his labors on earth are finished, like the low descending sun, "seems larger at his going down."

Dr. Isaac P. Trimble — I am always pleased when Dr. Smith makes an effort, and this is in his best vein. He has, however, excited in me a consuming desire to view our associate's farm, and I hope our Saratoga comrade will invite the Club, as a body, to see with their own eyes what Dr Smith has described with such fullness and poetic grace.

HOW THEY PLOW IN ENGLAND.

The Club was favored with the following interesting and important statements made by Mr. Henry Taylor: Various opinions still exist as to the required depths. This operation must be regulated according to the nature of the soil and the kind of crop intended to be grown. For instance, for the wheat crop the depth varies from five to six inches; barley and oats, four to five inches; beans and peas, six to eight inches; and for mangel-wurzel, turnips, kohl rabbi, carrots, parsnips and cabbages, the soil should be plowed from ten to fourteen inches. But once in four years it is undoubtedly essential to thoroughly plow or smash up the soil to the depth of two or more feet, where the depth of the soil will allow the implement to penetrate; and without the least hesitation I say that this depth cannot be uniformly done, only by that best of all agricultural implements, the steam-plow or cultivator, on strong or heavy soils. But the fens or the black lands in Lincolnshire, which have been reclaimed from the sea, can be cultivated to the depth named by horse-power. I know of large tracts in England that have been farmed by the same family for upward of thirty or forty years, and this land has been all but ruined, and would scarcely produce eight bushels per acre of any kind of corn in consequence of being plowed so shallow for many years. The best instance I know of this kind is the Britannia farm, the property of the Messrs. J. & F. Howard, the eminent manufacturers of all kinds of modern agricultural implements, at Bedford, England. Previous to the Messrs. Howard purchasing their home or steam-cultivated farm, it had been occupied for many years by a very respectable tenant, who used to drain shallow and plow shallow. The consequence was, his crops were upon an average fair crops, but in indifferent seasons the crops were quite inferior. The Messrs. Howard purchased this farm for about $150 per acre, which price will at once tell you that it was not first-class land in England, where many places cannot be bought for $500 per acre. After the purchase, the spirited proprietors drained the whole of the farm four feet deep, and about thirty-three feet apart from drain to drain. They then smashed the whole tract of land up, to the depth of twelve to eighteen inches — and they still continue to cultivate very deep, and I have no hesitation in saying that, take their crops upon an average during the past eight years, no better or finer could be produced in England, on the best soils. Also, I am sure if the same property was to be sold it would bring $500 an acre. All this vast improvement was entirely brought about by thorough deep cultivation with the celebrated steam plows. 'Tis very plain to me that the soil of this vast country could be improved in like manner, if the steam plow or smasher was introduced and used freely.

Trouble with Fruit Trees.

Mr. Albert Brewster, Sterling, Conn., stated that his apple orchard bears knotty fruit, and his pears this season were wormy and unfit for market. "What is the matter, and what can be done?"

Dr. Isaac P. Trimble — This is the same old story. The worm spoken of is either the grub of the curculio or the caterpillar of the apple moth. These, if let alone, will become beetles and moths, and continue the trouble the next year, and probably forever. Now, let these be destroyed in their larva stage; and as nearly all the fruit containing them falls prematurely from the trees, your domestic animals, especially the hogs, will do the work for you — they will eat this young fruit, and there is an end of those enemies. The great farmers I so frequently visit in eastern Pennsylvania and south Jersey understand this matter perfectly. They have small orchards of fruit trees closely connected with their farm buildings, and there the hogs run from spring to fall — sometimes, cattle, sheep and horses run there also; but the hogs alone will do it if not too well fed. Another thing, never mutilate the hogs' noses either by cutting or putting rings in them — let them root — generally they are searching for the larvæ of insects, and their loosening the ground is good for the trees.

Mr. Curtis—The crop of apples varies with different years. The season of 1870 brought a bountiful harvest of smooth, large fruit, but the crop of 1871 was very poor, although the trees were just as thrifty as the year before. This is owing to adverse winds and untimely frosts. Doctoring the trees will not, in such seasons, make good fruit; and when there is a scarcity of fruit the worms make it worse, for they have fewer subjects to forage upon, and hence make a greater show.

Mr. Quinn—Pears were more afflicted with worms this year than usual on account of the dearth of other fruit. The same curculio and apple moth, to which Dr. Trimble alluded, do the business in the pear orchard, and the same treatment must be adopted. In my own practice I gather up and feed to pigs not only the fruit that falls, but I pick from the trees all that look defective. This work should be done every two or three days.

POULTRY RAISING AND CAPONIZING.

Mr. Geo. Morton, Schenectady, N. Y.—Having seen a statement in the Farmers' Club once that hens did not pay, I thought that I would let you know my experience. I kept twenty-three hens the last year, ending November 30; I got 2,904 eggs, which is a little over 126 for each hen. I don't know exactly what it cost me, as I raised some corn myself; but last April I bought twelve bushels of corn, and it lasted six months, with some young ones eating with them. I fed them on corn all the time, except once a week, when I gave them a mess of scalded bran, with some sulphur in it, and in the fall potatoes once, and sometimes twice a week. They got no scraps from the table, as other animals got all of them. I also raised thirty-five chickens, and they used about one hundred weight of meal. Some men say that hens, to lay good, must have flesh, but I never gave them any, and they are shut in a small barn-yard from the time I begin to work in the garden until the grapes are picked. I think my whole cost is not over twenty-eight dollars. Counting the eggs at twenty-four cents a dozen, gives fifty-eight dollars and eight cents. The chickens were worth at least seventeen dollars and fifty cents. Their manure was worth at least five dollars, which makes in all eighty dollars and fifty-eight cents; taking twenty-eight dollars cost from that, leaves fifty-two dollars as profit of twenty-three hens, which is, I think, very good.

Dr. J. M. Crowell—This writer says nothing of breeds. As I was on the ferry-boat this morning a lady said she was going in the spring to begin to make a business of poultry, and asked me what breed she should select. I told her I would seek wisdom of the Club on this point.

Mr. F. D. Curtiss—She cannot get far wrong on the white Brahma; the Brahma, white or dark, is gentle, domestic, and bears confinement. The hen is a good mother, and the chicks will eat more and grow faster, and go through more wet and cool weather without loss, than the young of any other sort.

Dr. J. M. Crowell—The Brahma is admitted to be the best for producing spring chickens, but their flavor is not remarkable. The Dorking is a more tender and game bird, but I am surprised that so few farmers understand the advantages of capons. They grow a third larger. A capon will sell for twenty-eight cents in the market when a common fowl brings but twenty-one cents. Most of our capons came from Berks county, Pa., and from Burlington county, N. J.

We have visitors from Berks county, and would be glad to know of them how it is that they make such profit on capons.

Mr. John Ketchum—It gives us little or no trouble to raise capons. We have a few men in our country who know just how to open a fowl, and we pay them say two or three cents a head for going through the yard. Not more than two in a hundred die or fail. After the operation they grow faster and the flesh is all good; no difference between breast and red meat. It is all tender and juicy. It is no uncommon thing to sell a capon that weighs seven pounds. As to breeds we have a variety, and think a cross of Dorking or Brahma makes a good fowl for caponizing. Brahma, Dorking, Game and Dominick are the chief breeds in our county. We make it a rule always to change roosters once a year.

Dr. Isaac P. Trimble—I like the old-fashioned Dominick and the Game, but for eggs alone I have no better hens than my white Leghorns. For eggs as a special product, the Brahma would not be a good selection, for they are too fond of becoming mothers.

USING BONES AND KILLING MOSS.

Mr. Charles L. Spaulding, Cavendish, Vt.—I have a lot of bones which I wish to convert into something that will make corn grow. How is the best way to do it without much expense? I can get wood-ashes for twenty-five cents a bushel, and lime for one and one-half cents per pound. I want to use it on a piece of old pasture land which had been cultivated long ago, but has laid in pasture at least forty years, and become entirely moss bound. It did not produce grass enough for one sheep to the acre. I plowed two acres of it last June eight inches deep, and found that it had never before been plowed more than four inches deep. The land is a gravelly loam, free from stones, looks like good corn land; how is the best way to manage it? Plow deep and try to cut up the moss sods, and tear them to pieces with the harrow, or plow light and let the moss lay and rot where it is, for the corn-roots to work in one year? I have a small place of about forty-five acres, which I bought last spring; did not cut over three tons of hay last season; at least twenty-five acres are in pasture. It lays well for cultivation. Some of it was plowed and cropped long ago, and some never was plowed, but might be, and another portion of it was wet, and some stony and mucky, but my farm is termed a poor one. I think there is or may be some virtue that lies more than four inches deep in the soil. I want to work my land all under cultivation and soil my stock. But the trouble is to get started, so as to raise enough to keep three or four cows and a horse and a hog or two, summer and winter. That accomplished, I am satisfied that it can soon be doubled. I have several loads of beeves' heads and jaw-bones, and would like to know how to use them.

Mr. J. B. Lyman—The first experiment on that mossy pasture should be with lime. As a rule, lime will kill moss unless the surface is very springy and needs draining very much. Probably he made a mistake in turning up four inches of poor subsoil at the first plowing. He may bring the field up with liberal manuring, but it would have been better to have fertilized the four top inches first, and then gone down an inch a year, manuring the subsoil as he brings it to the surface. Now that he has it up, the true policy is to manure heavily and cultivate clean till the part broken up is good and rich. Then lay it down in timothy, and top-dress when it begins to fall off. As to his bones, let him crush them as fine as he can with a big hammer, and then rot them in a compost with ashes and horse-manure kept moist with soapsuds. Of course the compost heap must not freeze. Keeping the bones in this sweat for several months will soften all the small and fine pieces. The larger and tougher should be returned and allowed to decay another year in a similar compost heap.

Adjourned.

December 12, 1871.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

SOUTH-WESTERN TEXAS.

Mr. T. G. Williams, San Antonio, Texas, being present, and by invitation of the Chairman gave an extended account of south-western Texas. All that part of Texas west of the Colorado river is called western Texas, comprising a tract with an average width of 300 miles by about 900 miles long. Although there are fewer people living in all western Texas than in Brooklyn, yet to-day western Texas has for sale over 300,000 head of four-year-old beef cattle, and about one-half of western Texas is yet unused as a cattle range, on account of Indian raids—Indians living domiciled in the territory of our friendly neighbor, Mexico; no protection given by the State or the United States. Every farmer who last year—one of the driest ever known—planted his corn before the 20th of February, and who gave only ordinary diligent cultivation, averaged twenty-five bushels of corn to the acre. Wheat averaged fully nineteen bushels, oats over thirty-five bushels, with a weight to the measured bushel of forty-six pounds the Norway oats. Cotton, nearly a bale to the acre.

Pecans and Mesquit Beans.

The pecan crop—a spontaneous gift of nature—will yield not less than $1,000,000 to the people of western Texas this year, and not more than one-half gathered of those produced. The samples of pecans I present herewith—unusually fine ones—were grown on the San Antonio river, near the city of that name. Besides advantages for irrigation afforded by nearly every stream, at comparatively small expense, I would mention one natural product which, during drouths when the grass to a small extent fails, affords a most nutritious and abundant forage to cattle, sheep, horses, mules, hogs and goats—the bean of the mesquit tree. This bean is only produced in large abundant crops during a season of prolonged drouth. Horses and mules will often leave corn to feed upon this bean when accessible; as they, as well as cattle, get very fat upon eating the mesquit bean. This tree grows luxuriantly all over western Texas, except just along the Gulf coast. As to fruits, on the 8th day of November I saw in the San Antonio market fine large fresh peaches taken from the orchard that day—and from an orchard, too, which had furnished ripe peaches daily since the 15th day of May. For salubrity of climate western Texas has already become proverbial. I have seen active, profitable out-door farm labor—plowing and planting, harvesting or gathering, going on every month of the year. Poor, unproductive land is the rare exception. Unimproved lands of the best quality, and in any quantity from 160 acres up to tracts of 50,000 acres, can now be purchased, with perfect titles, at from fifty cents to $1.50 to $2, gold, per acre. Projected and rapidly-constructing railroads are enhancing the price of these lands. There not being from three to six months of freezing weather in western Texas, makes it pre-eminently the country for a poor emigrant.

Mr. J. B. Lyman—The gentleman from Texas will confer a favor by speaking more fully of stock-raising. We have often heard it stated that a four-year-old, giving 600 weight of dressed meat, costs the Texas grower no more than a spring chicken. It has been said, also, that the life of a stock-farmer on those savannahs is lonesome and semi-civilized. We would be glad to know the whole story.

Mr. Williams—Both statements are substantially true. Cattle need no fodder. They are as fat in February as they are in June. Young cattle keep on growing the year round. There are but three events in the existence of a Texas steer—to be dropped, to be branded, to be sold at the age of four years for beef. A range with us means a strip or body of land of indefinite extent, generally from 10,000 to 100,000 acres, between two streams. It makes no difference who may hold the patents to it or parts of it, as long as it is unfenced. In the spring the ranchero or herdsman goes out into his herd and brands his calves, sometimes by throwing a rope around them, but more frequently by driving them into a pen. Nobody is particular to know or inquire what cow's calf it may be. We call an unclaimed and unbranded calf on the range a "Maverick," from the name of a worthy citizen of San Antonio, whose possessions are so immense that he cannot identify his stock. It is no harm for anybody to brand a "Maverick."

After a calf or yearling is branded, it may not come within half a mile of a man for three years, and then it is sold in the herd, generally at so much per hundred head, and driven to the north-west, or to the seaports. All the animals, big and little, on a range, or in a specified brand, go, when a rancheman sells out, at so much a head. Four dollars and a half, in gold, is a common price. If a man has 1,000, we do not call him a rancheman, he only has a few cattle; 5,000 ranks him as a stock-raiser. When he owns that many, he can afford to hire a Mexican, and most of his time he can spend in town, or with his family. But with the stock-farmer, who owns less than 5,000, the case is different. He must pass most of his time in the saddle, with his stock, watching them, keeping them from getting mixed, and protecting them from Indian raids.

Such a life is not wholly festive or luxurious. But if a brave, hardy young man will take hold of stock with energy, he can turn $1,000 into $10,000 quicker and surer than by any other sort of industry. One may spend 300 out of the 365 days of the year out in the open air, night and day, with ordinary clothing, and a blanket or two, not only with impunity, but with increased robustness. During nearly the whole year beef is stripped from the carcass of a freshly-killed ox, hung up and dried in the open air, and kept until consumed for weeks afterward. We could feed three times as many cattle as we now do in western Texas. Instead of 300,000 four-year-olds annually, we could drive out a million a year, if it were not for Indians and sparseness of population.

LATE ROSE POTATO.

Mr. B. K. Bliss, the seedsman, sent half a bushel of this new variety.

The Chairman—I will give them out, one by one, to such members as will plant them. I do not know anything about their merits, but, of course, our expert who grows 300 varieties can tell us all about the tuber, its origin and its promise.

Dr. F. M. Hexamer—The first specimens of the Late Rose I saw were at the New York State fair. I was informed by the exhibitor that they were a sprout of the Early Rose. A farmer in digging his crop of the latter found a hill which was not ripe, and left it to nature. When it was dug at last, the tubers proved larger than those of the Early Rose. They were preserved and planted year after year, and these are specimens of last season's crop. Through all this time they are claimed to have preserved their characteristics. Whether they will keep on doing so when planted in different sections is an interesting but undecided question. In quality, they are about the same as the Early Rose, but appear three to four weeks later, are believed to be better keepers, and preserve their good table quality all through the winter, which cannot be said of the Early Rose.

Mr. P. T. Quinn—I received some of the Late Rose and was puzzled to decide which was which, when I compared them with the Early Rose. But when cooked I thought I perceived a decided dissimilarity. The Late Rose has the characteristic of the Peachblow when cooked, being mealy on the outside, and not so well done within. If the Late Rose is as good as is claimed, it will be a decided acquisition to the few satisfactory varieties we now have.

Mr. Wm. Lawton—Speaking of the White Peachblow, I consider it forty per cent better than any of the new-fangled varieties.

Mr. A. S. Fuller—That depends altogether where you grow it.

Hon George Geddes —Let me state a fact in this connection. We have a potato station up near my place and the city dealers sometimes come there to buy, and they prefer the Prince Albert, which is so poor a potato that we wouldn't eat it ourselves. Why they prefer this I can't say, and I sometimes wonder if you city people are satisfied.

Clover, how to Raise and how to Feed it.

Mr. J. A. Murray, Galloway, Tenn.—How am I to put in clover, and how and when to pasture it, and how prevent animals coming to harm by eating too much of it? The stand I have is good in some places and poor in others.

The Chairman—Deep plowing and plenty of manure.

Prof. Henry E. Colton—He can either plow it in now, and sow again in the spring, or pasture awhile and then plow in. His best fertilizer is the plaster from the Holston Salt Works. If his cattle are regularly salted, they are not apt to hurt themselves eating clover.

Hon. George Geddes—In regard to pasturing the crop, after he gets one to pasture, he must not be in too great haste. If he begins too soon the stock will eat so close as to destroy the roots. Let it get a good start. I have had clover on the brain for many years, and never lose stock by bloat. My practice is to turn the animals, when they go out in the spring, ravenous for something green, upon some old grass-field, for a few days, until their appetites are somewhat appeased. Then the morning of the day upon which I give them access to the clover-field, I let them start on the old ground, and, an hour or two after the dew is off, let down the bars of the clover lot. By being careful in this way for awhile, at the beginning of the season, farmers will not suffer loss.

Dr. Isaac P. Trimble—Suppose these precautions are not heeded, how can the life of the sufferer be saved?

Hon. George Geddes—The best method has been several times mentioned here, and I have often tried it with perfect success. Let the attendant take his stand on the left side of the animal, with his right hand holding the blade of an ordinary pocket-knife, and apply it at the hollow in front of the hip at the highest point. In this place the upper part of the paunch is attached to the sides of the animal, and the wound will rapidly heal. Drive the blade in lengthwise, about two inches, and quickly withdraw it. The gas from the fermenting contents of the stomach will escape and give immediate relief. Sometimes a goose quill is put in to convey away the gas that does the mischief. There may be remedies, as pulverized charcoal, soda, or ammonia, that have a chemical effect in reducing the bloat, but if the animal is suffering acutely, the knife alone will give relief quick enough.

ORANGE GROWING.

Mr. G. W. Lyle, Palatka, Fla.—It seems to me that the gentleman from Daytona gave a somewhat rose-colored statement of orange growing in Florida. It is thought that the entire number of full-bearing trees in all East Florida is less than 7,000. During the last five years there have undoubtedly been planted along the St. Johns and its tributaries more than 100,000, and of these not one in ten is to-day alive. A very few men, having some money, who work hard, stay here the entire year and devote their time to a few hundred trees, rarely more than 500, are now in a fair way of possessing an orange grove at some future time. Let us now examine the statements of the probable profits of such a grove. Mr. Day tells us: "It is safe to assume as a fair average of a grove fifteen years old 2,000 oranges per tree, and that these are worth upon the tree, the buyer to pick them, two cents each." But if we turn to The Florida Gazetteer, published by J. M. Hawks, M. D., 1871, we find the principal and important groves of the Halifax and Indian Rivers mentioned thus: "Lutton's grove, 600 to 800 trees in bearing; average crop, 100,000 or more. Dummit's grove, 1,300 trees bearing. He has had a crop of a quarter of a million." In the most favorable case, the yield is less than one-tenth of Mr. D.'s safely assumed average. Respecting the price, these Indian River oranges have been offered to purchasers each of the past four or five years at one cent at the grove, which cuts Mr. D.'s estimate down to $200 per acre. Even at this moderate sum, it is not a safe estimate, for it is well known that the scale insect, notwithstanding all attempts to stop its ravages, has completely destroyed the crop for the next two years of this celebrated Dummit grove, just as thousands of trees were destroyed all over the State some twenty or more years ago, in spite of all the labor and remedies that were applied. To show the reliability of the newspaper reports published in our midst, take this case, as it had a pretty large circulation: "The crop of the grove on Little Lake George sold for over $1,400 net." The truth was, the crop the year spoken of sold for a little over $400 gross, not quite enough to pay expense of caring for the grove. It is proper to say, however, in concluding the subject, that orange groves, well located with regard to climate, soil and access to markets, offer a fair reward to well-directed, intelligent labor. The Hart grove, at this place, seen by Mr. Day and pronounced in excellent condition, is over forty years of age. I am told it has never produced a crop of over 800 per tree. This year it is thought to have less than 300. The crop was thinned out by the cyclone of August 18.

Prof. Henry E. Colton—I have just returned from Florida, and having looked with some closeness into the orange business, can say something about these statements. I am inclined to think the gentleman errs as far on one side as many have on the other. The truth is simply this; a crop of oranges is no more certain than a crop of apples in the North. The cyclone last summer blew off much fruit, and hence there is not a full crop anywhere. This may occur again. In 1869–70, Mr. Hart realized $13,000 from his crop of oranges. If he sold them at two cents that would be 1,300 to the tree; but he gives away a great many, probably sells many more at less than two cents, and some of the trees do not bear as well as others. This would be $26 to the tree; probably the average is $12.66 per tree for each year. The orange crop of Florida is simply the same as the apple crop of the North. The question, then, is, do apple trees average $12.66 per tree? Then a great many people think the orange tree requires no work or attention. This is a mistake; yet it requires but little. The scale insect is, so far, its only enemy. Mr. Hart's grove was not greatly hurt by them before. I understood him to say his grove was twenty-four years old. What the gentleman says about the number of trees planted is true, and he may be correct about the number dead, as thousands were set out without proper care or knowledge, or care or attention paid to them after setting out. Mr. Hardee, of Jacksonville, guarantees ninety per cent, of those he sells and sets out, to live, if they are placed under his care. It is the simplest of folly to suppose that an orange tree can be treated as one would an oak or a pine; yet such is about the manner many in Florida have been treated. As to trucking, the line of the Jacksonville and Pensacola railroad is the place for that business, not the St. John's. Gentlemen near Live Oak told me they had made money there. The seasons are about two weeks earlier than at Charleston. Florida has been puffed too much, but it has many good qualities, and they can be developed by hard work. In my opinion the special crop of Florida is sugar-cane, and more money can be made raising it rather than oranges. As to transportation, every one has the choice of three routes now, and the figures given me by the A. & G. railroad were certainly very cheap. All those things regulate themselves. The St. John's is a broad stream, open to the world, and, if it pays, more boats will quickly be put upon it.

Apple-growing at the South.

Prof. Colton showed specimens from an orchard of 4,500 trees, in Calena, Alabama, planted in 1864 and 1865 by Mr. Adams, from Massachusetts. Mr. Adams informed him that he could sell all he had on hand, at five to six dollars per barrel, in Selma and Montgomery. The orchard contains, beside the apple trees, about 400 pear trees, of all the best varieties, yielding fruit, which was sold to the railroad passengers at seven dollars per bushel. The success of this orchard shows that fruit of good quality can be grown even that far south. The soil is limestone, and the growth of the woods oak and yellow pine. The orchard is fenced with a thrifty hedge of

Cherokee rose. Mr. Adams has also made some experiments with grasses, and proved that timothy, orchard-grass and clover would all grow luxuriantly; also some other grasses, heretofore supposed to be only fit for more northern climates. The land is about 600 feet above the sea level, and is as healthy as any place in the country.

Adjourned.

December 9, 1871.

Nathan C. Ely, Esq., in the Chair; Mr. John W. Chambers, Secretary.

Abortion in Cows.

Mr. Philip W. Lawrence, Spring Mills, N. Y.—"I milk thirty-six cows, and some of them are very unfortunate. Lately four dropped their calves two or three months before their time. I fed them through the fall until the last of November on cornstalks, and since then hay twice and good straw once a day. What is the trouble, and what shall be done to save the rest?"

Dr. L. D. Shepherd—Ergot in rye has frequently been believed to produce this result.

Mr. John Crane—The disease, if it can be called so, has prevailed in our neighborhood. We have not been able to explain it or prescribe a remedy. When the trouble once begins, it is apt to go through the whole herd in the course of two or three years. The best thing that can be done is to separate the cows. There is some sympathy or contagion which makes this advisable.

Mr. Henry Stewart—Abortion in cows has been a great trouble among dairy farms in New York for a few years past. The disease was little understood, and even now many dairymen are hopeless of finding a remedy. But it has been noticed that where the disease has been most prevalent it has been where cows have been fed more for the production of milk than for their constitutional thriftiness. Straw or dry hay or cornstalks will bring a cow into a poor, weak state, quite inconsistent with the draft on her system in producing a calf. If feed rich in phosphates, as wheat bran, oatmeal or cornmeal, is given to a cow in calf, the drain on her system is met, and the calf is generally saved. But in the average dairy farm a cow is fed to keep up her supply of milk, and her milk is drawn up to the last day that it is fit for use. Under such conditions there is nothing for the calf, and the cow's system is unable to supply the wants. Hence, mischief. When this tendency occurs in a dairy, it generally runs through the whole stock of cows. It has therefore been considered as contagious. But the cause which produced the effect on one is sufficient to act similarly with all, and so all are affected. Good nourishing feed is a preventive, as are also clean, airy stables, and, above all else, sufficient pure water.

Mr. J. B. Lyman—Four years ago this State gave $6,000 to some doctors to find a remedy for this malady. The doctors worked hard, went to a great many farms, asked a thousand questions, and collected great books of meadow flora, and wrote long memoirs on the subject, all to show that they had done something to earn the $6,000; but ask Dr. Carmault to-day what is the cause and cure for abortion in cows, and he will say, "I don't know." I examined his reports carefully, and from two bushels of clean-looking scientific chaff these three or four kernels of sound wheat may be sifted: 1. A cow ought to go dry about two months before she comes in. 2. While she has a calf to make, give her stuff that has bone and meat in it, such as oatmeal and wheat shorts. 3. For hay, give such as grew on high, sweet land. 4. To choose a herd of cows for milk-giving qualities alone, and to manage so as to get the greatest number of gallons out of an animal, is bad policy in the long run. Breeding for flesh and breeding for the pail ought to go hand in hand. Otherwise this, or some other constitutional weakness, will show itself.

PLOWING.

Mr. Thomas W. Nichol read the following paper: Agriculture is the foundation of all industry, and plowing is the foundation of agriculture. The crop depends quite as much on the preparation of the ground to receive the seed as it does on the nature of the soil itself. Every farmer knows that soil naturally poor often produces more than a superior soil, simply because it is better cultivated. Poor soil, or indeed any soil, may be improved by deep, thorough culture. If all our farms were plowed and well pulverized twice as deep as they are now, I do not think it utopian to believe that the quantity and value of our agricultural productions would be double in five years. Why, then, do not farmers perceive this and act accordingly? I answer that, with the implements in use from time immemorial, it was impossible to plow and pulverize deeply; and even yet it has only been done at such an expense of money, time and labor as to discourage the attempt save on the part of the progressive few. Having always been used to shallow plowing, many farmers do not appreciate deep culture; they do not understand how and why it will be an advantage to them. If they are pursuaded to try it once, and from any cause their crop is not so much improved as they hoped and expected, they immediately lay all blame to the deep plowing, and declare it a humbug and a nuisance. They judge too quickly.

To expect an old, impoverished farm or field, that has been botched for half a century, to respond at once to better culture, and produce equal to one that has always been well tilled, is about as reasonable as to suppose that a recently emancipated negro, fifty years of age, after one year of the opportunities of freedom, ought to be as intelligent, cultivated and useful as the man of the same age who has had all the advantages of society, education, culture, experience and liberty. But even those who know something of the philosophy of deep culture and its advantages do not practice it. Why is this? I think the reason is because plowing is very hard work. Deep and thorough preparation of the ground for the seed never will be generally practiced by the old system of plowing. It is too hard work. Often the seasons are such that plowing cannot be done at the proper time—they are either too wet or too dry. When a few days of favorable weather comes, and puts the ground in condition, as much of it as possible must be hurried over, and the quality of the work is almost always sacrificed to the quantity. These hindrances to deep plowing can only be overcome by the use of machinery, and by machinery, too, that will do the work easier, faster, cheaper and better than it can be done at present with the same amount of power. As every farmer, be he rich or poor, must have a plow, the price of the machine should not place it beyond the reach of the poorest. The time must soon come when we will look back on our slow, imperfect and laborious system of plowing as we now look back on flails, sickles, scythes and fanning-sheets.

I have placed before you a circular, with illustrations of a plow which I know will do good work without the aid of hard human labor, and which, I think, combines the elements of strength, durability, cheapness and adaptability to any strength of team or condition of soil, so perfectly as to be worth your consideration for a short time. The plows being made of different forms and sizes, the machine admitting the use of from one to five, and any of them detachable without affecting the work of those remaining, you will readily perceive that it can be adapted to any power and to any soil. The plows, also, when detached, can, in five minutes, be changed for use with handles and a team hitched to the point of the beam, like any other common two-horse plow. The attachment that holds the point of each beam can be moved from right to left, or from left to right, to regulate the land of the plow or the width of the furrow. The points of the beams can be raised or lowered in this attachment to regulate the depth of the plowing. There is also what is called the hinge-axle, by means of which the driver can vary the depth of the plows about five inches without leaving his seat or stopping his horses. The plows are raised out of the ground by a foot-lever, so that in turning at the corners, passing an obstruction, or driving from field to field, the driver can throw his plows clear of the ground, and at the same time have the use of both hands to manage his team. When desired, sub-soilers can be attached to each plow, which will tear up the ground any depth required. The machine will plow the hardest ground fully eighteen inches deep without the sub-soilers. All that is necessary is power; and the amount required will depend on the condition of the ground, the depth of the plowing, and the width of the furrows. The number of plows in the gang does not determine the amount of power required so much as the size of the plows. Thus, four six-inch plows will require no more power than two twelve-inch plows. If any difference, they will require less; and they will do a great deal better work. I would greatly prefer small plows, and more of them, to large plows, in a gang. I believe it would pay for all extra time, even in the use of single plows, to have them smaller; the narrower the furrow the better the plowing. The objection is, the amount of time it consumes. This objection is taken away when we work plows in gangs. We can put on as many small plows as we have power to draw. With this machine, whether we use one plow or five; whether they are each six inches wide or fifteen; whether we plow six inches deep or two feet, the labor of only one man is required, and he has little to do but drive his team.

As to the economy of the use of the implement, I will present a few points:

First. For use as a common two-horse plow, it costs no more than a wooden-stocked plow of equal quality and strength. Being made entirely of iron and steel, no trouble, delay or expense is ever caused by the breaking of a beam or handle. When the share and mould-board are worn out, new ones can be put on the old stock for just half the price of a new plow. As this can be repeated from time to time, when these parts wear out, it is evident that, in a few years, it will be a saving to the farmer worth noticing.

By the use of the gang-plow, we save the labor of one man for every plow attached after the first one; and the saving of leg and arm-muscle, we leave each man to compute for himself. I have heard farmers say that three horses, working abreast, to a gang-plow, are equal to four attached to two separate plows, and that they will do quite as much work. I have also heard them say that they have plowed five acres per day with four horses and a gang-plow, when the same four horses would not have plowed more than four acres if attached to two separate plows. A little time is saved in turning, and a man will make his team walk faster when he has only to ride and drive, than when he has to walk and hold a plow. I do not believe that it is any easier for the horses, as some say; but that you can get more work out of them, I do believe. Another feature that may sometimes prove valuable is, that an old man or a little boy, who could not follow and hold a plow, if he can drive the team, can plow as much and as well as the strongest plowman.

By the use of this machine, or a similar one, I am quite sure the expense of plowing may be reduced at least one-half. Mr. Greeley estimates that his plowing costs him nine dollars per acre. He uses two yoke of oxen, two men, and one plow—a man to hold and one to drive. They plow two acres per week. He counts nothing for the oxen, but nine dollars for each man. If Mr. Greeley had a machine of this kind, he could dispense with one of the men, and that would reduce the cost of *his* plowing just one-half. But Mr. Greeley's oxen move about as fast with a heavy load as with a light one, or even none at all. I believe, with two good plows in a gang, one man, with these same cattle, could easily plow three acres in a week, which would make his plowing cost him only three instead of nine dollars per acre; a reduction of just two-thirds.

Or, take another illustration. In the west, we consider two acres a fair day's plowing for one man and two horses. Say the man's labor is worth $1.50 per day, and that of each horse worth seventy-five cents, and it will cost three dollars to plow two acres—$1.50 per acre. This may seem to you a low estimate; but plowing, such as it is, is done at these rates in many places. Now, one man, with three horses and a gang of two plows, will plow four acres in a day. At the same rates for men and teams, this will cost $3.75, or ninety-three and three-fourths cents per acre, against $1.50 the other way. Or, if one man uses four horses, and plows five acres, the cost will be $4.50 for five acres, or just ninety cents per acre. This calculation is made from plowing done as it is, not as it ought to be. You cannot plow fifteen or eighteen inches deep for such prices; but the comparison will hold good, if applied in both cases to deep plowing. When we consider that three plows can be used without adding the cost of another man, and that in many cases they will be used, I think it is not an exaggeration to state that the cost of plowing, on an average, may be reduced at least one-half by the use of this or a similar implement.

As to cost: one of these plows can be made of a size to suit two ordinary horses for about fifty dollars. It would have two small plows attached. The advantages would be, that it relieves all human labor; that it will plow hard ground that could not be plowed with the plows in general use; and that it will plow any depth required not beyond the strength of the steam. Or, if a man has a three or four-horse machine, with two large plows, he can convert it into a two-horse one by simply leaving one of the plows off. Such a plow would cost about seventy dollars. With three plows, each one being large enough for two horses, it would cost eighty-five or ninety dollars, and so on. A gang of five plows, that could be drawn by eight horses, and plow, say ten acres per day, would cost probably not more than $140. This plow, however, could be changed by leaving off any number of the plows, so as to use it with four horses or two, or any number. Of course, subsoil attachments, rolling cutters, handles, etc., would be extra.

Something else than horse or ox-power we ought to have, and I think we soon will have, for plowing. But if steam plows were even now perfected, it would require several years to bring them into general use. A plow, adapted to the present kind of power, that will do the work easier, cheaper and better, is a practical thing. This machine, which I represent, has been in use for five or six years. Imperfect, clumsy and heavy at first, as all machines usually are, but with late improvements it is light, strong and convenient, and much cheaper than any plow of equal merit that I have seen. Several thousand of these plows, for use singly, have been sold in southern Illinois, and several hundred in gangs. They were all warranted, and to be taken back if they did not give satisfaction. So far, not one has been returned. A few have been sent to other parts of the State, and to other States, to be tested there, and the reports are equally favorable. It is the intention, now that they have stood a fair practical test, to introduce them to the farming public.

These remarks were regarded by the Club as very sensible, and it was hoped that the inventor would soon appear who could supply the deficiency indicated.

PROSPERITY ON THE PRAIRIE.

Mr. Horace Martin, Corning, Mo.—I have been over a great deal of the land west of the Mississippi river, and I have not seen the place where as large a body of as good land, with advantages of a healthy climate, good water and plenty of timber, can be found as in the three north-western counties of Missouri. Here we have a black soil from six to ten feet deep; and wheat, both spring and winter, corn, barley, tobacco, hemp, grapes, and fruit of all kinds attain their highest perfection. We gathered strawberries and raspberries by the pailful that grew wild; and in the timber the wild plum, crab-apple and wild grape, festooning from every tree, yield their fruit spontaneously to the new settler, while the stream that empty into the Missouri abound with fish, and for three months in the year swarm with wild fowl, such as some five or six species of wild duck, wild geese, brandts, pelicans and swans. Wild lands can be had from six dollars to ten dollars an acre. I paid ten dollars little over two years ago, and May 20, 1869, I turned my first furrow. I made no sod corn, for I had no fence. I have two boys, eighteen and twenty-two years old; I am past doing much only chores. Since that time these two boys have made, split and hauled the rails for over two miles of rail fence, staked and double ridered about three-fourths of a mile of board fence, put under cultivation 150 acres, and have in 110 acres of corn, that is at this writing from eight to ten feet high (July 12), and in silk; the remainder, mostly in barley, about ten of wheat and oats, now nearly harvested, and in doing this, have not hired a single day's work, except about four days, a hand to work the dropper on the corn-planter. If no hail-storm or frost occurs for the next two months, we shall have 8,000 bushels of shelled corn, have barley stacked enough to make 6,000 bushels. The fly injured my spring wheat, so I don't count on that. Now, where in New York, Pennsylvania, or in the New England States, can two boys, in two years, take 150 acres in the state of nature, fence it and put it in a good state of cultivation? In one field, containing 145 acres inside the fence, we can go from one side to the other, in any direction, with a reaper, or gang-plow, or corn-planter. It is as level as a parade-ground, not a twig or bush as large as one's finger, or a stone or pebble as big as a pea in the entire field; with a soil ten feet deep, and the plow, while plowing, runs right down to the beam. Now, there are 500,000 acres of land, equally as good, within the limits of these three counties, that can be bought at from six to ten dollars an acre. Good oak fence-posts, six cents apiece; cottonwood fencing, from $1.50 to $1.65 per 100; a good market for all that can be produced, two railroads traversing them north and south, and the Missouri river on the western boundary, a delightful and salubrious climate, an abundance of timber, limestone everywhere abundant, coal in inexhaustible quantities, good water from twenty-five to thirty feet, springs abundant. We are about midway between the two great channels of emigration—one across the Missouri, at Omaha, the other at Kansas City; and those seeking locations, hardly ever get this distance from the usual course of travel; hence thousands are rushing to the trackless plains of Kansas and Nebraska, where an emigrant sometimes is obliged to go ten miles to get a stake to lariat his team while they feed, saying nothing about fire-wood, fencing or building timber. Since the 20th February, the day we commenced plowing this spring, we have had only two days entirely cloudy, twenty-nine days half-clouded, the rest fair; four showers, in which over half an inch of water fell, thirteen showers of less than half an inch at a time. Last winter we had two days that a sleigh could be used to haul a load. The ground was frozen about two months; most of the time the surface was dry and dusty. Cattle usually winter in the corn-fields till the frost leaves the ground; then they are shut up, and, till grass starts, depend on straw and hay-stacks. At present, hay, to an ulimited amount, can be had on the prairies free; each one cuts when and where he chooses. Cows are worth from thirty-five to forty dollars; good choice teams of young horses from $300 to $350, and from that down to $120, according to quality. Building materials, dressed pine shingles, laths, doors, sashes, and blinds are as cheap as in any of the towns in the interior of New York.

Mr. Curtis — I hope that the gentlemen who represent the press here will not cut down this letter. I am one of the people, and as an honest farmer, with hayseed in his hair and an odor of the barn-yard about him, I must be allowed to think that these descriptions of localities, when they are so evidently conscientious, as this one seems to be, are not the least important part of the record of our doings.

SWINE HERD-BOOKS.

Mr. F. D. Curtis — When we take into account that at least thirty million hogs are slaughtered annually, and that the number is rapidly increasing each year, the importance of doing anything to advance this great domestic auxiliary is apparent, and a swine herd-book, in which a record of all the bred hogs or families in this country may be made, is, in the estimation of many farmers, required to protect the buyer of thoroughbred swine. If we do not have a herd-book, then we ought to have a record of the points and peculiarities which characterize the different breeds, so explicitly and carefully prepared that it shall be authority, and constitute a standard by which buyers and breeders, as well as judges, are to be governed. We have at present no such standard in print, and the whole subject of breeds and what is thoroughbred, and what marks and features are necessary to constitue a pure breed, and in several cases the correct names, are almost wholly open questions. Under this loose system of breeding and sale, grade animals are sold as thoroughbred, and inferior and impure stock are made to increase our herds, bearing a fictitious title, thus causing disappointment to the purchaser as well as loss, and filling a neighborhood or a township with distrust and checking the tide of progress. There is no remedy for this, except by the adoption of a standard authority, which should be done by the honorable and intelligent breeders of the different varieties in the several States. In order to accomplish this desirable end, as a preliminary work, I move that a committee of three be appointed to correspond with swine-breeders, with a view, if thought practicable, of calling a convention to consider their interests, and to take such action as may be deemed advisable.

This motion was carried unanimously, and the Chairman appointed as such committee, F. D. Curtis, of Saratoga county, N. Y., Lucius A. Chase and Mason C. Weld, of New York city.

Adjourned.

December 26, 1871.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Flax as a Crop.

Mr. J. S. Somers, Marshalltown, Iowa—Would it be profitable to raise this textile in the west, and if so, how much per acre? How many bushels would be a fair yield per acre, and how is it threshed? Will a common threshing-machine break up the bowls? Ordinarily, about what price should it bring at an oil-mill?

Prof. H. E. Colton—Growing flax for the seed only would hardly be profitable in most sections, though it is done on some rich lands. The seed should generally bring, per bushel, three times the wholesale price of the oil per gallon. A very large share of that used by the

New York mills is brought from Calcutta. There are mills in St. Louis and Minneapolis where this gentleman can get information as to price.

Mr. Henry Stewart—To make good fiber, the flax is pulled before the seed is ripe, and the seed broken off over a horse in which is fixed an iron blade with teeth. In Minnesota and other western States it is grown for the seed alone. The yield on good land is about twenty bushels to the acre. He should sow two bushels to the acre. When grown for seed it may be threshed in the usual way, but in that case the fiber is much less valuable.

The Chairman—It is one of the most exhausting crops he can raise.

The Secretary—When flax is raised for the seed, the straw loses its value for manufacturing purposes. In some parts of the west, agents are sent out who supply farmers with the seed at a certain price, agreeing to take all the seed they raised. I know of an agent who informed me that he added to the agreement that he would take all the flax straw at ten dollars per ton. This straw he rotted by a steam process, and then manufactured it into bagging, used by the planters for their cotton bales, which he can sell less than the imported article. Flax is an exhausting crop, especially when the oil-cake is exported. The business is now enormous. A friend informs me that his whole time is taken up in traveling from Boston to New Orleans engaging freight for this cake. The quantity exported was, according to his figures, so large that I could hardly credit the assertion.

Mr. F. D. Curtis—The growing of flax, unless near a flax or linen-mill, is not profitable, as it is a risky crop. Growing flax solely for seed will not pay. It is an exhaustive crop, and the straw is dangerous feed, and worth but little except for manufacturing. Stimulated by a good mill in the vicinity, at which a good price may be obtained, and plenty of help on the farm to pull it and handle it, it might do to raise flax, but under ordinary circumstances the receipts will not equal the expenditures.

RAISING POULTRY.

Mr. Gerry Valentine, Hammonton N. J., forwarded the following figures regarding his poultry experience for the year ending November 1: "I had twenty-nine hens, which have laid 4,364 eggs, and if my arithmetic is right, they averaged 150 and a fraction over. I raised sixty chickens, worth thirty dollars. The eggs averaged twenty-four cents per dozen, making $87.28 for eggs. Add thirty dollars for chickens, and you have $117.28. The cost of keeping I am not so sure, as the account has not been kept so exact, but about fifty-five dollars.

The hens are a mixture of several breeds, but none pure. The white Leghorn and Brahma predominate. The feed has been corn and wheat screenings, with some hog cheese and wheat middlings, pounded oyster shells, etc."

Mr. Edward Lloyd, Hartford, N. J., alluded to the statement of Mr. Ketchum of Pennsylvania, who said that "capons in Bucks county frequently weigh seven pounds," and added: Hereabout they frequently weigh twelve pounds, and I have seen whole lots of 100 fowls average eleven pounds. This, you see, is quite a difference; but even at that we think they don't pay, as we have to keep them till February or March, and they eat their heads off by that time. There is no sale early for them. Why, over at the Farmers' Club at Mount Laurel, December 17, we had a pretty show; to exchange, to compare stock, and to select. Roosters there weighed from seven pounds to nine, and blooded birds from eight to ten and a half pounds—dark Brahmas and buff Cochins, while we had pullets there that weighed seven, seven and a half, and eight pounds; old hens, ten pounds. So, you see, our friend from Bucks county is far behind old Burlington county, N. J., as regards size and weight of birds.

Mr. F. D. Curtis—There is no advantage in this forcing of poultry to an enormous size. As a rule, medium-sized fowls are the most profitable on the farm. The opposite opinion is inculcated by the poultry society and the fancy-stock men, and herein they do wrong. These large fowls are inert, poor layers, and their multiplication ought to be discouraged. Bigness is of little value compared with egg-producing and hardiness.

The Chairman—I agree. I had rather have for my use three medium-sized fowls than three of the ten-pounders. Of breeds, I place Black Spanish first, and Polands immediately after.

Dr. E. Ward Sylvester—It is only possible to have a continuous supply of eggs by continuous crossing. By changing roosters each spring and selecting a different breed I have no trouble about eggs. I cross a Brahma on a Leghorn, and a Dorking on that, and so on, getting a new style of rooster every year.

Mr. D. B. Bruen—After all, there is more in keeping than in breeds. Those who have great egg-stories to tell take great care of their fowls. Farmers generally let hens shirk for themselves.

Mr. F. D. Curtis—Which is all wrong. And, again, farmers keep the same old mothers too long. They should frequently be off with the old stock and on with the new. There must be a frequent infusion of fresh blood and young blood.

Mr. Mason C. Weld—In order to be successful with poultry, farmers must adopt the same practices which obtain in the successful keeping of other stock. Select thoroughbred males, and select these with a view to the end desired. If eggs are wanted, take the male of a breed which is known to be a laying breed, and so for table use. The grades thus produced possess these qualities to a very great degree.

In one of the letters an allusion was made to gapes. This disease is occasioned by little red worms in the throat. If the worms are numerous they choke the chick to death. They can often be killed by brushing out the throat with a feather dipped in kerosense or some other oil, as melted butter; but there is danger of injuring the chick in this way. The most effectual prevention is to sprinkle the yard with carbolic acid and water and give a little of this acid in the water they drink. When the disease is bad, the yard should be changed and the hens put on ground entirely fresh.

Gypsum and Farming in Virginia.

Prof. Henry E. Colton presented several masses of rock-plaster brought by him from the south-western corner of the Old Dominion. The samples came from the mines of the Holston Salt Company. They sell it there in lump at four dollars per ton, ground at eight dollars, and make a fertilizer of one-half salt, one-half plaster, at fourteen dollars per ton; and another, one-half plaster, one-fourth salt, one-fourth wood-ashes, at twelve dollars per ton. 10,000 tons of plaster were sold from the mines of this neighborhood this year. Three years ago the trade was unknown. The vein or bed of plaster exists along a section of a country many miles in extent. It is sent south and east by the East Tennessee and Virginia railroad, a branch of that road running parallel with the bed for several miles. The farm on which this plaster is found is owned Mr. G. W. Palmer, formerly of Syracuse, N. Y. Mr. Palmer has 11,000 acres of land, about one-half of which is cleared. The peculiarity of the soil of this section is, when the trees are deadened or cut down, blue grass immediately commences to grow, showing that it is indigenous to the soil. Mr. Palmer has 2,400 sheep, Southdown, and that crossed on common; 160 cows, 120 calves, 130 yearlings, and 140 horses and mules. He has seventy of the cows in a dairy-farm attended by a man he brought from New York. They make butter the greater part of the year, only making cheese in midsummer. This year he made 21,000 pounds of cheese, which netted him fifteen cents a pound. He furnishes the cows, land and all buildings, etc., and gives the dairyman half the net price for his labor and his hired help. The butter sells at forty to forty-five cents per pound at his railroad depot. It is sent all over the south. He furnishes his dairyman and help first-class frame cottages, neatly painted. He generally sows rye to winter his calves, and feeds his cows on turnips, wheat straw steamed and cut up with meal, and on corn-fodder on the stalks, spread in a pasture-field. He had twenty-six steers fattening for market, and had sold mules at $125 and $150. The mules and horses find market at home; the cattle are sent to Baltimore. His sheep average four pounds of wool each; this he sold unwashed in New York at forty-two and a half cents per pound. This is not a section where one can live without work, but it is a fine, healthy country, which yields good return for labor, and Mr. Palmer considers it the best country for stock that he ever saw.

The Closing Year.

The Chairman made the following remarks: This being the last meeting of the Club this year, you will pardon me for using a few minutes in remarks that may be found timely. I don't propose to review at length the doings of the Club for the year now closing. Through the press, each week, our proceedings are placed before, it is estimated, more than one million of readers; and I wish, in behalf of the Club, to thank those gentlemen of the press for the faithful manner our doings are reported, and for the valuable aid they render personally to the Club, and my thanks for the uniform kindness shown to the president of the Club. Nor can I omit to add, that to several members of the Club we are deeply obligated for the most valuable papers read from time to time; to add their names would be repeating what I have more than once said on occasions like the present, and yet I feel that I should not do right to omit to call to your recollection our indebtedness to that most able man, Professor George H. Cook, of New Jersey. We owe much to some of our correspondents, who give us a carefully detailed statement of their experience and of such matters as they think will be a benefit to the Club and the readers of its doings. Let it be well understood, that the Farmers' Club of the American Institute wishes to receive, as well as to give, information. The Club is under great obligation to a goodly number, for flower seeds sent for distribution, and especially for 6,000 papers sent by the Rev. Samuel Griswold, Old Saybrook, Connecticut. No other evidence need be furnished me to prove that he is fit and ripe for the kingdom of heaven. To all I say "be not weary in well doing, for in due time ye shall reap if ye faint not." I did intend to say something about the planting of trees, shrubs and flowers, those ministers for good, forever preaching and showing the goodness and glory of God. So long as they point heavenward, I entreat all to plant and cultivate them. You cannot fail to be influenced for good in so doing. I must urge you to be the friend of birds. Let no man insult his Maker by putting his wisdom against the Infinite, and, to correct the mistake of heaven, needlessly, wantonly and cruelly kill, destroy and maim birds, nor be selfish and mean enough to begrudge them their food while he asks for and receives his daily bread. Also, I beg you to use your best and constant efforts to prevent the abuse of animals — those dumb but faithful servants, that do so much to add to the wealth and comfort of all. As to the present state of agriculture as a business, and the inducements the country holds out to all the young and industrious, I have requested Mr. J. B. Lyman to give us a summary statement.

Review of the Agricultural Situation.

For a quarter of a century, the influence of this Club has been felt in circles that grow wider year by year, and the uniform bearing and drift of that influence has been to discourage the perpetual plethora of the trading and book-keeping class, and to encourage young men and middle-aged men, in fact all whom cities have not enriched, to become farmers. Every year letters reach us from those whose love of rural life was stimulated by our weekly talks, and who, greatly to their advantage, abandoned these pavements, and from being dependent consumers rose to the dignity of independent producers of the staple articles of life. I propose, on this closing session of the year 1871, to review the agricultural situation, and in view of the facts and the prices of to-day to judge whether it is still proper and wise to encourage a perpetual hegira from the Babels of traffic and speculation to the peace and plenty and calm of the country. We are generally met at the outset of such a discussion by a man with a pencil and paper who asks us to prove, by dollars, dimes and cents, that farming as an investment will pay. He will take, for instance, the sum of $15,000, which, at seven per cent, gives a little over $1,000 a year at simple interest. His question is: suppose I take that $15,000 and invest it in the land, tools, stock and fertilizers required by a farm of the average size and fertility; suppose I hire a competent head man and put him in charge; is he sure, after paying taxes, labor, seed bill and all, to report the place at the end of the year in as good condition as it was when he received it, and to hand me $1,000 net profit? I answer, no. Judged by this sharp standard of Wall street, I say to a man who requires of me the surest way in which he may receive $1,000 a year, from a $15,000 investment, keep clear of farming; you will never succeed if you approach the business in this way; keep your funds in five-twenties, go to a cheap boarding-house, and be as happy as you can on your thousand.

It is a pet fancy with many, that square old-fashioned farming won't pay, but that there are by-ways of tillage, novelties, improvements, untrodden paths to sudden fortune. For instance, a salesman at Stewart's has never met me for seven years past without asking what I think of sheep raising in western Texas or in Colorado. "He doesn't believe in farming as a general thing; it's hard, dirty work; you wear rough boots and have coarse hands; you go without gloves and pavements and daily papers; a cow-stable has an ill perfume, and a worn plow-horse is a dull roadster; but he believes that if he should take $1,000 and go to the far west or south-west and embark in the sheep business, he would soon make a fortune." Another nurses the same romance about orange growing in Florida, or the wine business in California, or spring wheat in Minnesota. The truth is that the fewest number of persons succeed on a single specialty, and these few came up to that specialty by degrees from the common level of general farming. The best farm for an unskilled farmer to buy is a tract that will support two cows, two horses, two pigs, and a gang of poultry the first year. If it is too small or too poor for that, there is little thrift in owning such a tract. From this as a basis, let him expand his system in any direction in which he is drawn by the advantages of his situation. He may become essentially a truckman, or a small fruit-culturist, or a grain farmer, or he may greatly increase his stock, and take most of his money from sales of flesh or wool, or butter or milk. Within a hundred miles of this city the farming situation is in brief as follows: The increase in the production of southern fruits and vegetables has seriously damaged trucking; the great crops of corn in the prairie States have made pork too cheap to leave any margin of profit east of the mountains; but on the other hand, strong and permanent meadows yielding two tons per acre are a profitable possession. They give more profit, with less risk and less outlay for labor, than any other branch of farming. Improvements in tools have done most for the hay crop; and a green and clumsy farmer can hardly fail with ordinary industry to master the difficulties of a hay-field. Our hay crop is harvested at a cost of from fifty cents to $1.50 a ton. It is easier to keep up the fertility of a meadow than of a grain field or a truck patch. Such mineral and condensed manures as lime, ashes, plaster and bone-dust will make restoration to meadow lands, and enable their owner to sell hay, without selling his farm, by the ton. But to cart hay to market and restore nothing to the meadow, is ruinous policy. In attempting to work without grasses the farmer is lifting without a lever; he is pulling a load with the weight on the hind wheels; he is cutting with a dull saw; he is chopping with a broken ax. With grass as a basis, grains, fruits, roots, quantities of flesh, all the triumphs of our art are possible. To sum up, I would say, first, to all who propose to buy farms east of the mountains, look sharply into its capacity to grow nutritious grasses, and learn what means may be available for fertilizing such meadows. You may convert that grass into milk and its products, into flesh, into manure for grains, or you may sell it by the ton, according to the facts of your particular locality. I would not advise any one to talk about farming as his business, unless he has twenty acres of good land, a surface that can be made to give two tons to the acre. The greatest thrift and profit I have seen among the eastern farmers is on tracts of about 100 acres.

West of the mountains, and especially on black lands, the conditions of thrift are different. While eighty acres give a sufficient homestead, and all who can should secure such a tract as the foundation of an independence, I consider 320, or half a section, as none too large for a man of force and brains, who proposes to thrive and win competence at farming. If I were to spend $3,200 in western land, for farming purposes, I should go where I could get 320 at ten dollars, rather than stop where I must give twenty dollars and get only 160. The difference in prices in roads and in society may all be overcome; but after a country is settled, ony remarkable thrift will enable a man to double or treble his area. On the other hand, for the average farmer, 320 acres is enough; and he can do full justice to this area more easily than he can to a farm that numbers its fields by sections and half-sections.

In these remarks I have supposed that a person has considerable capital — as from $5,000 to $10,000 — to use in establishing a rural home. Let us for a moment consider the attractions farming now presents to a poor man: In the west, he gets eighty acres for office expenses — *i. e.*, for about fourteen dollars. If a soldier, he gets 160 acres in railroad belts, and 160 beyond those belts. He can buy lands well situated, near growing stations and somewhat improved, for ten dollars an acre; he gets unimproved, well situated, at five dollars, and more remote at three dollars an acre. The industry that would give him just a living if he continued the life of a hireling, will, in ten years, make eighty acres, that cost him perhaps nothing, and perhaps $400, worth from $1,000 to $2,000. This is the reasonable and average expectation on western farming lands well chosen. Now, in what way can a day-laborer, in old communities, set before himself any reasonable hope of winning a fortune of $1,500 or $2,000 in ten years? Now, let us look at it in the east: If a poor man has special knowledge and skill, if he can raise hot-house grapes, and make 15,000 good hard head of cabbage by the 10th of July, he can afford to go in debt for a patch of land near a city, and by hard toil, early and late, he may work off a mortgage, and find his land doubled in value as garden land, and doubled again from the growth of the town near which he bought. Some have made fortunes in just this way. But it should not be attempted by a moneyless man, except, on three conditions: 1. He must be an expert gardener. 2. He must work like a slave. 3. The choice must be good.

Here we are met by the question, what land is in fact the cheapest, rich soil near a city, selling at from $200 to $1,000 per acre, or fertile prairie near the Platte, or the Kaw, or the Republican at $1.25. It depends, I answer, on the use a man makes of it and the time he proposes to hold it. Looked at as a speculation, as a temporary investment, I would say buy a patch near a city, and allowing 100 loads of manure annually to the acre, raise celery, cabbage, lettuce, beets, and onions. Looked at as a winning of a permanent home, I would say, go more than a thousand miles westward and buy half a section, if he can, and eighty acres if he can no more. While presenting the case in a purely commercial light, and every man should take that view, with others, I protest against a judgment against farming adventures because they do not always pay ten per cent. Ten thousand business-men are paying from $100 to $3,000 a year to life insurance companies, and the ruling motive is to secure peace of mind as to the future of loved ones that would be stripped by death of their sole protector. Their course is a wise one, and life insurance companies rob death of half his terrors; but suppose the same money were as regularly applied to securing the fee simple to a modest yet productive home? On a farm some things are a certainty; there can always be bread enough and milk enough, and an abundance of some sorts, perhaps full variety of fruits. With unwise management even, and irregular industry, the wants of the body can be met;

there may be enough of wool and wheat and flesh and fuel. Rent day has no terrors; a landlord is not a lion in the way. With thrift and good management a farmer's condition is equal to that of the average tradesman, artisan or professional man. He is superior to the hot rivalries of cities; there are hours in every week, there are whole weeks in midwinter, when he has all the time he needs for filling his memory with important facts, and lifting up his spirit by high views of truth and nature.

If in time past, as a Club, we have urged the claims of the country, and begged the young men who earn more than enough to pay their board to be sure and buy land with their surplus, that advice was never more pertinent than now. A wave of migration rolls steadily westward, settling the country at the rate of fifty miles a year, and will very soon cover every desirable quarter section in the Missouri Valley and the no less fertile land upon its tributaries. While we hesitate, each acre becomes, on an average, a dollar higher in price a year. The land you could buy for five dollars last year, will command seven dollars before 1873. Those that are now young will live to see a state of society in which one class will be counted above all others fortunate, secure in their rights, and strong in their position; namely, those who had the forecast and the thrift to put four score or more acres of this free, fertile American soil in fee simple under their feet.

Adjourned.

January 2, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

DEATH OF MR. JOSEPH W. GREGORY.

The Chairman announced to the Club that our associate, Joseph W. Gregory, was dead. His earthly labors were terminated; a short time since he was stricken with paralysis. He has already joined that great, silent procession; and on the first day of the year, he had, as it would almost seem, been selected to head this silent column, whose numbers are being hourly increased by sickness, disease, casualty, and even the cowardly hand of the assassin. It is due to our departed friend that we should acknowledge, here and now, that we have received much at his hands, and are laid under lasting obligations to him for many things. He had traveled extensively, and gathered up useful information wherever he went, which he was ready to give to others. He was of a firm temperament and plainly expressed his views, and if his argument did not upset his opponent, his ever-ready sarcastic wit often discomfited. I had great respect for him while he lived, and I honor his memory. I offer for your consideration and adoption the following resolutions:

Resolved, That, in the removal by death of Mr. J. W. Gregory, the Farmers' Club, of the American Institute, has lost a most valuable member—one who was ever ready to meet and discharge fully his duty.

Resolved, That while we deplore his sudden death—stricken down at one stroke by the angel of death without warning, and taken at once to his eternal home beyond the clouds—we bow in submission to the will of Him who doeth all things well.

Mr. J. B. Lyman—I indorse every word that Chairman Ely has said. I would add, that few men were inspired with a more unselfish public spirit. Soon after the war, Mr. Gregory traveled over the south, urging upon the people of that section, especially of Texas, the importance of diversified industry, and urged them, particularly, to the culture of ramie and castor bean. He devoted much time to this labor, and had never realized any pecuniary benefit therefrom. The people of Texas and Florida will hear with regret of the death of one so earnestly devoted to their interests. In his early life, Mr. Gregory was a farmer of some wealth and standing in England, and, coming to this country, he brought with him, and freely imparted to others, much valuable information.

Mr. P. T. Quinn—One point in Mr. Gregory's life has not been alluded to. He was one of the founders of an establishment now known all over the world. He referred to the Wells, Fargo & Co.'s Express.

Mr. F. D. Curtis—Mr. Gregory was of an unselfish and genial nature. He was one of those men we rarely meet with, who never think of their own interest first.

Prof. H. E. Colton—Mr. Gregory was one of a class of men who are ever the pioneers of civilization, and the leaders in all great enterprises, and, like that class, he died poor, while those who came after him made fortunes. As the founder of the great express company, he at that day handled more gold than any other man in the United States. By nature he was warm-hearted, unselfish and impulsive. He had his faults, but there was no meanness in him. He was a man we could ill afford to spare in this generation, when so few think of anything other than money-getting.

The resolutions were unanimously adopted.

WINDMILLS.

Mr. C. A. Brown, Monerville, Ohio, inquired if it is feasible to use wind as a motive power, and, if so, what would be the probable cost of a four or six horse power?

Dr. J. Ware Sylvester—At Syracuse a windmill pumps all the water for the railroad trains, and works well.

Mr. Briggs—When I visited the Pacific slope I found windmills scattered everywhere, particularly in the Santa Clara valley. They did not seem to be expensive affairs at all.

The Chairman—I think $100 invested would give the power our friend asks for. I have in mind a windmill that pumps, grinds and turns farm machinery of various sorts, and its cost was not greater than the sum I mention. Of course the rods and cogs or belts that connect the shaft of the fans with the saw or other machine cost more or less, according to the ingenuity of the farmer and the cheapness of labor.

CORN CULTURE IN KANSAS.

Mr. S. French, Silver Lake—I am located on the river bottom land, deep, mellow, and somewhat sandy, Experience has proved that deep plowing is advantageous; but the manner of cultivation, I am convinced, is erroneous. One horse is used, and a double-shovel plough. Upon this warm soil corn grows rapidly.

In four or six weeks the roots will be two and even three feet in length. This I know from having examined repeatedly. The second time plowing, as we pass each hill, we snap these roots. I saw a neighbor at work in his corn, and he was cultivating very deep, raising his plow from the ground; roots of corn were hanging across the blades of it. Would it not be better to use some implement which would effectually clean the row and not go more than two or three inches deep?

Mr. J. B. Lyman—I saw a good deal of corn-raising in Kansas last summer. One farm that I visited was remarkable for its crop; there were seventy-five shelled bushels on each of fifty-two acres, cultivated by two men. It was plowed in the usual way, about seven inches deep, and harrowed fine. Then a light, one-horse plow struck out the rows, and a man, walking in the furrow, dropped the corn at proper intervals, and led a horse that drew a flat, triangular stone. This stone, coming right along the furrow, drew the earth in, and covered the corn and pressed the soil over the row. In cultivation no plows were used, but the surface was kept clean by frequent cultivation with a small-tooth harrow or cultivator. The earth was not stirred deeper than two inches, but the surface was kept clean. There was no manure applied. I saw no better corn in Kansas than that field; none more uniform and regular. The soil is certainly no better than the Kansas bottom, and if as much pains were taken with all the Kansas cornfields, their average might be sixty bushels to the acre.

Mr. Fuller—A piece of thick oak plank, cut in the shape named, or in such other shape as might, upon trial, be found preferable, would answer the purpose as well as stone.

Farming in Florida.

Mr. W. N. Hart, Federal Point, St. Johns River—Those of us who have come here with the determination to succeed in raising profitable orange groves, in bringing our land to a high state of cultivation, and making attractive homes, are desirous to promote the welfare of the State, and ready to welcome all industrious and energetic new-comers. As to our soil, properly drained, manured and cultivated, it will produce very satisfactory crops of anything adapted to it. I mean pine land and high hummocks. Our low hummocks need no manure, and are almost inexhaustibly rich. We do not expect our poor pine ridges to produce heavy crops without manure. The natives living on them, by cow-penning, raise good crops. Yet many northern men, unused to farming, having settled on them, perhaps in some worn-out field, have been trying to make a living without the aid of manure, muck, or compost heaps. No wonder they at last get the blues and look at everything connected with Florida as through a smoked glass. I have been digging sweet potatoes to-day on new pine land never manured. One row, thirty-five yards long, produced two bushels. The rows are five feet apart. Where I reside, the land is what is called flat-woods land, which covers most of East Florida. It needs draining and good cultivation to produce fair crops; and if one wants to raise big crops and make money, let him follow the advice of the Farmers' Club, viz.: "Keep hogs, keep hens, dig muck, haul and mix, mix and haul, draw out and spread on the land." There are some soils along the river, some heavy clay hummocks, which do not appear adapted to Irish potatoes, though they grow cucumbers to perfection. This potato seems to revel in low, mucky situations, and I have seen them grow on very poor pine land at the rate of forty barrels to the acre by a liberal application of potash. Our low hummocks produce about one hundred bushels to the acre, and they pay well, bringing a good price in New York, in May, though freights last year were one dollar and ten cents per barrel. Muck is abundant here—at every man's door, and of the best quality. I am hauling it now for my spring crops, for my vineyards and orange trees. Let all discouraged ones follow the advice of the Club about hauling, mixing, etc., and they will rejoice over beautiful crops next spring. Our weather is delightful; wind south, and mercury up to eighty degrees four successive days, averaging sixty-six degrees at sunrise. Notwithstanding the freeze of last winter, we have had several large bunches of ripe bananas, and have promise of a great abundance next year.

MEATS IN MARKET.

The paper of the day was read by Dr. J. V. C. Smith on the subject indicated in the foregoing sub-head. Allusion was made at the outset to the large consumption of animal food in our country, in England, throughout South America, and in the Orient. In the latter localities meat is not easily obtained, but the appetite for it is quite as strong as in Great Britain, on the Continent or in the United States. The demand for meat in the equatorial regions of Africa is so great that if it cannot be procured from other sources, prisoners are frequently slaughtered and consumed for food. Persons mainly sustained on animal food are unquestionably bolder, braver and more intelligent than pure vegetarians. The contrast is striking between a beef-eating English army and East Indian soldiers who subsist almost entirely on rice. A Chinese, Japanese, or Corean regiment would have neither the physical energy nor skill for resisting 200 European troops whose daily rations are beef with bread, and few or no fresh vegetables. Bread is common to both, but the real bone and muscle belong to beef-eaters everywhere. Admitting, then, as we must, on physiological investigations, that man requires animal food in order to develop the full character of the race, if put upon an exclusively vegetable diet, neither great intellectual power nor muscular activity need be expected in northern climates. The further north men reside, the more animal sustenance required. It is precisely so with a large proportion of animals in those bleak and stormy latitudes where the Esquimaux and polar bear both hunt for seals. If people who subsist principally on fish are examined by such tests as reveal their nature, they will invariably be found kindly disposed, obliging and easily persuaded. They are the most daring, fearless and implacable of foes when their rights are withheld or they are wrongfully oppressed. No sailors compare with well-trained fishermen. In the navy they always stand by the flag. The student of nature thinks he understands how it happens that such ignorant, clumsy creatures in heavy cow-hide boats and pea-jackets are so brave, generous and reliable in the phosphoric influence the brain receives from a fish diet, on which they are mainly fed from early childhood. Dr. Smith proceeded to speak of the quality of the meats sold in our markets. This, he said, is, very much of it, not of first quality. Being either too fat or too lean is no evidence of its nutritious properties, although so received. Very extraordinary processes for making animals marketable develops disease in them, which would ultimately terminate in death, were they not slaughtered before the system begins to exhibit very prominently the vital disturbance that has commenced. The liver is affected, owing to interference with the laws of digestion; lungs are ulcerated by restricted freedom; pork is measly, particularly that fed near cities. The tape-worm has frequently been traced from hogs to humans. We are the greatest pork-eaters of the present age, and eruptions, blotches, boils, tumid patches of inflamed skin on the face, pimpled noses, scrofulous enlargements of the glands of the neck, and even ulcers, to say nothing of many other internal difficulties, are thought by many learned physicians to be the direct consequence of this taste. Certain it is that Jews and American Shakers have clearer complexions, and are freer from those annoyances than any other people who have come under our medical observation. Neither of them raise swine or touch pork, which is held by them in utter detestation. There is an ingenious mode of making meats salable in our markets, which carry directly into the human stomach materials that produce various forms of sickness, which are charged to all causes but the true one. It is sausage-making. Of the process of this manufacture, Dr. Smith gave this appetizing description, which may interest country readers:

Bones of the head, joints and fragments are scraped together, after all the best of the flesh has been prepared in other forms, and chopped and compounded with pepper, salt and garden herbs, to disguise the quality of the meat, and thus death is retailed at a satisfactory profit. The mixtures thus served as country sausages are abominable. Country sausages are presumed to have been manufactured from sound, wholesome meat, with clean hands and clean vessels. But, alas, the imposition is so skillfully managed, that tons upon tons of country-made sausages are really made in New York — the scrapings of bones that should be given to starving dogs instead of being sold for human food. A building belonging to me some years since was interviewed one day, with a curiosity to ascertain what business was carried on upon the premises. It was in July; the door being open on a level with the ground, and the operative gone to dinner; it was discovered to be a Bologna sausage manufactory. A huge collection of bones was noticeable, from which fragments of tainted meat had been scraped off and thrown into a circular pit. A wheel of eight feet in diameter, the periphery studded with chopping knives, was turned, like a cider-mill, by horse-power. Sweet herbs, pepper, millions of flies and hungry vermin were ground up together, and the disgusting compound, after being moved, with barn shovels, into tubs that did not appear to have ever been washed, was finally forced into prepared intestines, offensive to every sense, to be smoked and packed for market. There are gastric inflammations, nausea, disturbed conditions of the bowels, eruptions, and, no doubt, fatal forms of scrofula, generated by sausages. There are, doubtless, many honest city sausage-makers, but how are they to be known? That old joke about the disappearance of cats and dogs, even were it true that they are sometimes made into sausages, would not, in a sanitary aspect, be as objectionable as those made of tainted scraps.

It has not been discovered that individuals, when driven by stress of circumstances to subsist on reptiles, were in any way injured. The Sandwich Islanders, in the time of Captain Cook, and the dog-eaters of China, were as perfectly nourished as they would have been on other diet.

A cat was served for me in Damascus, which I supposed to be rabbit; nor should I have known to the contrary, had not a gentleman assured me he saw the claws cut off; and, the day after, the very thought of dining on a tom-cat produced nausea. Such is the force of habit and early associations.

Should any one dare sell horse-flesh in New York, he would doubtless be promptly prosecuted; and there are medical gentlemen who might give an opinion that it was unwholesome and improper food, and perhaps detrimental to the public health; yet there were eight markets in Paris last year in which horse beef was sold exclusively.

We all consume too much meat. The public health would improve were people satisfied with having it once a day, instead of twice or three times, as thousands do, under an impression they positively require it. Public health in great cities largely depends on the kind and quality of the food consumed by the masses. Beyond question, much sickness, individual suffering, and even mortality, have an origin in a vital effort to dislodge and throw off various improper elements taken with our aliments. There is a prodigious struggle in the system, while the contest lasts, in trying to eject noxious elements which are dangerous; and quite frequently the power fails before the object is accomplished, and the patient dies.

Gourmands dwell with delight on venison which has been kept till a putrefactive process has actually commenced. It is tender in that condition, but it carries with it, into the stomach for distribution, the seeds of many aches and twinges, that the high-liver cannot account for. The longevity of the whole country is modified; and many persons would reach three-score and ten, were they not so intensely carniverous, who die before they are forty years of age.

Good food in abundance, the test of quality and quantity being a normal appetite, conduces to health and long life. Multitudes die prematurely in consequence of abusing their digestive organs by compelling them to do more work three times a day than can be accomplished without impairing the apparatus by which assimilation is performed.

If fluids of any kind are taken in faster than they can be disposed of by appropriate organs, direct disease follows. Diseases of the kidneys are greatly on the increase in this country since excessive beer-drinking has become common. Those glands whose special office is to separate, from the circulating blood, properties that are injurious to the individual, are so excessively overtaxed, they fail altogether, and death often claims a victim, who, under ordinary circumstances, by simply conforming to natural laws of his organization, might have reached the age of seventy or eighty years.

Precisely the same sad result occurs from overworking those delicate membraneous sacks and tubes in which solid food is dissolved before it can be distributed. Too much, at any time, especially if of a character requiring a greater quantity of gastric juice than is secreted when the receiving organ is very much distended, either brings on an instantaneous apoplexy, or engenders chronic derangements, which embitter life, and sever the vital cord long before the sufferer would have died, by living in conformity to the dictates of reason, to say nothing of our natural instincts, which guide safely till morbid cravings obtain the ascendency.

Civilization, with its refinements, drags many woes in its train. One of them is excessive meat eating. If more of it is taken than is required for nourishment, no one knows so well as a medical practitioner how often persons die from being over-fed. Horse-tongues are frequently sold here for buffalo tongues, and who knows the difference? The opinion was expressed that we all consume too much meat. Once a day is enough. Of all the kinds that come to the table, mutton, lamb, wild game and poultry are the safest, because they are rarely diseased. In addition to these, eggs, milk and fish afford ample materials for building up strong bodies, sound teeth, fair complexions and vital force. They carry with them into the stomach fewer disturbing elements, which injure and actually destroy life by indirect means, than much of the beef, pork, hams and tainted venison, presumed to be of a wholesome quality. Fresh fish, and the dried and smoked, are excellent human food. They all contain an amount of phosphoric material, which is admitted on high authority to be necessary for perfect mental development. Pork becomes less fit for human food the older it is, because it carries with it more dangerous properties, tainting the blood of a family through several generations. Poultry comes to maturity in a single season, and therefore it is free from objections that appertain to animals whose preparation for market actually develops some form of disease that would eventuate unfavorably for them if the slaughtering is too long delayed. A mixed diet of animal and vegetable food is necessary for man. All meat makes him irritable, intractable, domineering, and, in a rude state of society, ferocious. This whole matter, concluded Dr. Smith, may be reduced to a very few simple propositions:

1. The consumption of meats should be very moderate in this latitude. Once a day is quite as much as can be naturally disposed of without producing disturbance in vital processes.

2. Excesses in drinking are recognized as positive sources of disease and premature death, since only a few of the many have vital force enough to sustain them to old age in a career of habitual intemperance. It is quite unnecessary to dwell minutely on the injury produced in the organs of digestion by daily overloading them with more than can be appropriated. The first destroys the nervous system, the latter the complicated apparatus of alimentation.

3. To maintain the best standard of moral health, avoid, if one has the moral resolution, the flesh of old animals, fattened to meet the morbid taste of those who are perhaps ignorant of the fact that old oxen and old cows become diseased by the operation of being hastily prepared for market. If fattened a little while longer, a large per centage of them would die of chronic maladies. Supply the table abundantly with fruits. They are of incalculable value in a family. Where most freely used, fresh and cooked, there will be healthy children, vigorous in body and mind. Fruits cost less than almost any

kind of animal food, and contribute far more largely than is generally supposed in furnishing appropriate nutrition for persons of all ages from infancy to old age.

4. Substitute for beef of old, worn-out animals, made ready for human food when no longer profitable to their owners, mutton, lamb, poultry—such as ducks, geese, turkeys, chickens, pigeons, fish, oysters, and every kind of garden vegetable and fruit which a bountiful Providence has placed before us. Avoid pork, especially such as is raised near cities; avoid livers from old animals and those of calves, if bearing the least evidence of ulceration; avoid sausages, unless made by very conscientious manufacturers; avoid minced meats sold ready for cooking, and be particularly careful in purchasing salted meats, as vast quantities are saved by salt till it can be turned into money. It would be a melancholy history if we knew how many thousands of brave soldiers and hardy seamen were annually destroyed by the vilest of all rations—tainted salt beef and pork.

5. To live long in vigorous health, nothing would be lost, but much gained, by being influenced by the foregoing suggestions. They are not theoretical speculations, but results of careful observation with a view to ascertaining the laws of life in this climate. Therefore those who avoid abuses of the stomach have a reasonable prospect of uninterrupted health, an essential element of usefulness and happiness.

Mr. D. B. Bruen—I have been a pork-eater all my life, and now I am threescore and sixteen years old, and stout and healthy as ever.

Chairman Ely—But you ate pig pork fattened by yourself, and you knew what you were taking into your stomach.

Mr. A. S. Fuller—I think Dr. Smith is right as a general proposition, especially when he prescribes for sedentary men. But let a man go to the woods these cold mornings and lay up his two cords before dusk, and he could digest even those sausages made in Dr. Smith's old shop. I am a strong believer in fruits, and urge the farmers to raise more and consume more; but I can't take my own medicine. I can't eat an apple without making me sick; but if I worked hard every day at sawing or chopping, I could eat apples and sausages and fat pork and salt junk.

Dr. I. Jarvis—Fish is good food for farmers, and I wish our chairman had added the advice, that every one of them raise a supply in the streams upon his premises. This is easily done. If there is no stream, then make a pond.

Professor Nash—I have known such a pond to be supplied by the drainage from uplands. This drainage is certain to pay in an agricultural point of view, and the ponds, and possible fish production, are thus secured free of cost. The water reached by a ditch three and a half feet deep is equivalent to spring water, and very suitable for trout. Many people suppose they have no facilities for fish, because their water is not lively and cool enough for brook trout. It is a mistake. Nine farms in ten have the means for excavating and filling ponds, in which catfish, perch and eels can be produced.

A Day's Work with the Ax.

Mr. John R. Boyle, Bolton, Conn.—I consider your Club the best authority on all questions relating to practical agriculture, and would know of you how many cords of wood can or ought a man chop in a day; how much is counted a fair day's work?

Mr. J. B. Lyman—Very much depends on the age and size of the timber. Probably the easiest wood to work in is slim young chestnut from ten to eighteen inches through. In such chopping, a man who has his first kex cut by sunrise can lay up three cords, if he works as long as he can see. That is the limit of what can be done as a regular thing. If there is some oak and some hickory, and now and then a black birch with the chestnut, two and a half cords is a big day's work. In beech and red and black oak, especially when the timber is young and quite free of knots, two cords will keep the ax flying till an hour by sun. If the wood is knotty, and must be split the usual market size, a cord and a half will tire a man. The best regular chopper I ever knew was a man who would take his ax after breakfast, come in at dinner with a cord of wood between the stakes, and go out in the afternoon and do the same, and keep it up six days in a week. When chopping on a bet, a cord an hour has been cut in very free timber, as slim chestnut. I knew a man to lay up seven cords in a day, working in pine, where one blow would split a log.

Land on Cumberland Mountain.

Mr. Isaac Pittsford, Yorktown, Ind.—Is that Cumberland county land good for wheat, corn and grass; is it right for stock?

Prof. Henry E. Colton—I have just returned from a tour through those mountains; I do not call it a farming country proper; the soil is thin and soon wears out, but it is the healthiest country on the continent, and the most desirable as to climate. The business that will prosper there is sheep husbandry, fruit growing, and the production of two and three years olds for the farmers of lower lands to fatten. A railroad is going right through it, and the chance is good that land which he can now get for one dollar per acre will soon sell for five dollars.

Fertilizing Strawberries.

Mr. D. Oglesby, Washington county, Ill.—Permit me to inquire what fertilizers are best for strawberry plants in the absence of stable manure. How do the bone phosphates answer? How pure bone-dust? How plaster or lime? Is salt beneficial? How, when and in what quantities should the several manures be applied?

Dr. F. M. Hexamer—The bone phosphates and pure bone-dust are good for strawberry plants. Plaster and lime cannot be recommended unless in composts. Salt is not a special manure for them. If he cannot get stable manure, let him make a compost heap by piling up turf, mixing forest leaves with it, and using some lime to hasten decomposition. To this pile add bone-dust, a barrel of it to each two-horse load of the compost, shovel all together and work it down fine. Then make the land mellow to the depth of a foot, open a furrow and shovel it full of this compost, cover and set the plants in this enriched furrow, planting deep and pressing the earth firmly around the crown of the plant. Keep clean, and after a crop reward the plants with a liberal top-dressing of the same compost. He can get big berries only by having large plants, and they will grew only in a rich soil.

Everybody Should Have a Midden.

Mr. D. McDonald, Heislerville, N. J.—I have never had pluck to put my ungrammatical words in letter form, and thrust them in an editors's way; but having read much of the sayings and doings of the Farmers' Club, and finding in the minutes of December 5 an invitation for plain talk on farm topics, I venture a short letter on manure making. Any one having a ditch, bank, muck swamp, wood-pile, dirt, or any waste material can have a midden, and those who have never had one will be surprised at the size their pile will get to be in a year's time. For instance: The last of October we made a new midden, and if $50 will take it off these twenty-five acres the 1st of next April, then I am mistaken. How to make a midden: Select the most convenient place for house and privy, for from these two places come the life of the heap, and most of it must be wheeled or carried, while in most cases the muck, or whatever it may be, will be carted on cart or wagon. Four or five loads should be dumped together for a foundation; leave the top with a hollow in it, and into this hollow throw all soap-suds, chamber lye, refuse, feathers, and salt. If a chicken, pig, cat, or dog should die, throw it in; add wood ashes, waste lime; in fact, anything not worth saving for swill should go on the heap. The privy should be cleaned out in the fall, and well mixed with the whole pile, so that it will get well rendered by spring. A bushel or two of old salt will keep a good-sized midden from freezing, and will be found an important ingredient That nothing be lost, keep a barrel as near the door as decency will permit; and whenever any one washes let them pour the water into this barrel, and when it gets full there is no danger but it will find its way to the dung-hill.

If any one thinks that lime, ashes, fish, flesh and other ingredients, all put together, will so work one on the other as to throw on and waste their strength, let them use a little plaster, and all danger will be avoided. All kinds of flesh should be covered as soon as put on the heap, or the cats and dogs will make way with an important part of the heap during the year. Be sure to use plenty of muck if it is to be had, and you will not fail to make a midden worth many dollars during a year's time. If you think this worth publishing, I will give my experience in preparing muck.

Chairman Ely.—I like that letter. Let other farmers do like Mr. McDonald. He is a good farmer, for he is alive to the importance of saving every sort of waste matter and composting it with muck. There is no thrift so important as this which he recommends. Take a family, of say eight persons, and they can make a dung-hill in one year, in just this way, as valuable as two tuns of phosphate, costing at least $100. I hope he will write us about his muck-heaps.

INQUIRIES ABOUT TEXAS.

S. Higgins, Cazenovia, N. Y.—I have thought for a long time of going west, but am yet undecided as to the best locality in that section. I have heard a good deal about great advantages to be derived from going to Texas. I am seventeen years of age, and have been brought up on a farm. Would it pay for me, in company with a friend of mine—a man of 37 years of age—to go there, and engage in the business of stock-raising? If so, how would you proceed in commencing said business? Would it or would it not require much capital? About how much would it require? What is the best season of the year in which to start for Texas? Is the business of stock-raising there very profitable or not? Would you advise me and my friend to go?

Chairman Ely—Advising a man where to settle is like telling him which girl to marry. He must inform his mind and get the data for forming a sound judgment for himself. This next letter may help his case.

Mr. William M. Long, Veal's Station, Parker County, Texas.—Allow me to inform the destitute and homeless thousands who are now toiling upon old, worn-out lands, which compel them to observe the strictest economy to barely make a living, that there are, and always have been, sufficiently good inducements to warrant a wholesale emigration to north-western Texas. There are thousands of acres of land here that the State is now offering for settlement, which, as respects convenience to wood, water and fertility of soil, are as good as could be desired. This is the place to secure homesteads, ye starving thousands who have been rendered houseless by the late great fires of the north! It is a well-known fact that it does not require one-half of the labor here to make a living as it does in the old States; therefore we are unable to see why the destitute thousands will not use a little exertion and economy, and move west. In fact, all this country lacks for being settled up is the introduction of railroads and protection from the Indians. Allow me to assure you that all the rumors about Texas being notorious for its cut-throats and ruffians are simply untrue; no Ku-Klux; plenty of good vacant land out of the Indian range to be given away.

Mr. J. B. Lyman—If a man has money, say from $2,000 to $5,000, he can go and buy out a range and begin business at once. But if a young, unmarried man has nothing but his hands, is it not better policy for him to work and save, and go with say $500, than to venture empty-handed into those remote countries? Those south-western people deal too much in glittering generalities. We don't care to be told that Texas is the most fertile and magnificent State the sun shines on, that she is the empire republic of the sunny South, and all that. What Higgins wants to know is, how much a month he can get, how much his boots will cost, how much a day he must pay to a carpenter, how much he will give for a good span of plow horses. If he makes twenty bushels of wheat on an acre, how much can he get for it? If he drives three hundred head of four-year-olds to Abeline, how much will he pay for them in Waco, how much will it cost per head to drive them, and how much will he get in Kansas? Another question of great importance: How much does it cost to go from New York city to Parker county, Texas?

HOW TO CONSTRUCT A COAL BIN.

Mr. Mark W. Stevens, Sloansville, N. Y., stated that his coal bin, which is constructed upon a new plan, "works so well that others might like to try the method." He sent the directions to the Club, because through the Club "they are given to, and read by, nearly the whole world of readers."

It should be eight feet high, and for two tons of coal, three feet square; for four tons, four feet square; for six tons, five feet square; and for eight tons, six feet square; with a small opening at top to receive the coal. Let the floor be raised from the ground just sufficient to admit a coal-scuttle under the end, and project three inches at the place where the coal is to be discharged. Out of the lower board in the side cut a notch six inches square for chestnut coal, and eight inches square for stove; cover this notch with a door ten inches wide, that can be raised and lowered (like a mill-gate) in slats nailed on each side of the notch. The door should be wider than the passage, to prevent lumps of coal from gathering into the grooves of the slats and under the door, thus preventing it from being closed. About two feet above the floor should be a door to swing inward, for ingress when the coal is nearly out; but until then coal can, by this improvement, be drawn from a bin as easily as liquid from a spigot, thus saving time and labor and also avoiding the dust that arises while shoveling it.

Mr. C. D. Patterson, Girard, Kan., criticised as follows the statements of Mr. Hall, of the same town, who in a previous report made an effort "to answer the question as to how little money will do to go west with and make a farm on the prairie:"

I think that what he says will have a tendency to lead some inexperienced persons to think it an easy matter to open a farm here. Therefore I wish to say a few words for the benefit of "poor men with $500." Mr. H. tells you how to dispose of $475, but does not tell you how to subsist a family (if you happen to have one) on $25 until you can raise a crop (or fail to raise one). He does not tell you that your time, with two or three with you, will be required to open your farm to get it in condition to get a living, even. He does not tell you that it will cost you $100 or more to make a well. He does not tell you that all the stock you have need as much protection as in Wisconsin. He does not tell you that stock are not allowed to run at large (with no law preventing) because people shoot them on sight. He does not tell you that our markets are overstocked with produce, wheat excepted. He does not tell you how to raise the first dollar to make your first payment. He does not tell you that fully one-half of the men here will not be able to pay their interest this fall (and most of them came here with more than $500), and in fact the majority of the settlers will not be able to stay here after suffering all the inconveniences and privations of a new sttlement. A man, about to go to a new settlement with $500, should if possible have a team to go with, that will enable him to take along a few useful articles of light weight, which it will be almost impossible to get along without. And if he has pluck of the first water, and a wife that is ditto, and willing to undergo all kinds of privations, then let him strike out for a quarter section, and, when he enters his homestead, "stick." He must expect that his children will go barefoot, his wife ditto, and himself ditto. His wife will patch his clothes as they need it, as well as her own; new ones will be out of the question for at least two years. Industry, economy and perseverance are the only requisites that will make for a poor man a farm on the prairie.

Adjourned.

January 9, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Grapes under Glass.

Mr. Isaac C. Wilbour, Little Compton, R. I., expressed a desire for "some information relative to the profits and process of growing grapes under glass without artificial heat, especially by a person located a hundred miles from New York, and who must depend upon commission houses for the sale of his fruit."

Mr. A. S. Fuller—Mr. Wilbour should purchase and read "Allen's Treatise on the Grape," and "Chorlton's Grape Growers' Guide." In these works he will find cost of structures necessary and other practical information that he needs. When he has read these works and watched for awhile the market reports relating to the price of grapes, he will be able to make up his mind whether it is best to engage in such an enterprise or not. There are men who make money out of their cold graperies, but many lose money. If a man is obliged to employ a competent gardner to take care of his graperies, he will need to produce a large quantity of fruit to pay expenses, to say nothing of profits.

Plowing.

The paper of the day was read by Mr. Henry Stewart. Some time ago, he said, a correspondent of this Club asked for some information on plowing by some practical farmer, and it was jocosely remarked that no practical farmer was connected with the Club. It would be unfortunate if such an idea should go forth, and the numberless farmers looking here for practical information should be led to believe that they should ask in vain for it. Many men have undertaken to cultivate farms for the purpose of procuring a more comfortable and independent living than they could gain in towns and cities; and this Club is responsible to many of those men for the advice which has led them to make this change in their condition, and is bound to see that they do not fail therein for want of any further guidance which is needed to help them along. Now, a great deal has been said in this Club on the subject of plowing—whether it is best for the farmer to turn over the surface soil merely, and give his plants a shallow seed-bed, or to invert the subsoil ten or twenty inches in depth, as the case may be; the deeper the better, some have said. But the discussion has led to no result either in or out of this Club, and it is doubtful if the opinion of a single man has been changed. If any position has been assumed by the advocates of one view which has been found unassailable by those holding the other view, they are still like the man who, "convinced against his will, holds to the same opinion still." But to a practical man who has sufficient intelligence to give all theories due consideration, it is apparent that the true ground is still untouched, and that all the discussion has been ineffectual for this reason. A preliminary question needs to be answered why do we plow at all? Then the question should we plow deep or shallow resolves itself? Just as the question, what shall we eat? depends wholly on the solution of the one, why do we eat? Tell us why, and we can find out for ourselves, what. For the farmer plows variously to suit various soils and various crops, and has a distinct object in doing so. Different soils need different treatment, and the question, what this or that man should be recommended to do is no more possible of a general answer than what physic this or that man should take if he were sick. The conditions and necessities of soils and crops are as varied as are the ills that man is heir to. Then the question is to my mind resolved into a triplicate one—what is plowing, why do we plow, and what is the nature of the soil we are plowing? Here is matter to fill a space equal to an old-fashioned three-volume novel; but I intend merely to lay down a few points of an undisputed character, of the nature of axioms, on which those numberless farmers who look with interest on the proceedings of this Club, may build a theory for themselves.

First, what is plowing? It is a process by which the soil is cut into slices of a certain width and thickness, which are inverted more or less completely, and, so far as this process is perfectly completed, the plowing is perfect. The ingenuity of inventors and manufacturers has been taxed for years to produce a plow that will perform this operation perfectly, and when one is acquainted with the immense variety of plows in use, one can understand the importance to the farmer of perfect plowing. A field is plowed when every portion of its surface has been turned over to an even depth in furrows of equal width. As the main point in plowing lies here, too much care cannot be taken to do this perfectly well. It cannot thus be done unless the furrows are straight as well as of even depth and of equal width. It will not do to suppose that a field can be well plowed with crooked furrows. Where the furrows are crooked some parts of them must be necessarily wider than others, and those wider parts cannot be cut off by the wing of the share, and those parts are then unplowed. The furrows cannot be of even depth unless the plow is held steadily and squarely on its sole. If it is allowed to roll from side to side, the bottom of the furrow will not be flat, but will slope from or to the land side, and will make a sort of ridge, and one side of the slice will be thin. If this is permitted the plowing is imperfect. To secure a perfect furrow, two poles should be set up at the farther end of the field, in line with the desired furrow, and the plow should be driven so that these poles should be seen between the horses' heads as one single pole. If, by accident, a crook is made, the plow should stop immediately, turn back to where it commenced, and start again on the line. A little practice will enable a straight furrow to be turned with ease. Then the team must be hitched with long and short traces, so that the plow will run evenly at the proper depth; a little practice will secure this. Hip-straps should not be used. The plow must be held steadily and tightly, and not allowed to pitch and roll like a small boat in a rough sea. If a hard spot or a stone is struck which throws out the plow it must not be passed, the plow must be drawn back and the obstruction removed. In short, everything must be avoided or removed that will interfere with or prevent perfect plowing. The curse of American farming is poor, imperfect, miserable plowing; and a farmer should be ashamed to have a crooked furrow seen on his farm.

Why do we plow? Plowing has but one single object, which is to prepare a seed-bed. All other objective purposes are falsely assumed. Plowing, for instance, is never done with a view to draining or lowering the height of the water in the soil; this it cannot do. The level of the water is not disturbed by the deepest plowing. This idea never enters the head of a farmer; it exists only in that of an impracticable theorist, and yet we often hear of it. When seed is sown it needs at certain depth beneath the surface a receptacle of soft, finely pulverized earth, in which it can germinate and grow, and which is easily penetrable by the young and tender roots. The loose earth, easily permeable by the warmth of the sun and the moist air, forms just such a seed-bed as the plants need to grow and thrive in. Nothing further is needed to be done by the plow. If the plowing is perfect, this has been perfectly done, and the needs of the plant provided for. It can take care of itself as soon as the first growth occurs. We do not plow to make a place for the plant to complete its growth in; this would be beyond the power of the deepest running plow yet dreamed of. Plants push their roots far into the subsoil in search of nutriment, and, strange to say, the farther they penetrate into that region, never reached by the plow, the finer and more delicate they are, and the least able, it would seem, to penetrate the compact soil. Compact soil, I have said; but it is not compact, at least as we understand the term. In digging post-holes four feet deep, I have often had to bring soil from a distance, to completely fill the hole after the post has been set. The earth dug out of the hole has not been sufficient to fill it again when packed, even though the post has been set in it, and of course has taken up considerable room. The soil in its ordinary state, then, is not compact, but sufficiently open in texture to admit the passage of roots. Always there is a crust formed by the continued pressure of the plow sole which needs breaking up, and therefore we use a subsoil plow, or an attachment to a common plow, for that purpose only. But clover roots have been traced to a depth of fourteen feet, and in one of the experiments of Mr. Lawes, on his experimental plots at Rothampstead, in England, he found the roots of grass occupying the first six inches of soil, in a perfect mat; while at a depth of forty inches, roots were found which were as fine as the film of a spider's web. We plow, therefore, only to procure such a seed-bed as we need for the first growth of the plant, and for no other purpose, and in plowing, this object only must be considered.

Lastly, what is the nature of the soil we plow? This is a point

I have never seen considered in all the discussions I have heard or read on plowing, and yet it is a very important one. Soil is surface and subsoil, and they are of very different characters. Mineralogically, they were probably at the first exactly similar, for we cannot imagine any conditions which should make them otherwise. But, during many ages the soil has been producing vegetation, whose roots have been abstracting something from below, which has, in the shape of leaves and wood, been gradually deposited on the surface, and there decomposing has formed, or helped to form, a surface soil distinct altogether in its nature from that beneath it. Thus we have to treat, not a homogeneous soil to a great depth, but one which completely changes its character a few inches, generally, beneath the surface. What we call a virgin soil, is one where this distinction is most marked, where the surface is highly charged with fertility which has been abstracted during ages from the soil beneath. This surface soil alone is able to bear crops. If we were to remove it and plow and sow the bare subsoil we could not expect to reap crops. Then while the virigin soil is fresh and fertile we do not think of touching what lies beneath it, and if it is sufficiently deep to enable the operations of the plow to be properly performed to make a sufficiently deep seed-bed, the subsoil is left intact. But by and by the surface is exhausted, and we hear the poverty-stricken farmer told that he has another farm underneath the old one if he will only dig it up. Perhaps he has; but I have not yet seen it. I have often, on the other hand, seen the surface soil kept increasing in riches of fertility by good management; which has consisted in merely preserving the *in statu quo*, which nature left when man took possession, by returning to the soil something of what the soil has been so bountifully yielding. If we were to denude the soil of the arable surface, long years of work and much expenditure of manure would be necessary to bring it into a state of cultivation. How, then, can its condition be different while still covered with the original surface? There are exceptions, as where in alluvial bottoms a soil is very deep, but on ordinary lands the difference between the surface and subsoils is so marked that it is impossible to consider them equally fitted for the plow or to bear crops. If this is true, for what purpose then should the farmer permit his plow to penetrate beneath the surface soil into a foreign and uncongenial one?

FISH CULTURE.

Dr. Slack, of Troutdale, New Jersey, one of the fish commissioners of New Jersey, was invited by the chairman to give the Club some items of his experience in raising fish. Among much other valuable information, Dr. Slack said: In 1866, Seth Green made the artificial production of shad a possibility by the invention of his egg-hatching apparatus. This apparatus Mr. Green placed in the Connecticut river, under the most disadvantageous circumstances. He would place it in position in the evening, and during the night the fishermen would break it to pieces. After many trials Mr. Green succeeded, and in 1870 there was a larger catch of shad in the Connecticut river than ever before since 1802. It was a common remark among the Sound boatmen that the schools of shad were unusually large, and all had their heads turned to the Connecticut. What had been done for that river, Mr. Green would also do for the Hudson, but it might be two years before we should see the great result of his labors. I and others hope to accomplish the same good end in the Delaware and the Passaic. The great troubles in the way of fish culturists were baskets, dams and stake nets. Of all, the basket-dam, made of wooden slats, was the most injurious. I have seen thousands of little shad dead in these traps. The young shad is a very delicate creature, and is killed by the slightest stroke from any substance foreign to his element. A few years ago the Delaware river was full of these dams. I am happy to say that, through the efforts of myself and others, there is not to-day a single one. If we are properly aided by the law-makers we shall make shad cheaper than they ever were in days of old. The efforts of the fish commissioners were solely directed to the production of shad and salmon for the rivers. This was in their public capacity. I own fish-ponds in which I raise trout and other fancy fish for market, but I look on them as bearing the same relation to shad and salmon as good solid meats do to high-priced foods. I think with a little care any farmer can raise his own fish. I have now at my place trout from the egg to the weight of fourteen pounds.

The thanks of the Club were voted to Dr. Slack for his interesting address.

BROOM CORN ON THE PRAIRIES

Mr. T. G. Ferguson, Aspinwall, Nebraska—Is there a variety of dwarf broom corn that does well? Will broom corn grow well on prairie sod, plowed two to three inches deep, then subsoil the other three, dropping seed in furrow after breaking team? Should the seed be drilled in or put in hills, and how many seed to the hill? When should the corn be tabled, cut, how cured, etc., when scraped?

Mr. F. D. Curtis—I am very glad the people of Nebraska are waking to a sense of the value of this crop. But they must not expect to make much of a crop on a prairie sod. While it resembles maize, it is more delicate and hard to start off. I would say that the nutriment given by a raw, wild sod was quite too crude. Broom corn wants a warm, fine, mellow soil. The Missouri variety is the seed they want in Nebraska. It is larger than either the dwarf or the Ohio. Plant nine to twelve kernels in a hill, hills four by four apart if the land is strong and the variety large. Cultivate with a light fine-toothed harrow, and keep clean till the crop shades the surface. Plant a little later than corn, say about June 1st. There are two modes of harvesting, one in which the seed is disregarded, and the other where the seed is a matter of importance. Probably the seed should be neglected in Nebraska, but this depends on the price of corn. If that is worth fifty cents to feed, broom corn seed is worth thirty cents. The stalks are stripped of the green seeds in the field, and then laid on scaffolds to dry. If the seed remains long enough to mature, the broom with the seed is tabled or bent over, and after partial curing on the stalk, cut and cured on scaffolds. In curing, care must be used to prevent heating and molding. A large crop is 500 pounds to the acre, or a ton from four acres. Illinois is at present the leading broom-corn State. There are no parts of the country more prosperous than those towns along the Connecticut and the Mohawk where the farmers grow broom corn in summer, and make brooms in winter. It gives steady occupation, enables farmers to hire by the year, and, by presenting substantial rewards of good farming, renders it popular and noble. I hope Nebraska will make several thousand tons in 1872, but she will not do it by planting on a raw prairie sod.

Tobacco Culture.

S. W. Clarke, Seneca, Crawford county, Wis.—My neigbor and I are calculating to plant a crop of tobacco, and we would feel very much obliged to the learned Club if they would tell us how to plant it and to take care of it, and how the crop is managed after it is harvested. What kind of seeds should we plant in this latitude, and where the seed may be got. And, if it would not be too much trouble, tell us where we could get the pure Long Evergreen broom corn seed. We have the Red or Foxtail.

Mr. J. B. Lyman—Before they go into tobacco growing they should know that it tears land all to pieces, and does no good, but only harm to all who consume it. But if they will raise a noxious weed, this is the outline of what they should do. First, as early as March burn a brush-heap on a warm slope toward the south where the land is rich; then spade up the ground, mixing the ashes well, and work in half a cart-load of hen manure or hog manure, the finest and strongest on the place. This is the seed bed. Sow, as soon as you do onions, broadcast, and rake in weed, often using a ladder to lay across the bed so as not to step on any plants. Urge the growth of the young plants by liquid manuring. By the middle of June they should be big enough to set. The field is to be as fine and rich as a garden; fifty loads of dung to the acre is not too much. Set out just like cabbage plants; hoe often, keep perfectly clean, and break off the suckers. About the last of August the plants get their growth. Cut them with a hatchet close to the ground, and when they wilt a little, so the leaves will not break by handling, lay on a wagon and take to an open shed, and hang with tops down till it cures. It is hard to give instructions for curing, as so much depends on climate. In cool, damp weather the leaves are stripped, care being used not to tear them. The most valuable tobacco is the Connecticut leaf, used mostly for wrapping cigars. The seed he will get of some farmer in Windsor, Conn., or West Springfield, Mass. As for the Long Evergreen broom-corn seed, he can get it probably at St. Louis, certainly in New Orleans, but it is doubtful whether it will suit the latitude of Wisconsin.

GRAFTING GRAPES.

Mr. C. A. Fisk, Harmonsburg, Pa., wrote that he has some wild ones which he desires to graft with improved varieties. "How shall I do this, and when?"

Mr. A. S. Fuller—It is not every one who can graft grapevines and be successful. It is well enough for every one to try, because there is a chance of success, and that is something worth striving for. Vines may be grafted at any time during the fall or winter when the ground is not frozen. Cut the vine to be grafted down close to the roots, and if two or three inches below the surface so much the better. Split the stock and insert the scion in the same manner as we graft large branches of apple or pear trees. If the stocks are too small to be split, then splice the scion on to one side, being careful to have the two neatly joined together. If the grafts are inverted during cold weather they should be covered deep enough to prevent freezing. In the spring uncover, leaving only the upper bud exposed. No wax is used in grafting grapes, the scions being tied in with string or bass bark. The grafting may also be deferred until the leaves on the vines are about half grown in spring. Some of our vineyardists prefer this season to any other, but there is little use in trying to graft vines in early spring when the sap first commences to flow.

Growing Evergreens.

Mr. H. C. Chapman, Goshen, N. Y., stated that he has gathered a quantity of evergreen seed of various kinds which he wishes to forward to friends in the prairie States; but they will be asking, what shall we do with it? And Mr. C. requested the Club to reply in advance.

Mr. A. S. Fuller—Evergreens require far more care in growing from seed than deciduous trees. In the first place, it will not answer to sow the seeds in an exposed situation, where no shade or other protection can be given the young seedlings. The seeds should be sown in a half-shady place. Sometimes the shade of a large tree will answer, but the best way is to make frames the same as used for hotbeds, but use no manure or other stimulating materials to produce heat or rank growth. These frames should be covered either with coarse cloths or screens made of common lath or any other material by which shade can be secured for the young plants. If exposed to the direct rays of the sun, few will grow. To give full directions how to grow evergreens from seed would be too long a story to tell here; and any man who cares enough about this subject to attempt the culture of such plants, can well afford to purchase and read the books which give the required information.

Large Yield of Corn.

Nathaniel Tuttle, Milan, Ohio—I send you to-day an ear of corn as a specimen of my two acres. Perhaps you have noticed some of the papers give me credit for having harvested 254 bushels of shelled corn the past season from that surface. The ear I send is shortened nearly one-third by the severe drouth, which, at one time, threatened to entirely destroy the crop. I have for more than fifteen years selected the best ears when I husked, and endeavored to get rid of the roughness of the "hackberry," with which I began, and have been successful. I have never been off my farm for seed-corn during that time. I am seventy-three years old, and one of the pioneers who cleared away the forest and made this portion of the State what it now is. I thought perhaps your Club might be interested in learning what a man of my years can do, and how he did it. As all the labor of raising my two acres of corn was performed by myself, I can tell you the better.

The land is what is called "oak openings," light sand; and being low, was wet, cold, and the sub-soil quicksand. I underdrained, and on the two acres put twenty loads of barn-yard manure. Then turned under the wild sod, plowed four inches deep. Harrowed level and planted May 18th, four feet each way, in hills, five kernels in a hill, with the hoe. When well up, cultivated and hoed, and thinned to four spears. I then put fifty bushels of unleached ashes on the hills. I did this to destroy the cut-worms, which began to injure it, as well as for manure. It was effective. When six inches high, cultivated and hoed thoroughly. This was all the culture I gave it. It ripened about the last of August so much that I "topped it," as I learned to do in my boyhood in the east; and when I husked I was able easily to husk and store fifty bushels of ears a day. By always taking the earliest ripe ears I think I have ten or fifteen days the start of the original hackberry, which, sometimes, as in case of early frost, is a desirable quality. In husking, I found where the corn was best that twelve hills made a bushel of ears.

Adjourned.

January 16, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

A FARMER'S OPINION OF THE INSTITUTE.

The Chairman announced that we had with us one of those solid, able men that have done so much to make the agriculture of western New York famous all over the country, and called for the Hon. Harris Lewis, of Herkimer, who responded: I was in hopes, Mr. Chairman, that I might come in, and, taking a back seat, hear you talk without being called upon thus directly to say something. But since you have run me out from behind my haystack, for this I will not forget Frank Curtis, who told the chairman and drew me into this; and some time, when he has his hair full of hay seed, I will call on him to tell what he knows of farming.

You had an existence, Mr. Chairman, before I did, and I am not young. In 1812 there was a society organized at Tammany Hall, for the encouragement and protection of American industry. Some forty years ago you made some change in your organization, and became the American Institute, for the protection of the great and lasting interests of this nation, and among those interests you place agriculture at the bottom as the mud-sill, the bed-rock, the indispensable support of all that stands above, even to the cap-stone. In this you were wise. Then you started these conversational meetings for exchanging your views and knowledge of rural things, and ever since then, for two score years, I have read your talks every week, and read them with profit. Sometimes you are not right — who that is mortal can be ?— but you are always earnest and honest and conscientious and public-spirited, and those are golden virtues, and will shine when wit and balderdash have been raked away as chips, late-cut hay and stubble, trash that they are.

You have done a great deal in these forty years to instruct the farmers of the country. You have broken down the old prejudice against book farming. Men have read your proceedings and discussed the speakers, and criticised and thought over what was said; and while they were only amused, as they supposed, they have swallowed knowledge, and became book farmers, and better farmers, without knowing it. So, Mr. Chairman, without using any more of your time with my words, let me bid you God-speed, and long years of such service and such usefulness.

Oyster-shell Lime.

Mr. H. Todd, St. Stephens, N. B.—Does it pay to burn oyster shells for lime, hauling the shells two miles, with soft wood at ten cents per load, and lime selling at one dollar per cask; and how should it be burned ? How much are soft-wood ashes worth, burned out in the air, per barrel, for top-dressing on clay loam soil ?

Mr. H. Stewart—He can burn the shells by piling them in layers with wood, each layer a few inches thick, and covering the heap with sods to confine the heat. Shell lime is worth more agriculturally than stone lime, but not for any other purpose. Soft-wood ashes are worth less than hard-wood ashes; probably twenty-five cents a barrel is about their value.

Professor Nash—It will pay to haul oyster shells twenty miles, if he cannot get them nearer. Lime is of use to make other manure available for the plants. On light soils ashes are no good, for the more you put on the land the less you will take off.

Mr. F. D. Curtis—I have known a case where the effects of a dressing of ashes on a field were perceptible after fifty-three years.

Dr. F. M. Hexamer—The only reason why ashes are of less use on light soils, is because such soils do not retain manure so long as heavy clay soils. They need manure to be applied every year, and this increased expense is more than counterbalanced by the greater ease in working a light soil; with this allowance, ashes are as useful on a sandy soil as on a clay soil. But I object to the sweeping statements of Prof. Nash. The truth is that ashes are soon lost on sand, and are kept near the roots of plants for many years by a tenacious soil.

ORANGE-GROWING IN LOUISIANA.

Mr. J. H. Jones, New Orleans—I have been engaged for several years past in trying what can be done in planting and cultivating orange trees in this State, believing it more profitable, and the trees subject to less casualties and diseases than any other fruit tree raised in the country. Several years ago we purchased a tract of land having about 125 acres suitable for the raising of orange trees. At this time we have about 100 acres set out with 9,000 trees—the oldest trees being nine years old last spring, and the youngest two years old from the seed. We have twenty-five acres of land left suitable for orange trees, and about seventy-five acres of good land for rice culture, which is a profitable crop in this part of Louisiana. As the place now stands, it has cost about $50,000, with its buildings, fences, ditches, etc. We are now taking off the third crop of oranges, which has doubled each year since they began to bear. The place has not paid its expenses any year yet unless it does this year, which we cannot know until we get the returns from the present crop, which we are now shipping to St. Louis, Louisville, Cincinnati, Nashville and some smaller western cities, omitting Chicago this year. We expect, in a few years, our orchard will yield large returns for our outlay, as we find that the crops around us, where the trees are in full bearing, are sold to the fruit dealers at an average price of $1,000 per acre of 90 to 100 trees. So far we have done much better, in proportion to our crop, by sending them to market ourselves. Two years ago I gathered from one tree, seven years old, three barrels of oranges, and there might have been a very few more had as many. Some trees of the same age had none. Trees do not generally have any crop worth marketing until they are eight years old, and from my observation they bear as much fruit at twenty as they ever will. I have seen trees in bearing from five to fifty years old, but have never seen any more fruit on any than those at twenty. The orange tree rarely fails of a crop. I know of trees fifty years old, which the owner told me had never failed of a crop but once. In the great freeze in December, 1836, the extremities of the limbs were injured so much that no crop was borne the following year. Another said he bought his place twenty-six years ago. The trees looked as old then as now, and never failed of a crop. The tree is subject to but one disease, which is known here as the chenille, and is, no doubt, the same spoken of by Mr. Day as the scale insect. It is the same disease which caused so much injury to the orange tree in Florida thirty or forty years ago. At that time Congress sent a committee to Florida to examine and report. The committee did report, but like many other reports from Congress committees, it resulted in nothing. The disease made its first appearance here about six years ago, and has been through every orchard on the Mississippi river, with more or less injury to the trees. Where the orchard was in a healthy, vigorous condition, very little injury was done—no more than about the loss of one year's crop. Where they were in the condition of many of the apple orchards of the north they fared worse, in some cases losing a few trees. It has been through our orchard within the last three years with but very little injury and without the loss of a tree. No remedy has been found for the disease. Thousands of dollars have been spent without any good results. At present there is very little of the disease left, only here and there a dead limb among the evergreen foliage of the vigorous growing trees. Oranges are cultivated here in small quantities, very few persons owning more than 500 trees. I know of but one man who owns as many as 2,000. At present there is plenty of land can be bought here suitable for orange trees, both cleared and uncleared. Land is sold here by the acre, or 208 feet fronting on the river, and running back forty acres. So that buying what is called an acre of land, you are really buying forty acres. Of the forty acres, six or eight acres will be good land for orange trees, and as much more back of that will be good land for rice cultivation—back of this is called prairie, on which cattle range and keep in very good condition the year round. This land can be bought cleared and partially ditched, for $1,000 to $1,500 per front acre. Uncleared, for $750 to $1,000. The climate is healthy, free from epidemics, but we have plenty of musquitoes. Our place is sixty-five miles below New Orleans, on the Mississippi river; we call it Orange Farm. Any one wishing further information in regard to raising oranges in Louisiana, who will address me at Newton, Mass., after January 1, 1872, will be cheerfully answered.

Prof. Henry E. Colton—The quantity of land in Louisiana fit for orange growing is very limited; it is the narrow strip between the river and lakes Pontchartrain and Borgne. It will not do to call that section healthy, when it is notorious that the yellow fever exists in New Orleans every year, and frequently extends to the country below. At the price he states, the land would cost $25 to $37.50 per acre, as we buy and sell land. It would be unwise for a man to buy that land at such a price when he can get better near Mellonville, Fla., where oranges are certain, at two to five dollars per acre.

LAND IN VIRGINIA.

Mr. H. C. Sherman, Chicopee, Mass., went south because the health of his family requires a milder climate. He spent a couple of weeks prospecting in Virginia, "examining her soil, climate, social and educational advantages, modes of doing business, and the manner in which northern men are received there," and sends back the following conclusions:

"I find in the eastern part of the State what is known as the tide-water district, a region offering great advantages in its cheap and fertile lands, with their nearness by water transportation to all of the great markets of the world. I also find the settlers on most of that district subject to chills and ague, which to one who regards health more than money is enough to outweigh all of its pecuniary advantages. There is the Piedmont district, extending through the State from north-east to south-west on the east side of the Blue Ridge, which has a red clay soil, well adapted to a mixed husbandry, to which it is mostly devoted. The region lying between the tide-water and Piedmont districts is mostly known as the gray lands, which have been long cultivated with wheat and corn in a most ruinous manner, seldom or never being seeded to grass. The farmers in this district keep but little stock, except the teams necessary to carry on the farms, and take no pains to make or save the manure from the animals which they do keep. The farming here is one continual system of exhaustion, with nothing done to restore the fertility of the soil. The lands of this district are not usually as highly prized as the red lands—upon which a less exhausting system of culture usually prevails—the lands there being kept in grass a portion of the time. It is a great wonder that these gray lands continue to produce anything to repay the labor of culture after so long a continued system of exhaustion. I find a great many northern men have settled in the vicinity of Fredericksburg, and along the line of railroad from there to Richmond; and all that I have seen are well pleased with the country, and I have heard of no dissatisfaction, except from those who have purchased more land than their means would warrant. I think that no one should invest more than one-third or one-half of his available means in a Virginia farm; the balance will be needed in improving the fertility of the soil, the erection of suitable buildings and the purchase of farm stock and implements, and the support of a family until an income shall be derived from the farm.

There are no Ku-Klux in Virginia. As good order prevails there as in any of the northern States. The uniform testimony of every northern man whom I have seen is that they are well treated by the native Virginia inhabitants, who are anxious to have good inhabitants come from any country to buy their lands and develop the great resources of the State. It is a poor place for a laboring man without sufficient capital to go into business on his own resources, as there are plenty of negro men and women that can be hired for less than one-half of the wages paid in the northern States, which is one of the advantages of the country to the man of means who wishes to carry on any kind of business. All of that section of country between tide-water and the Blue Ridge has a very mild and salubrious climate. But little snow falls, and that remains but a short time. Stock requires but little feeding from the barn. They have there but very few of what we at the north should call barns. They have a mass of hovels, which, together with the little negro huts, give the greater part of Virginia farms an uninviting appearance. Barns are needed in Virginia as much as in Massachusetts, for the manufacture of manure, but as a shelter they do not require so much expense in making them warm, nor in providing storage for roots, as they can be kept in the field with but little more protection than is required in England. Some large purchases have recently been made in the vicinity of Fredericksburg by parties from Scotland, who propose to make a specialty of stock-raising, which I think might be carried on in that vicinity as successfully as in the Piedmont district, as the best clover which I have seen in the State was on the gray lands near Guineas, excelling anything which I saw in the noted Shenandoah valley, which is indeed a beautiful and fertile district; but the price of land is there so much higher than on the east side of the Blue Ridge, that I could not see as great advantages for settlement there as there are on the east side of the ridge, considering the price of land, the distance from market, and the high rates charged on the Virginia railroads, which is about double the amount charged on northern roads. The most remarkable thing which I noticed was the rapid growth of the timber, which has sprung up on all of those gray lands which have not been cultivated since the war. Fruit does well in all of this section. There are large quantities of apple trees that have sprung up on the entrenchments at Spottsylvania Court-house. Some of them are quite large, and produced fruit last year. The State has recently passed a law providing free schools for the education of both white and black children; but in a country where the land is held in such large plantations, the population is too small and scattered to have schools convenient to but a small number of families. I think Virginia offers greater inducements to the emigrant than any other section. Land can be bought there for less money than in any other part of the country, where the soil is equally good and as convenient to all the great markets of the world. The expense of moving to Virginia is small compared with the cost of moving to the cheap lands in the west. A family can step on board a steamer in New York, with all of their goods, and be landed in Richmond in a few days, and at a small cost. The way to make a settlement in Virginia pleasant is to form a colony embracing farmers, mechanics and all of the useful professions, with the dramsellers left out. Let a locating committee be chosen, who shall go on and select a location on the line of some railroad where a station could be established, and let them go on together and unitedly build their roads, school-houses and churches, while they apply the principles of improved culture to the renovation of their lands. In this way all the conveniences of an old settled community might soon be secured, and the lands which can now be bought at from fifteen to thirty dollars per acre, would soon be worth two or three times their present value. I am so well pleased with the country that could I go in this way I would be glad to attempt building me a home in old Virginia.

Adjourned.

January 23, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

WINDMILLS.

Mr. A. Blewett, Brooksville, Miss.—Can windmills be used to run the cotton gins on our open prairies, where we have a breeze every day? I considered them the cheapest power we had, until I heard on one of our railroads that they had been condemned. Mr. Ely's remarks have again raised my hopes, and I should like to know whether they will answer to run a cotton gin.

Mr. D. B. Bruen—This man is a large planter, and has raised 2,000 bags of cotton in a season. He had better get a steam engine. A six horse-power engine will cost $500, and can be run cheaper than the use of horses. Windmills are failures, because they do not furnish a steady power.

The Chairman—I have often thought the great power of the wind could be made useful for heavier work than cutting feed, sawing wood, etc. For one horse-power I know they are successful, and why should they not be for six horse-power? I like to see them; they are a great addition to the landscape, and if I live I intend to put up one at my country-house.

Mr. S. E. Todd—Windmills are now made by companies in several parts of the country, that have wings which will adjust themselves, take in sails if the wind is too strong, put their "eye in the wind," and on Long Island they are used for grinding flour. In central New York there is a large carriage factory where a steam engine was lately changed for a windmill, which runs the saw and other machinery much cheaper than by steam, as it saves fuel and the hire of an engineer, to say nothing of avoiding the risk of loss by fire or explosion.

Black Knots on Plum Trees.

Mr. Mark W. Stevens, Sloansville, N. Y., writes: "My theory of the cause of this disease is that the disease is caused by an excess of sap in the branches at a time when the growth of wood and leaves do not absorb it, and when the leaves do not protect the branches from the sun. The ground at that season is usually saturated with water, and the heat often extreme; they, acting together, produce a flow of sap which cannot be absorbed by the young leaves, and is therefore detained in the young wood, where fermentation takes place, caused by the sun's heat, and the result is the disease described.

"The reasons for this opinion are these: The disease seldom occurs in the kinds of plums which have an early and luxuriant growth of leaves, such as the Princess Imperial, Gage, Jefferson, Orange-plume and Yellow Gage, but does appear on others growing alongside the above, and growing under precisely the same circumstances, such as Smiths, Orleans, Damson and Red Gage, which have smaller and fewer leaves than the first mentioned. It seldom occurs upon trees root-grafted into the wild plum stock, which develops a small root compared with the top of the tree. It seldom occurs in trees that are making a good medium growth of wood; not too much or too near none at all. It does occur most frequently in trees which stand in a moist, deep, dark and rich soil, and without a sod upon it; or in places where the winter snow-drifts remain late in the spring, retarding the production of leaves until the spring is so far advanced that a few hot days hasten an excessive flow of sap, for which the top of the tree is unprepared.

"The only way to prevent this disease is to plant plums upon rather a dry soil, of kinds least subject to the blight, and which kinds these are, almost every nurseryman of experience can name in a minute if he will. Mulch with chip-manure, four inches deep and four foot wide around each tree, in March or April, and if the soil is very deep and rich then root-prune a little once in two years, in the fall, after the leaves have fallen."

Mr. D. B. Bruen—Bitter plums and bitter and sour cherries are attacked by this disease, but trees which have vigorous leafage and bear sweet fruit never suffer from it.

S. E. Todd—The ground is wanting in potash and lime where this malady prevails. If four or five bushels of wood ashes and two or three of lime are stirred in the soil around the trees the black knot will disappear.

Mr. Thos. Cavanach—I have known black knot to attack trees where lime and potash were plentiful in the soil. I think easterly storms, followed by a hot sun, will originate it. I knew an orchard of five acres totally destroyed when two years old by this disease, and it occurred after a cold east storm, and commenced on the east side of the orchard and passed through it in two weeks

Poor Food for Stock.

Jeremiah O'Brien, Oneida County, N. Y.—I have long wished to ask your advice with regard to the matter written below, but I waited, hoping some one else would do so, or at least that something would be said or written among you that would throw some light on the subject. Know, then, that right here adjoining some of the finest dairy lands in the country is a large tract in which dairying or stock-raising cannot be carried on at all on account of the great difficulty we have in getting cattle to live, barely to live, through the winter, unless fed on something besides hay, such as roots or mill-feed.

This extra feed is accounted neither convenient nor profitable, so the cows are usually left to get on as best they can on hay alone, and here is how they do it: About the middle of winter their dung becomes hard and black, the appetite fails, and they grow poor and scraggy-looking. When the calves come they are poor and weak, and most of them die within twenty-four hours after birth. Perhaps I ought to mention that various remedies have been tried in the shape of medicine, and nothing has been found so efficacious in improving the appetite and giving relief as copperas, dissolved in water and poured down the throat out of a bottle. This seldom fails to give temporary relief, but cannot the assembled wisdom of the Farmers' Club give us something better? I believe they can and will.

Here are some of the questions I would like to have answered: Is not our soil deficient in some essential ingredient—say lime, iron or potash? And, if yes, then how can we best supply the deficiency?

Our soil is what is termed sandy, but it is not lacking in fertility and strength enough to produce good crops of hay and grain. We have plenty of swamp muck, also pure "blue clay," but there has been little or no use made of either of them yet, because this whole tract that I've been describing is what might be called "new," and, as you may suppose, the people are poor and loth to try experiments—the more so as it is not fertility we are after so much as to raise good, healthful food for our cattle on our own meadows. Now, gentlemen, you have heard my case, and I trust that you will give it a "good hearing." If you have any possible plan to offer I shall begin next spring to put it in practice.

Mr. F. D. Curtis—Want of good food is what's the matter. We don't have such stock in Saratoga county. The feed ought to be steamed. On Beacon Stock Farm there are 106 head of horses and cows fed on cooked food, which are in the best condition possible, sleek and nice.

Dr. J. V. C. Smith—I am opposed to feeding cooked food to animals. Cattle have a digestive apparatus capable of assimilating the raw material of food, and when it is cooked their secretions are not made use of, and they become unhealthy.

Mr. John Crane—When I was young the stock on my father's farm was fed on poor hay and straw. The best cattle were sold and the best hay. Such cattle as remained had the hollow horn, which, I believe, was the hollow belly. I do not believe in cooking food for stock. It is slavery for women and boys. I was called to see a dying woman, a farmer's wife, once, and in the next room to where she lay were four or five big pots boiling food for hogs. Here was the cause of that poor woman's death, and there are scores just like her.

The Chairman—That is the most convincing argument I ever heard on that subject.

Mr. Bruen—Many of our farmers have not enough feed for their animals, and so must economize by cooking; they thus make the feed go twice as far as if eaten raw.

Mr. John Crane—When corn is worth only twenty-five cents a bushel it will not pay to cook it. Hay or straw, with corn meal and cotton-seed meal, will keep stock in good condition without cooking.

A member—If these scraggy cattle are fed on good sweet hay and a peck of roots apiece every day, in the spring they will be healthy and strong. Horses and cattle must have roots or they will get into bad condition.

Mr. Frank D. Curtis read a paper before the club on

Sheep Husbandry and the Tariff—No Reduction.

Whenever wool commands an average price of less than fifty cents per pound it is grown in the eastern States at a loss to the producer. For the years 1866, 1867, 1868, 1869 a large proportion of farmers received less than fifty cents a pound for their wool, and under these discouraging results slaughtered their sheep by the thousands, went into the business of making pork and beef and butter and cheese, creating an excess of those staples, and forcing the market for meats down to ruinous prices. This wholesale sacrifice of sheep and proportionate reduction in the quantity produced cleared the markets of the surplus wool, and stimulated prices so that for 1871 an average of at least ten cents a pound increased price has been obtained, with a prospect of ten cents more for 1872. These prices will pay, and enable the farmers of the United States to compete with the pauper colonies and labor of England and the uncivilized portions of South America, where the favorable climate and reduced cost of production offset our improved culture and skill in a climate and under an expense for labor which more than doubles the cost of production. Congress very wisely imposed a protecting duty on wool and woolens when the great depression in this important industry was manifest, and now, when there is a prospect of paying prices, it is, in our judgment, unwisely proposed to reduce the tariff on imported wools ten per cent, thus destroying at once the small margin upon which the business of wool-growing and sheep-husbandry depend for success in the future.

I shall make no extended argument to show the necessity of fostering this great industry, which is more important to the masses of American people than the iron interests, or almost any other. Shall Australia clothe America, and enrich her soils with the golden hoof of the sheep, which our impoverished farms of the east need to increase their fertility and our plains to make them profitable? Shall we willfully place beyond the reach of our people the cheapest, sweetest, healthiest and best animal foods, and in time of war, with our ports blockaded, depend upon a foreign power for our fabrics? Of wool 40,062,929 pounds were imported into the port of New York during the year 1871. Without protection, this import would be increased to such an extent from the immense regions of the Cape of Good Hope, South America and Australia, where millions of acres are still unoccupied, where the value of land is merely nominal, and where no winter-feeding is necessary, that every sheep would be driven from the east toward the setting sun, and, like the Indian, would only find rest on the plains and in the deserts of the west; and here, with a depreciating value, and a doubtful future, they would grow less and less until our markets would be depleted of what ought to be the coming meat—mutton and lamb; the shepherd's vocation would be gone; a long line of wealth for the citizen and the railroads striking across the prairies and plains, penetrating the mountain gorges, and reaching out to the deserts and through the canons, gathering up the wool and the flocks, would be wiped out. What shall farmers and those interested do to prevent the repeal of the duty on wool, and save the sheep-husbandry from ruin? We answer, petition Congress, and ask them to stand by the unorganized but earnest yeomanry of the land. Let the foundation of this country's prosperity—agriculture—be based upon no changing, shifting, sandy ground-work; but upon the substantial principle that we legislate for Americans and American interests. I cannot close this brief paper without embodying in it a form of petition to Congress, which any citizen can copy and sign and get his neighbors to sign and forward to his representative in Congress, or one of the senators in Washington, D. C., without any payment of postage, and in this way, within thirty days, we can open the eyes of Congress to the wishes and wants of the people.

To the Honorable House of Representatives and Senate in Congress assembled:

The undersigned citizens of the United States would respectfully petition your honorable body not to reduce the tariff duties on foreign wool, believing that such reduction would injure, if not ruin, the wool interests of this country.

The Chairman—We cannot say much one way or another on this question. We go in for no class or interest in particular, but for the whole country. I like American wool if it does not scratch too much, and I like American mutton. The sheep is a delicate feeder, and, like the horse, cannot be induced to eat anything unclean or disgusting. So I believe in mutton for food.

Adjourned.

January 30, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

DEATH OF MR. JOSEPH B. LYMAN.

The Chairman announced that in deference to the dictates of his own feelings, and the general desire, all ordinary business would be suspended, out of respect to the memory of him who has been accustomed to be present here each Tuesday for many years.

How sad is the thought that we shall never again see the manly form, nor hear the pleasant, earnest voice, nor longer enjoy the warm friendship of Joseph B. Lyman, our late associate. But He who controls all things has in his wisdom so ordered. Our brother Lyman rests in the bosom of mother earth; and while we are left sorrowing, our departed friend, I doubt not, is rejoicing. Mr. Lyman was an educated gentleman, a well-read lawyer and a Christian man. When I made his acquaintance he was residing at Stamford, Conn., about half an hour from my country residence in Norwalk. The acquaintance began about six or seven years ago, and has been one of great intimacy since; and I never saw a single transaction, or heard a word from him to which I could take any exception. You all know his earnest, devoted efforts were given to advance the agricultural interests of this country, and how zealously from the first he has exerted himself to extend the influence and benefits going forth from this Club. By his death one of the main supports of this Club is removed. Most sincerely do I mourn our loss. May we all profit by this sad event. May we be admonished of the uncertainty of life. Soon our days on earth will be numbered. Ere long, my most respected fellow-members, we too shall pass away. May we so live as to be ready for the last call.

Mr. Ely then moved the adoption of the following resolutions:

Resolved, That in the death of our late associate, Joseph B. Lyman, the cause of agricultural improvement has lost an earnest and effective advocate, this community a valued and blameless citizen, this Club a most useful member and a warm-hearted friend.

Resolved, That we tender to his bereaved widow and children our heartfelt sympathy and sorrow for this great affliction.

Resolved, That a copy of these resolutions be properly engrossed, and transmitted to the family of the deceased.

Mr. P. T. Quinn—I sincerely mourn the departure of our late and highly esteemed associate. His loss is a loss not only to our Club, but to the hundreds of thousands of those who for years have felt a strong personal interest in our proceedings and have been instructed by them. To this instruction Mr. Lyman largely contributed. Personally, he was frank, open, direct and intelligent. He impressed a stranger as a man of weight. As managing editor of Hearth and Home, in the early days of that excellent journal, I had opportunity to judge of his capacity in a field other than agricultural. What he has done since his connection with the Tribune we know well. His place cannot readily be filled. His like we shall not soon see.

Mr. F. D. Curtis—It is but two hours since I heard of the death of our friend. I can verily say that I was never so shocked as by this sudden announcement. I have known Mr. Lyman for three years. Circumstances made me know him intimately and confidentially. In a business way I have frequently been connected with him, and in all that intimacy I never saw or heard anything, not even a single expression, from our friend that I could disapprove of. I spent Sunday week with our friend. We had visited the home of William Crozier for the purpose of inspecting his farm and his farming operations. He was remarkably active in gathering ideas and information of value to his constituents. His mind was not a common one. He had a grasping and comprehensive intellect which could not be taken up with details; these he left for others to fill up. I must speak of him as a husband, a father. In that capacity he illustrated most beautifully his character as a gentleman and a Christian. He took pains to make his home lovely, and instruct his children in the way they should go. His young family of children and his bereaved wife have experienced a loss which can never be replaced, which no other can ever fill. He was a purely Christian gentleman, and in the trying hours of disappointment, which occasionally occurred to him, his character shone out brightly. He never experienced the feeling of revenge, but a true Christian charity radiated always from him in all his dealings and intercourse with others, and this was one of his brightest qualities. My heart is too full for utterance when I look on this vacant seat.

Dr. F. M. Hexamer—If we try to speak words of consolation to his family, and to those who know him here, what can we say to those thousands and hundreds of thousands to whom he has ministered as an unknown friend? He did, unknown to most, a class of work which he imbued with a high moral tone. Some of his papers have not been excelled. There are those, as I know from personal knowledge, who have been so helped by his writings, that they will almost revere his memory.

Dr. J. V. O. Smith—On no former occasion have I felt a deeper emotion than I do now on this occasion. We mourn the loss of a member of this Club who was dear to us. This draped and empty chamber suggests thoughts that are sad indeed. Others have spoken of his official influence and character. I can speak of my intimate acquaintance with him in various explorations and journeys, and as dwelling in the same house with him. I knew of his strict uprightness and his high character; I also knew what the high ambition of his life was. It was to help to improve the people, and develop the vast agricultural interests of this country. In the pursuit of this he spared no labor, and devoted his life. During the travels I made with him over the Rocky Mountains and on the Pacific coast his thoughts were continually on this. He was also an excellent father. The progress of his children's studies was constantly an object of solicitude with him. He was a good man, and his life was one which gave no terrors to death, for he had lived so that he had hopes beyond the grave.

Professor J. A. Nash—The occasion is full of sorrow; and yet in the termination of such a life there is something to mitigate grief, and even to create joy: it is, that with our departed associate all is well. We bemoan his loss; we cannot bemoan his lot. We can sympathize with his wife and children, and for their sake and our own we mourn, but not for his. With him it is well. He has gone to reap the reward of a pious, earnest and highly useful life. Mr. Lyman was an honest, conscientious, upright man. His constant effort was to circulate sound instruction and important information to the great agricultural community of the whole country. In this he succeeded admirably. I have never known a man who guarded himself so strongly, and I might almost add so successfully, against writing or uttering a word that could be tortured into an error to mislead the farmer. In Mr. Lyman the whole farming community have lost a most valuable friend and helper—a faithful, earnest and safe guide to just such common-sense, practical knowledge as their profession requires.

Mr. R. J. Dodge—I knew Mr. Lyman, not intimately, but long. Whenever he spoke I listened and gained information, and although his remarks and writings have passed, their influence lasts, and must go on. He was genial, pleasant, never captious or quarrelsome. I grieve that we have lost him. Though gone while still young, I doubt not he was fully ripe and rests in peace.

Mr. H. T. Williams—I indorse heartily all that has been said. Mr. Lyman labored earnestly to promote the fundamental interest to which he devoted his life. He wronged no one, and was a great help to thousands.

Mr. S. E. Todd—This vacant chair is an impressive commentary on the brevity and uncertainty of mortal life. For us to say that our departed associate was an estimable citizen and respected friend, is frigid eulogy. We loved him. He was a great man, for whoever is truly good is truly great. Few men in a public capacity, who have done so much as Mr. Lyman, and who have been so exposed to the attritions and asperities of life, have made less mistakes than he. I have been in Mr. Lyman's family, and he has been at my home. Perhaps I knew as much of his every-day life as any other man in New York. It affords me transcendent pleasure to attest that in all our intercourse I have failed to see any manifestations of that professional jealousy which too frequently rankles in the breasts of contemporaneous journalists. In all this intercourse with men in a private or public capacity, his aim seemed to be to do right and to avoid every appearance of wrong. His character always appeared to be founded on principles of the strictest equity. So far as I knew him, the record of his life furnishes an illustrious example to every young man who has virtuous aspirations to rise in the scale of being to a noble manhood. He acted his part well. He was a man of prayer; and he taught his children to approach the throne of heavenly grace and to say, "Our Father." While we feel the bereavement and mourn the loss, we are cheered with the consideration that he died in hope of a glorious immortality beyond the grave, trusting alone in the atoning merit of Him who is the resurrection and life of his people.

Professor Henry E. Colton—I have known Mr. Lyman with more intimacy, perhaps, than any person here, with one exception. He was my personal and social friend: I knew his business and private affairs, as well as the views he was constantly urging for the advancement of the agricultural interests. He had told me his plans for the future, his hopes and ambitions. When I needed a friend among New York journalists, he extended the hand of friendship, and he not only continued to give me his own personal influence, but he also used his own friends to aid my plans. In him I have lost a friend, Mr. Chairman, my feelings since this loss I do not know how to express. It is impossible for me to do so in tame words. It has been well said that Mr. Lyman was peculiarly a domestic man. He seemed ever to be studying how he could educate his children mentally and physically. He strongly believed that a sound mind should be in a sound body. I remember some time since that he told me, in his opinion, one of the first things to be instilled in a child's mind should be a thorough knowledge of the earth's surface, and that, in building his new house at Richmond Hill, he intended to paper the walls of his sitting-room with Guyot's series of maps. In his religious culture, Mr. Lyman partook fully of those principles which were so carefully instilled into the young of New England country homes. He firmly believed in prayer, and never undertook any business, no matter what, without making it the subject of earnest prayer. I remember his allusion to this in the days of his courtship; that he felt that he was not living, in New Orleans, the right character of life; and after careful prayer the Lord directed him to Laura, and he knew that she was the one above all others for him. We all know that he believed thus at the day of his death. He has often told me that he did not believe any one's life could be a perfect success without prayer. In his agricultural department, Mr. Lyman carried the same earnest devotion to principle and right as in his family; he ever endeavored to do justice to all sections. No one knew better the great value of our vast western prairies, and no one was more able to state the needs of the south in her new position. He was ever ready to give information of either, and always heard with fairness the advocates of any section or measure. His style of writing was a type of himself, smooth, polished, no harsh, grating words or sentences. Removed but lately to a new home at Richmond Hill; he had hoped there to gather around him a circle of literary and agricultural friends, attractive to himself and his talented wife, and make there his permanent abiding-place.

Col. J. A. Slipper—After what has been said, I can hardly add to the eulogy of our late associate. I must bear my testimony to the esteem in which I held him. Sitting in my seat adjoining his, I have felt as if this death-bolt has struck very near me. Our relations were not of an intimate character, and yet so favorably impressed have I been with our friend, that I have felt the same sorrow I should have felt had he been an intimate friend. I knew him as a journalist. As such he was honest and conscientious. Knowing him first as an agricultural editor, and at the same time knowing him to have been a lawyer and not a practical agriculturist, I had some prejudice against him on that account. I soon found that he had a mind capable of discriminating and choosing facts, and a journalistic method of getting at the kernel of things which he wanted to present; and that he could learn and make use of information about agricultural matters in such a way as made him of great use to farmers for whom he wrote. Thus his writings were valuable as containing information gathered laboriously from all sources. I think of him, as I sat here by his side two weeks ago, when I made use of the expression, "though lost to sight to memory dear," and this sentiment now springs to my mind as I think of our lost associate.

Col. M. C. Weld—Mr. Lyman and I were schoolboys together. Afterward I knew him in college, and later I watched his successful career in New Orleans, where he practiced law. We were never intimate, but I always desired to know him better. As long ago as I can remember, he was the same amiable yet forcible character. In regard to his practical knowledge of agriculture, he was, I think, underrated. His early life was passed upon a farm, and he had quick perceptions, and, as has been remarked, he knew where to find what was necessary to know, and this is a very valuable trait in one who teaches others.

Mr. A. S. Fuller—I had no particular personal acquaintance with Mr. Lyman, and the highest compliment I can pay him is, that as a journalist I always watched and read whatever he had to say, and always with advantage.

Dr. Isaac P. Trimble—So much has been said that I feel I can only indorse it all. This is a sad occasion, and we mourn one well worthy of our respect. I have traveled with Mr. Lyman frequently, and have ever been more and more impressed with his integrity of character and devotion to the cause of agriculture.

Mr. A. B. Crandell—I knew our absent friend intimately since 1864. It has been said that to know a man well, it is necessary to follow him home. I had peculiar facilities for acquaintance with Mr. Lyman in his domestic relations. Here he was wholly admirable. I never met a man whose conduct as husband and father was deserving of greater praise. His devotion to his wife, after a dozen years of marriage, was something unusual in these days of divorce and matrimonial infelicities; and as an educator of and companion for his children, of whom he left six very promising ones, his equal, I am confident, could not readily be found. Another of his distinguishing and charming characteristics was the cheerful spirit he maintained under misfortune and in the darkness of disappointment. He knew well how fortune looked when she frowned, but he never permitted his soul to be disquieted within him. He saw in every cloud, no matter how black, a silver lining. He seemed to be sustained by an unfaltering trust, and, to one easily cast down, his perpetual bravery was a perpetual mystery, and a not-to-be-forgotten lesson; and also, when his sky cleared, and success came, he kept the even tenor of his lovely home life, and though he is dead now, the wholesome fireside influence he exerted upon the interesting children who survive him, and upon the friends who knew him best, cannot be measured.

Mr. G. B. Weeks — I knew Mr. Lyman as a dairyman. He used always to attend our sessions of the National Dairymen's Association at Utica. He was present at our latest meeting, and spoke interestingly. The dairymen of Central New York will feel that they have suffered a severe personal loss.

Mr. Alfred Greenleaf — I came here as a duty. I wished to impress upon my own heart the lesson this sudden death teaches, namely, the necessity of doing quickly what we have to do. It will be well for each and every one of us, if—as was the case with Mr. Lyman—we leave the world better than we found it.

The resolutions were unanimously adopted.

Adjourned.

February 6, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

LIME AS TOP DRESSING.

Mr. D. C. Bruce, Cumberland, Md.— I would like to be correctly informed as to the propriety of top-dressing meadow or grass land with lime; if so, what quantity should I apply to the acre? I have not a sufficient quantity of stable manure to apply to all my meadows, and as lime is cheap, costing but seven to eight cents per bushel, and within two miles of my farm on a good road, if it would be of advantage to use it, I could very readily and cheaply supply all my wants. I take great interest in reading every week the proceedings of the "Farmers' Club," and have derived great advantage from it.

Colonel M. C. Weld — The presence of organic matter in the soil is an almost certain indication that the application of lime will be of value. The quantity which it will pay to apply cannot be determined without experiment; but if the vegetable mould is present, the soil will be benefited by lime.

Dr. Trimble — By all means try it; lime is useful anywhere except on wet meadows—there it is no use at all. In the country where I have lived, lime is used as a top dressing for corn and grass, and its use has made the farmers rich. But this man must experiment. Perhaps his soil is not suitable for it; and some limes—those containing magnesia, for instance—are injurious to vegetation. For the first experiment, twenty, thirty, or a hundred bushels per acre may be tried. Very large quantities are sometimes applied to rich, alluvial soils. On the flats of the Delaware, lime has been spread on the soil and mixed to form a compost for other land; and after this compost has been removed, the flats have given very great crops.

Mr. Hauser — There are some wet meadows upon which lime should most certainly be used. Some wet soils contain organic acids, which are corrected by the action of the lime.

Transportation of Milk.

Mr. Augustus Skeen, Montgomery county, Pa.— In an impromptu gathering of about fifty farmers, the question was agitated, whether carrying milk warm from the cow three quarters of a mile, a little more or less, in a common spring wagon, and then setting it for the purpose of creaming and butter-making, would injure it for that purpose at all, or in the least. The majority thought it would not; a few said positively it would. If you have any definite knowledge on that point let us know. Also, you are aware, doubtless, that milkmen who send their milk to market always take out the animal heat before sending it. All such milk gives less butter if set for it. Many of the Club appeared to think it would not, though I believe the contrary opinion is generally advanced.

Col. M. C. Weld — Milk transported warm will be somewhat injured, even in going a mile. The action of the air on milk is much more rapid when it is warm than after it is cooled to the temperature of spring water, say fifty or sixty degrees. At this lower temperature the action is very slow. First cooled milk may be carried far in close cans, and smell sweet when the cans are open. If transported warm from the cow it will have a very bad odor. Whether or no less butter will be made from such milk I do not know, but certain it is, the quality will be improved if the milk be cooled before transportation.

KENTUCKY BLUE GRASS.

Mr. A. F. Cole, of Glensdale, Lewis county, N. Y.—I would feel under obligations to the Club for information in relation to sowing Kentucky blue grass on interval land or on river flats that flow twice each year, spring and fall. I clear a few acres of this land every summer. I pull the alders in the summer by hand, and with teams leaving the soil loose and mellow. I usually seed with timothy, but that kills out in a few years from the effects of the water. The information I desire is whether I could succeed better with Kentucky blue grass or with blue joint or red-top, and where could I find the seed. One of my hired men told me last summer this was just the land for the Kentucky blue grass, he having had experience in Ohio farming. I have five acres of this interval land ready for the seed in the spring.

Prof. H. E. Colton—From my knowledge of blue grass, and the region in which it grows, I think that it would not grow on such a meadow as that he describes. The Kentucky blue grass is a peculiar plant, and grows on a peculiar soil. There is another blue grass very much resembling it, but not the same. The western papers have devoted much time and space to discussing these different grasses, and a series of articles, with illustrations, in the Western Rural last year carefully and clearly explained their differences.

Dr. Isaac P. Trimble—I do not believe the Kentucky blue grass will grow on that gentleman's meadow. Red-top is the grass for him.

FIRE-FANGED MANURE.

Mr. W. M. Woodcock, Watertown, Tenn.—I have about forty loads of manure in my stable, where I am feeding a drove of mules. It has all accumulated since December 1. Have used considerable quantities of sawdust and bedding, and have never removed any of it from the stable, where it now lies to the depth of two feet, and very moist from liquid manure. If I haul it to a heap it will be hot enough to cook an egg in twenty-four hours. Is there danger of fire-fang, and will the Club tell me the best means to get it rotted without losing a great quantity of its virtues?

Dr. F. M. Hexamer — To mix his manure with muck is the surest plan. I would advise twelve inches of manure, three inches of muck and so on. The muck will absorb the ammonia.

The Chairman—Dirt from side ditches or from the roads is good.

I have had the roads raked, and used the dirt thus collected with good success.

Mr. H. Stewart — The manure referred to in this letter is in as good condition as it can be. When manure is allowed to be trodden down and kept moist it does not ferment injuriously, and in the spring is in excellent order to be drawn out and spread on the fields. The labor and expense involved in composting this manure with muck or earth would be very great, even if this man has a supply of those materials ready at hand. But there is a mistake about the heat of fermenting manure being sufficient to cook an egg. No heat so great as the boiling point of water is ever produced by manure. Generally the temperature of a manure heap when it is in active fermentation is not over sixty degrees, and a hot-bed, which is built up for the express purpose of giving heat, will very rarely attain a temperature of 100 degrees when the sashes are closed. Fire-fanging is dry rot, and if manure is kept moist it will not become fire-fanged.

Cape May Soils and Crops.

Dr. Isaac P. Trimble, from the committee appointed last summer to visit the county of Cape May, N. J., submitted the following report:

In company with David Petit, that well-known practical farmer of Salem county, they spent the sixth, seventh and eighth days of July most pleasantly in that county. They were met everywhere by kind and hospitable friends, who seemed to have arranged beforehand their plans so judiciously that we were able to see everything of interest in agriculture that the entire county afforded. It would give us pleasure here to return our thanks individually to all those who showed us such marked attention, but the list would be so long as to take too much of the space allotted for our report. By a reference to the map before you, it will be seen that while New Jersey is one of the smaller States of the Union, it stretches from north to south through more than two degrees of latitude, the county of Cape May being the extreme southern limit, running south of the thirty-ninth parallel, and comparing with the other counties of New Jersey as Florida does to the other States of the Union. While we expected to see vegetation much in advance of our own, we were greatly surprised at so great a difference. We were shown a field of tomatoes, where a large portion of the crop (July 7) was fully ripe. Another field was pointed out to us, then planted with potatoes, where a crop had already been taken off and sold for nine dollars per barrel. We found apricots ripe, and peaches and pears nearly so, indicating a difference of three or four weeks between south and north Jersey. As a rule, those who see the country from railroads are not able to form a very correct judgment of the agricultural wealth of a country, and this is especially the case in south Jersey. Poor justice would be done to the county of Burlington, if it was judged by what is seen from the railroad between Bordentown and Camden. The same may be said of the counties of Gloucester, Salem, Cumberland and Cape May, as seen from the west Jersey roads. In most of the counties of south Jersey spots may be seen called sand barrens, which are useless. There are other tracks so light and sandy as to be of little value except to be left in timber. These, however, bear but a small proportion of the whole in any of the counties; and what was to us remarkable, we saw no such lands in any part of Cape May; on the contrary, the entire area of uplands could be made into profitable farms, and large portions, if not the whole, of the marsh meadows, both on the coast and bay sides of this peninsula, could be redeemed to great advantage. The business of farming all along the coast of New Jersey has been, until recently, a subordinate pursuit, the inhabitants depending chiefly upon coasting, fishing, lumbering, or some other business. Mother earth resents ill usage and neglect, as farmers sooner or later find out to their cost. While most of the lands of Cape May are naturally as good as the best portions of Salem, the farms of to-day, under this long-continued different treatment, show a marked contrast. But the farmers we saw assured us that old things were now passing away. A most spirited agricultural society had been formed, funds had been liberally contributed, a tract of land bought and buildings erected, and we have learned that their recent fair has been very successful. During the three days of our visit we had the opportunity of seeing their soils, timber and growing crops.

We feel it our duty to express our opinion of the country and its capabilities of improvement. The county, as a whole, is admirably adapted to the growth of corn, sweet and round potatoes, and truck generally. We saw no upland too poor, too sandy or too stiff to be made to produce good crops. The corn and potatoes then growing looked remarkably well. Oats was well grown. The wheat and grass crops had been gathered. The greatest difficulty the farmers here seemed to encounter was a good stand of grass, for to this crop, in a great measure, depends success in farming. The three past summers had been unusually dry, and in such seasons the young grass plants often perish. This difficulty may be obviated, in a great measure, by sowing the grass seed, clover and timothy with or soon after the wheat in the fall, and then rolling it in hard to make the land more compact or solid, thus enabling the young plants to take a firmer hold and get a start in the fall, that they may grow stronger the next spring before dry weather, and so insure a good stand. Rolling will not injure but rather benefit the wheat, as it delights in a firm soil. If the grass should become large enough to injure the wheat, which is hardly likely on such land, the loss will be much more than made up in the grass. When the seed is sown with the wheat, or soon after, and rolled in, one-half or even one-fourth the amount of seed will give a better stand than the usual quantity sown in late winter or early spring. One quart to the acre of timothy seed put in with the wheat has been known to give a good stand. Situated as the land is between the Delaware bay on the west and the Atlantic ocean on the east, the climate in the winter is much tempered by the warmer air from these bodies of water, so that snow seldom lasts over three or four days, and spring and summer open several days more forward than in the latitude of Philadelphia. The corn and other crops do not suffer with intense dry atmosphere, as they do further inland, on account of the air coming from these bodies being more humid. One great want with the farmers is fertilizers in sufficient quantities to bring up their lands to a high state of improvement. Their resources for these fertilizers we believe are ample.

Cape May county, according to the geological report by Professor G. H. Cook, of Rutger's College, contains 170,171 acres, of which 106,923 are upland, 48,381 tide marsh, 4,424 beaches, and the balance — 10,443 acres — sounds, bays, etc. The county is thirty miles in length, by from three in the south to eight or nine in the north in breadth of upland, across which from Dennis creek, which empties into the bay across in a north-east direction to a branch of Great Egg Harbor river, extends a great cedar swamp. In the tide marsh bordering on Dennis creek, and for many feet below it, large quantities of cedar logs have been quarried and worked into shingles for covering buildings. Logs have been quarried with a thousand rings and upward, overlying stumps, showing the tides rise higher than when those logs were deposited there, or rather the country has subsided, and that they have been deposited there hundreds if not thousands of years. Shingles made of these are all heart and very durable. Bordering on the south-east is a strip of salt marsh, nearly its whole length, from two to four miles wide, including sounds or lagoons and creeks connecting them, and protected from the ocean by sand beaches, with several inlets through these beaches, which are generally timbered. These sounds or bays abound in excellent fish and oysters, and form safe inland navigation in rough weather. On the bay side, too, the upland is bordered by marsh and swamp two-thirds its entire length, and on the north-east by marsh emptying into a branch of the Great Egg Harbor river, which forms its north-eastern boundary, thus bringing the upland of nearly the entire county within easy access of these marshes for hay and vegetable matter for manure, comprising over one-fourth of the whole county, more acres than there are now under cultivation. A great portion of this marsh lies so high, we are informed, that ordinary tides do not cover it, and the extreme tides rise but four feet above it. The mud being solid, and so situated that 25,000 acres of it might be reclaimed from the tides for about five dollars an acre by reclaiming it in large bodies, it could be then seeded down with the cultivated grasses, which would produce double the quantity of hay of the salt grass, and be much more valuable. This would make the marshes much more profitable for hay and manure.

In Salem county we learn there are 15,000 acres reclaimed from the tides, where ordinary tides did rise two or three feet over them. They make the best farm lands where they are high or kept dry. Lime alone will keep up their fertility for many years. Good marsh mud composted with slacked lime, twenty bushels of the former to one or two of the latter, have made a very good compost for upland in some places. If it will do as well with the Cape May mud or salt marsh and on their uplands, they have no lack of resources for fertilizers; and their lands being sandy, it would seem to be the very dressing adapted to improve them. Of all the cultivated grasses, clover is the most valuable for improving land. It makes excellent hay, an abundance of pasture where the land is made rich, and is of great value for soiling, to be returned to the land in some form, but is invaluable as a green crop for turning under. A large part of it being absorbed from the atmosphere while growing, and being turned under while green, makes a good fertilizer for other crops, especially wheat, making it a direct fertilizer, while other green crops turned under produce but little or no benefit to after crops; therefore the inference is fair that they had precisely absorbed from the soil what they returned to it.

Soiling must be resorted to in Cape May county at no very distant day, by the thrifty farmers, in the day time in fly-time, as a means of keeping their stock in better condition. The usual estimate is that one acre for soiling will go as far as two acres in pasture. With all these resources and advantages within their reach for improving their lands, it seems there can be nothing but proper energy in the farmers wanting, with help and means sufficient, to make the lands now under cultivation doubly productive. We were informed, while there, that there are 70,000 acres in the county in timber or not brought under cultivation. This leaves but 36,923 acres under cultivation — a little over one-third of the upland. Another third might be safely brought under the plow, as the land is good and easy of tillage, and then leave a third for wood. We were informed the price of land is ten dollars an acre, with the value of the timber and improvements added. The land being so well adapted to trucking, and as that branch of farming requires much labor, it may be made to maintain a dense population.

The soil of Cape May county is entirely of the tertiary formation, and the subsoil being porous like the soil, it needs no deep plowing or subsoiling to enable the moisture to rise from below to the surface to sustain the growing crops; and the great point to be attained is, in a dry time, to arrest this moisture as it rises (and rise it must before it can be evaporated) and make it subservient to the growth of crops. And as farmers have no better retainer of moisture at their command than vegetable matter, and as the nearer it is kept to the surface the better, where the main body of the roots do naturally grow, it behooves the farmers to apply and keep all their fertilizers as near the surface as they well can for food, in order to procure the largest crops and maintain their lands in the best condition; for the poorer the land is made the more and faster it will dry. Five inches is deep enough to plow, under any circumstances, to produce the largest crops (unless the subsoil is richer in plant food than the soil), and shallower plowing will produce more. If there are any who disbelieve this let them experiment in plowing under five inches, and over six inches, the more the better for a contrast, and have published the results, and see which will withstand dry weather best. If plowing only four inches will make better crops and improve the land faster, it will besides be a greater saving of labor in team, in manual labor and in farm implements, and therefore must be preferable. This can be demonstrated as follows: Take for experiment a piece of new or virgin soil of two inches, with five per cent humus, and plow ten inches deep and pulverize thoroughly, so the humus will be distributed equally through the ten inches. Instead of five per cent humus in the soil there will be but one per cent; the soil will therefore be but one-fifth as rich as before plowing. Just so with every application of manure, the deeper it is plowed under the less benefit. But this is not all; plowing ten inches makes it even worse, for it turns the larger part of the humus in the bottom of the ten-inch furrow, where the main body of the roots do not naturally run, away from the heat of the sun, the dews and gentle rains. Nor can all the ingenuity of man make them run out of their natural course to please his whims; but they do run where the poor clay has been turned up in such plowing, hence his failure. That experiment of Theodore Frelinghuysen is a case in point; but if the shallow plowing of six inches had been four, it would have been even more striking. If such is the result on land which the deep system theorists say, is the most beneficial, of what possible use can deep plowing be on land which Horace Greeley says does not need plowing at all?

J. P. TRIMBLE.
F. D. CURTIS.
J. V. C. SMITH.
DAVID PETIT.

SHEEP RAISING IN NEW MEXICO.

The Chairman read the following paper from Mr. Edwin Lyon, of Fort McRae, New Mexico:

I have taken pains to collect some reliable facts relative to the profits of sheep raising in this territory, but will confine myself in the present article to the information received from sheep owners in the immediate vicinity of Fort McRae, New Mexico. Within a radius of thirty miles from this point there are about 30,000 sheep, of which General Montoya, of San Antonio, New Mexico, owns 20,000, and Senor Garcia, of Alamosita, 10,000. There are no small flocks. The area indicated is capable of pasturing over a hundred thousand sheep without going beyond water limits, which means within six miles of the Rio Grande. These flocks are of the common Mexican breed, originally from the State of Chihuahua. Their average weight of carcass about thirty pounds. They are herded in flocks of from 3,000 to 7,000. A flock of the latter number is divided during the day, but corralled together at night. They require the constant attention of herders and dogs. To take care of a herd of 7,000 sheep required the services of three herders, one majordomo or chief herder, one burro (donkey), and a dog for each herder. The majordomo is generally paid twenty dollars per month and the herders fifteen dollars, with rations. These are outside prices and obtain the most experienced herders. Boys or incompetent herders can be hired at nominal rates, but they prove in the end to be the most expensive. The rations consist of about a bushel and a peck of corn meal or parched corn per month to each herder. Sometimes the herders own a few goats which supply them with milk. If they have no goats they milk the sheep. They are also entitled to the carcasses of all sheep that may die by reason of old age, accident or otherwise. Sometimes the coyote is too smart for them, and succeeds in getting a mess of mutton before being discovered. What remains from his feast goes into the commissary of the herder. These herders remain with the sheep night and day, in all seasons, except when occasionally absent after rations. If any shelter is required at night it is easily obtained under a mesquit bush or an overhanging rock. In the morning their entire stock of household and kitchen furniture, in all scarcely worth five dollars, is packed on the burro, and all hands leisurely follow the grazing herd.

Range of Pasture.

During the hot months, June, July, August and September, sheep must have water once a day. They can range daily six miles from water. The scarcity of water is the only drawback, otherwise the extent of pasturage is almost illimitable. As it is, it is inexhaustible. The broken plains, and river hills stretching back to the mountains and up their sides, are covered with clumps of grama grass, which has the peculiar property of curing on the stalk. It is, therefore, good pasture all the winter, and, indeed, until the new growth appears, when it falls to the ground. It is preferred by stock to bottom or cultivated hay. The Jornada del Muerta (journey of death) is east of this post, and separated from the river by a range of mountains. Its eastern boundary is defined by the San Andres range. This is one of the finest natural meadows in the world, ninety miles in length by an average of twenty in width, extending from the Mexican town Paraja, southward to Fort Selden. This entire field is covered with a thick growth of grama grass, except in spots where the sage bush has taken possession. With the exception of some springs at the foot of the mountains along its eastern border there is no water ; but at Aleman, a stage station on the road about half way between the extreme points, a well has been sunk and an unlimited supply of water obtained at the depth of 160 feet. The traveling public are indebted for this inestimable improvement to the energy and pluck of Captain Jack Martin, the present proprietor. During the two years in which he was engaged sinking the well, except in rainy seasons, he hauled water from Fort McRae, eighteen miles distant, to supply the wants of his workman and travelers. This success of Captain Martin demonstrates that all this vast meadow can be made available for stock raising. During the winter months the present custom is to drive the herd up the mountain sides, partially covered with snow, which melting in the hot sunshine of midday supplies the sheep with an abundance of water. This naturally inclement season is passed by both sheep and herders very comfortably. The herders not being required to follow or drive the herd miles away for water, build themselves a wigwam of poles and brush, in which they may abide for months at a time; while the sheep, in case of a sudden "spell of weather," can find ample protection under ledges of rock or in close ravines. "Sudden spells of weather" in New Mexico do not mean what they call in Texas a "norther." Storms are mostly prevalent in the hot months or during the rainy season. Except on the mountains, snow rarely lies more than twenty-four hours. (I am not speaking of elevated regions, such as Santa Fe.) In the months of February and March high winds prevail, which, on account of the sand, are more disagreeable than inclement. At this point, during the months of October and November of last year, there were nights in which small ponds of still water were frozen over half an inch thick, but throughout December no ice of any consequence has been formed. The following table shows the mean temperature of the months of December, January, February and March, taken at the hospital of Fort McRae, New Mexico.

Observations taken at 7 A. M., 2 P. M., and 9 P. M., by Dr. W. B. Lyon, A. A. Surgeon United States Army.

	D.	M.
December, 1868	38	84
January, 1869	36	95
February, 1869	43	69
March, 1869	51	73
December, 1869	36	39
January, 1870	37	53
February, 1870	47	75
March, 1870	48	35
December, 1870	34	56
January, 1871	Instrument broken.	
February, 1871	41	40
March, 1871	52	69

December, 1871, not yet averaged—about forty-one degrees.

Annual Loss.

Leaving out of account the depredations by Indians, the annual loss is so small as to be insignificant. They are subject to no prevalent disease, but an occasional one is poisoned by eating a certain plant. With good herders the loss from coyotes is trifling. The loss is generally graduated by the appetite of the herder. When a sheep begins to lag behind from age, his days depend on the condition of Mr. Herder's larder. So that, taking into consideration the fact that herders have to be fed, the loss is actually nothing—and a gain of the hide. I have heard the annual loss from all causes estimated at five per cent. General Montoya makes the astonishing assertion that, aside from thefts by Indians, he doesn't lose more than 100 annually out of his flock of 21,000. To give this statement full credit, it is easy to suppose that the Indians generally select the old and infirm of the flock. He says that the Indians have been very bad until the last year. One year the loss from Indians was estimated at 1,000,000 in the Territory of New Mexico. Sheep owners used to calculate upon their entire flock being "gobbled" every five years, and yet the business paid.

Natural Increase.

The fecundity of Mexican sheep is amazing. In the average flock the majority of ewes will have two lambs, and quite a large minority will have three. They are dropped in the months of April and May—mostly in April. During the month of April high winds prevail, and young lambs require some care. Of course there is some loss at this period; but in August, when they are brought in to be counted and marked, they will average 100 to 150 lambs to the 100 ewes, according to the condition of the herd. The lambs are then considered hardy enough to be counted sheep. Last year, from 1,900 ewes in one flock, Gen. Montoya raised over 3,000 lambs, counted in August, and says he can keep it up; this, without the expenditure of a dollar for food or shelter. (Think of this, you eastern stock-fanciers, who tremble to risk an extra pound of mutton at the cost of an extra bite of food.) These lambs will increase in the same proportion by the next April. For instance, suppose a man to start now (January, 1872), with 1,000 ewes with lamb. In August of this year he will count 2,500 sheep; and, supposing one-half of the lambs to be ewes, by August, 1873, he would have 5,125 sheep, and by the time the Indians came for their share he would have a flock of — well, count for yourself.

Wool.

Sheep are clipped twice a year—in April or May, and October or November. Lambs that are dropped in the spring are clipped in the fall. The average weight of fleece of the native sheep is two pounds each clipping. In flocks that have a sprinkling of States sheep the average is more. A few years since they were sheared with sharp knives—a very imperfect and cruel process; but of late, wool-shears have generally been adopted. The cost of clipping is one and one-half cents per head. A smart Mexican, it is said, can clip 150 in a day. Of course he doesn't make nice work, nor is he squeamish about cutting holes in the skin. The sheep are washed by being driven several times through a rapid stream. There is no manipulation of the wool. The fleece loses by washing about one-fifth. Wool was worth at the ranch, in 1870, from twenty-three cents to twenty-eight cents per pound; in 1871 it brought thirty-five cents. Sheep are valued at two dollars per head, but in the State of Chihuahua, Mexico, they can be bought for thirty-seven to fifty cents each, and brought here to cost but one dollar per head.

How expenses are paid.

The only expenses are the wages of herders and the cost of clipping. These expenses, with the annual loss by death, General Montoya says, can be paid by the sheep themselves in the thrashing season by tramping out grain. During the night the sheep are driven over the grain, and rewarded for their labor by being permitted to graze during the day. In one night it is calculated that each sheep will tramp out a fanaga (two and a half bushels) of wheat, for which the sheep-owner is paid one-tenth. In one season, 1,000 sheep can, in this way, earn 500 bushels of wheat. Last year, General Montoya says, 500 of his sheep earned 295 bushels of wheat, equivalent to \$531. At this rate, if the whole herd could be employed, after paying all expenses there would be a large margin of profit. It is quite sufficient, we think, if the sheep "tramp out" all expenses, as they really "work for nothing and board themselves." Taking it for granted, then, that all expenses are paid, and all losses made up by the labor of the sheep, I will take General Montoya's figures and estimate.

The Profits.

Suppose we start now (January, 1872) with 1,000 ewes brought from Chihuahua—cost on the ground \$1,000. These 1,000 ewes will, in April and May, drop upwards of 1,500 lambs; say 1,500 lambs that will live to be counted as sheep in August. This is not up to the actual experience of General Montoya, but they are outside figures of course. In May, 1872, the 1,000 ewes are clipped, yielding 2,000 pounds of wool. In October and November, 1872, there are 2,800 to clip for 5,000 pounds of wool. Supposing we have 750 young ewes, we will have in the spring of 1873, old and young, 1,750 ewes to drop upwards of 2,625 lambs. In May, 1873, we clip from our flock of 2,500 another crop of 5,000 pounds, and at the clipping of October, 1872, our flock, amounting to 5,125 sheep, turns off 10,250 pounds. So before the two years are complete we have a flock of 5,125 sheep worth two dollars each, and will have clipped 22,250 pounds of wool. Taking stock in January, 1874, we have:

5,125 sheep worth two dollars each	$10,250 00
22,250 pounds wool at thirty-five cents	7,787 50
Total	$18,037 50

Don't forget the original outlay of $1,000. These are immense profits, but sheep-men are beginning to figure beyond them. They say that the introduction of Cotswold bucks will more than double the yield of wool and the weight of carcass. Of course, where the cost of food is absolutely nothing, we need not be afraid of big sheep because they eat more than small ones.

Mr. H. T. Williams—In our excursion this season to the Rocky Mountains, we found in the midst of the south part, in the very heart of the mountain range, 150 miles away from all post-offices or rail-road communication, a Frenchman, Yankee-like in disposition and money-making. He had a ranche of 1,600 acres, where he raised about 1,500 sheep and 300 cattle. The year round he and his wife made butter and stored it; then, in the spring, he takes his stock, goes to the provinces of Mexico and New Mexico, sells it for the enormous price of ninety cents per pound, reinvests his money in sheep at the bare cost of fifty cents per head, drives them home, feeds them one or two years, fats them up, and then sells for three dollars to five dollars per head for mutton; in the meantime having clipped enough wool to pay for expenses and the original cost of the flock. It is the shrewdest business transaction I ever knew. During one journey we came upon several sheep ranches at other elevated portions, many of them 2,000 to 5,000 feet above the level of the plains, or an altitude of 12,000 to 15,000 feet above the level of the ocean, and the uniform testimony was that the sheep lived through the winter without the slightest protection, and snow rarely ever fell or remained twelve hours. Mexican ranchmen cost only fifteen dollars per month; the further south you go, to the Arkansas river or Texas, the wages decline to ten dollars or eight dollars per month; further north the prices advance to twenty dollars per month. Many exaggerated reports of the disastrous effects of the weather have been published this winter. I have just received a letter from Dr. Lathan, of Laramie Plains, in which he states these reports are all false; the actual loss, even among Texan cattle, freshly driven from the lower plain, has been but two to four per cent. J. W. Iliff, out of a herd of 3,000, has not lost one. Creighton's flocks of 17,000 have lost but thirty. But in middle and lower Nebraska and Kansas the losses have been severe. Sheep raising is to be the most profitable pursuit of the plains and mountains, and capital will double every three years.

REPORT ON THOMAS'S SMOOTHING HARROW.

Mr. John Crane, from the committee appointed to make trial of Thomas's Smoothing Harrow, submitted the following report:

We have used it on soils that differ widely in their composition, and on a variety of crops. The chairman of the committee makes the following statement: "I have used the Thomas Harrow the past season, and my experience warrants me in saying that it is all that its inventor claims for it, as a pulverizer, for ease of draft, and as a cultivator of young growing crops—such as wheat, oats, barley, and particularly corn and potatoes. My first trial was on an old meadow that had been top-dressed with manure. The manure was in a coarse, wet state, and partly frozen when it was spread on the ground; consequently it was in lumps. The harrow worked admirably, breaking up the manure and spreading it over the ground without clogging. The next trial was on a piece of winter rye; part of the field was harrowed as an experiment. It broke up the ground admirably, preparing it for sowing the clover seed, and decidedly benefiting the rye. For smoothing and mellowing the ground, preparatory to planting vegetables, strawberries and corn, and seeding down for meadows, it worked most effectually. In the potato field it saves half the labor of cultivation. I used it on rows of strawberry plants which were put out last spring, going over them twice; it pulverized the soil and thoroughly destroyed the weeds, disturbing but few of the plants and destroying none. I tried the harrow on corn, going over one field; it destroyed the weeds, but the corn looked as if it had suffered also;

as the season advanced I found, however, that I was mistaken, as the corn was not in the least injured, and I only regret that I had not harrowed all my corn, not only once but twice. This piece of corn was the cleanest and best that I had." Your committee concur in the following opinion:

The peculiarities of the Thomas Harrow consist, first, in the size of the teeth, and second, in their number and slope. They are small, about a half inch in diameter, and made of steel. They are very numerous, and the holes for them are bored so they have a backward slope of about 45 degrees. When put to work on an upturned sod these teeth do not tear or upset, but, riding on the surface, they work it fine by a downward cutting stroke. As the tooth is round it will not tear up or cut small plants, as wheat, corn and potatoes, if they are on a level, or a little below the general level of the field. We have found it effective as a pulverizer of the surface, and it can be used to kill weeds and stir the ground around the young crops, yet not materially tear or uproot them, and for this peculiar service it surpasses any other tool with which we are acquainted. In potato culture it is really excellent, and saves half the usual expense; it prepares an admirable seed-bed for young plants, is a very effective leveler and pulverizer, and in seeding down land for meadows it leaves the surface more level, uniform and smooth than any tool in general use. In short, we confidently recommend the Thomas Harrow as simple, rational, effective and satisfactory to the tiller of the soil.

John Crane,
F. M. Hexamer,
Joseph B. Lyman.

Adjourned.

February 13, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Cross-plowing for Corn.

Mr. J. H. Moore, West Bangor, N. Y. — I have a piece of land that has been in meadow four years. It was top-dressed with compost of muck and heap manure of equal parts, in the fall of 1870. Last fall I turned it over, plowing about four or five inches deep. Soil, a gravelly loam. In the spring I wish to plant corn and apply about ten loads of compost of ashes, muck and rotten manure per acre. How shall I apply the manure and plant? Shall I sow the manure broadcast and plant on the sod, or cross-plow, cultivate and manure in the hill? Also, will it pay to use plaster—if so, how and when?

Mr. H. Stewart — This gentleman should spread the manure now, or as soon as convenient, and as it is drawn out, and let it be there until he is ready to plow the field. He should not plow any sooner than is necessary for the corn, so as to get as good growth on the sod as possible. Then turn all under and plant his corn. When it is a foot high a small handful of plaster should be scattered over each hill, permitting it to fall on the leaves of the corn, from which it will be washed by the first rain.

Dr. Isaac P. Trimble — I would not advise any one to cross-plow, but to harrow it over and over. Plow the corn in its early stage, but after that use the harrow.

Mr. John Crane — A harrow will cut up the soil better than a plow, and pulverize it as it should be. I would not advise manuring in the hill; I do not think it is best.

Oyster-shell Lime.

Mr. Daniel Cummings, Hampton, Va. — Last year I burned 1,500 bushels of oyster-shells for my corn crop, but was hindered from hauling out. It is now lying in a large heap, just as they were burned. I wish to ask how I had best apply them. Had I better scatter them on a wheat field close by one that is to be sown in clover, to lie two years; or on last year's corn ground, which is to go in corn again this year, and which is new land, cleared three years ago, and has never been in anything but corn? The original growth was large yellow pine, with some gum and chestnut. The lime has no doubt been wet through the whole mass. Will your chemist say whether it will act chemically on the soil, which I judge has much acid in it, from the very great growth of sheep sorrell on some parts, or will its action be only or mainly mechanical? I would say that the wheat was put in with guano and ground bones, 200 pounds to the acre, mixed half and half. Would the lime be injurious to it?

Dr. Trimble — Mr. Cummings would do wrong to put his lime on the crops which he has already manured. He would not know which was of benefit. It is likely his lime would be of value on the sour soil of which he speaks.

Mr. H. Stewart — If he uses it on the land he intends to sow in clover, it may be of some value.

To Decompose Bones.

Mr. C. S. Osgood, Wright City, Mo.—I have frequently seen directions to break bones tolerably fine with a hammer or axe, before salting them down with ashes. I have found the breaking process quite tedious, and there are but few farmers that can be induced to save bones at all, let alone a process of reducing to useful shape, that would cost more in time and labor than would buy as much bone meal ready for use. For if all the pieces that fly in every direction are run after and brought back, the "traveling fees" will run higher than the constable's when he levied on the old woman's ducks. Having a beef cow die suddenly of distemper, I dressed her, tried the tallow, broke the bones to let out the marrow, boiled the carcass, and fed the meat slowly to store hogs, with other food. I then packed the bones, without further breaking, with first-rate hard wood ashes, about filling a lime-cask, put on water gradually to moisten through, and let them stand through one summer, adding water to keep damp. I had sold my farm in the meantime, but surmising that my successor would make no use of the bones, and wishing to learn the result of my experiment, I shoveled them out upon the garden, and found the experiment a perfect success, there being but few pieces not perfectly decomposed. The big joints cut and looked very much like soft cheese, so that I at first thought I must have made an oversight and put in some chunks of fat beef with the bones. If I had no first-rate ashes I would leach some to get lye to moisten with instead of water.

Gypsum—How does it Act?

Mr. W. T. Early, Charlottesville, Va., writes: This is a vexed question, which has long perplexed chemists and agriculturists. There have been many theories upon the subject which I propose to examine. It is said by a distinguished professor that it is food for plants, or manure. This cannot be true, because generally, when applied to land, about seventy pounds or a bushel to the acre, is found to be sufficient for all purposes, and that over that amount is a waste of material.

It is believed by some that it acts upon the soil mechanically. This is obviously a mistake, as, everything else being equal, it acts in the same manner upon all soils; those which are light, loamy, stiff, clayey, sandy or rock, being equally and in like degree affected by it. And beside the quantity used, a bushel per acre is too small to have any appreciable mechanical effect upon the soil.

Others claim that it acts only as a constituent of plants. This cannot be true, because, if it were so, much more than a bushel per acre might be profitably used upon common land as manure, as it is perfectly obvious that common manure, bone dusts, and guanoes of all kinds, can be used to any extent almost, with results corresponding to amounts employed, while in the case of plaster, generally speaking, no appreciable results follow beyond a certain limited quantity.

Others call plaster the saliva or gastric juice of vegetation. This cannot be the explanation of its action, for if fifty bushels be applied, where one bushel is enough per acre, no injurious effects follow, as would be the case from excess or over action, if plaster performed any function at all to be assimilated to that of saliva or vegetable gastric juice.

Some say it is simply a stimulant of vegetation. This explanation will not do; because there is no doubt plaster permanently improves the soil if the vegetation produced by it is not removed from the land. Others attribute its powers to its possessing the power of supplying water and carbonic acid to plants. This explanation will not hold, because of the fact that only a very small quantity of plaster will act when sown upon land in its ordinary condition, and it is only another form of expressing the first explanation of the action of plaster, viz.,—that it acts as a manure, which we have shown to be untrue. Others say it owes its power to the fact of its supplying sulphuric acid to plants, which is but a modification of other explanations which I have shown to be untenable. The question still remains, how does plaster act? I think I can answer it in great part, if not to the full satisfaction of the inquirer. It acts as a condenser of the ammonia of the atmosphere and of the soil. Gypsum is composed of sulphuric acid and lime. A bushel of this substance, if it acted as a manure, would clearly exert but a very small effect upon an acre of land by its chemical action upon plants, or by entering into combination in the growth of crops. By observation, however, it is concluded that gypsum acts as a condenser of ammonia, which is found everywhere in the atmosphere and in all soils to a limited extent—that it holds this most subtle and powerful manure in its grasp, fixes it and gives it out to the growth of plants as they require it, instead of allowing the ammonia to pass away and remain unfixed and unadapted to plant growth. There are a few phenomena which seem to me to fully establish the fact that this is the true explanation of the action of plaster, that only a certain amount will act. Thus a bushel to the acre, sown upon a clover field, acts as well as fifty bushels—showing that it does not act as a manure, as a stimulant, or a gastric juice, or in any other manner analogous to any of these agencies. Sow a field with plaster in clover, or any other grass, leaving out a breadth, or in plastering a crop of tobacco—as I have frequently seen it done—leave a few rows without the application, and the result will be that, while the parts of the crop to which the plaster is applied will be flourishing and green, those on which no plaster is put will be yellow and worthless, indeed greatly inferior to what they would have been had no plaster been placed in the adjacent parts of the field. How can this be explained except upon the hypothesis that the plaster draws from the atmosphere passing over it a part of its fertilizing properties and retains it for the use of the plants in proximity to it, while those portions where there is no plaster do not thus derive this greater share from the atmosphere? Again, sow upon a dunghill, streaming and giving off ammonia, a quantity of plaster; enough—it will stop the escape of the gas. Wait awhile, until the plaster sown becomes saturated with the gas, and it will again begin to escape. Put on plaster again, and it will stop; and so on until all the ammonia is taken up and fixed.

Take Peruvian guano, whose great fertilizing property is ammonia—mix plaster with it in proper quantity, and it will become inodorous. And so of any other animal or vegetable manure which gives off ammonia.

Great losses are sustained in stables, in cesspools, in all animal and vegetable manures by the escape of ammonia, which constitutes by far the richest part of all manures. Gypsum may be most profitably employed in fixing this volatile and most valuable ingredient, to the great profit of the former and of the public.

USING ASHES AND SPREADING MANURE.

Mr. S. W. Quale, Linden, N. Y.—I have a quantity of unleached ashes. Shall I apply to my wheat field, which is rather poor? If so, where and how? I have an underground stable, 35 x 45, in which I keep cows. I throw the manure on a shed and draw it out, and spread it on grass lands as it is made. I intend to put the land in corn in the spring. I treated a piece so last year; plowed it about four inches deep, and had a good crop. Is this the best time and way to apply the manure?

Mr. John Crane—He should spread ashes broadcast over his land just as soon as the frost is out of the ground, and should spread manure as fast as made, but take care that it is not so spread that the strength is likely to be washed away.

EXPERIMENTS WITH MANURES.

Mr. R. S. Hinman, Riverside, Conn.—Some months since I addressed an inquiry to the American Institute Farmer's Club, concerning some marketable manure adapted to growing grass. I received no definite answer, and I experimented a little, with the following result: Having a four-acre field, part of which faced the west and part the south, I turned it over once and sowed with turnip and clover seed the latter part of July. On the lightest and most gravelly part I applied a compost of night soil, ashes and muck, and on the western slope of the field adjoining it, on successive lands, four different kinds of phosphates, differing the quantity in proportion to the difference in price. Just as far as the compost went the turnips and clover started finely, but when it stopped the clover stopped almost as entirely as if I had sown seed no further. Where the phosphate happened to be sown a little thicker, the turnips grew, but no clover. On the southern slope next to the compost, I put two kinds of ground bone, one costing thirty-five dollars, and the other fifty dollars per ton, sowing the former the most plentifully. Here the difference was not so marked; but unfortunately for my experiment the land was naturally better adapted to clover, and I am not certain that clover would not grow there any way. What I proved to my satisfaction was, that my compost would grow clover if the land was a little too cold and thin; that the phosphate that I used would not grow clover but would grow turnips, if applied plentifully enough on the same land; and according to my judgment the bone dust benefited both turnips and clover. I only applied each at the rate of about ten dollars per acre, and that is not enough to apply in manure of any kind.

A gentleman of my acquaintance who is said to make money by farming, buys stable manure for four dollars per cord and carts it on to his farm from the village, at an expense of not less than four dollars more. He applies say twelve cords per acre, at an expense of about $100. I am so far from any village that I cannot put that amount of stable manure on my farm for less than $120. I propose to apply ground bone the present season, with several other bought manures and barn-yard manure at the rate of fifty dollars and upward per acre, for the purpose of ascertaining, if possible, what will come nearest to barn-yard manure in its adaptability to grass growing. I am perfectly willing that all should benefit by my experiments; but it would facilitate matters wonderfully if a score or more of the farmers who are benefited by reading the reports of the Farmers' Club would agree to make a series of experiments of the same nature, and report to the Club, for two or three successive seasons, thus showing the increase in product and durability of each kind of fertilizer used.

Rye Grass.

Mrs. Thomas Kennedy, Opelika, Ala.—Can you or any member of the Farmers' Club give me any information when and how to plant "rye grass" seed? I received a package from the Agricultural Department at Washington, but with no directions; and as grass culture has never had much attention in the south, until recently, any light on the subject will be gratefully accepted. We live on the thirty-second parallel of latitude; soil very thin, with a substratum of yellow clay. What kind of fertilizers should be used? Would not some other species of grass be better adapted to our soil and climate?

Prof. H. E. Colton—The grass spoken of is probably the Italian rye grass. Clover will grow where that lady lives; but they have there two indigenous grasses called crowfoot and crabgrass, which can be saved from any corn or cotton field, which are probably better for that climate than any foreign grass.

Mr. Hauser—The Italian rye grass grows only on a dry soil; I do not think it will do well on clay lands, as it shoots its roots deep into the earth. It is a very nourishing grass, and I am glad to see that the Agricultural Department is introducing it into this country. There are several kinds of rye grass not so good as the Italian.

Perverted Appetite in Cattle.

Mr. M. L. Phelps, Colebrook, Conn.: I write for a little information of the cause of cattle eating each other's ropes, gnawing the mangers and floor plank, and a ravenous appetite for old carpets, leather, pieces of boards, bones, etc.; also the cure, if any is known. I will state that they have been well salted and fed ground bone, but to no purpose.

Col. M. C. Weld—The probability is that a little ground bone fed to his cattle might correct the evil.

Mr. S. E. Todd—The best corrective is hay or straw and bran. Plenty of good food will correct the evil. If fed well now, it is probable that they need forage for distention; their present food is too concentrated.

Dr. Isaac P. Trimble—Cattle will eat these earthy and other matters, no matter how much they are distended. The fact is, that this perverted appetite generally occurs in cattle that are fat and well cared for.

Mr. Hauser—The same trouble is had in Europe with sheep eating their wool. No one knows the cause, and numerous agricultural committees have failed to find any reason for it. These sheep are kept in good stables, and are in good condition. The very fine herds of Silesia all act thus, and every remedy has been tried to correct it without effect. Hunger is not the cause.

Mr. John Crane—This is simply a perverted appetite, common to human beings as well as wild and domestic animals. It is not from any want of food. I have seen hogs eat gravel when they had plenty of corn in reach of them.

Mr. Henry Stewart—The trouble is caused by indigestion. This leads to a depraved appetite, which craves something which the animal cannot procure, and it devours anything which comes in its way. We see this same thing occur among all animals; even the human race are subject to the same peculiarity. We see them eat clay, and girls often eat slate-pencils. Among domestic animals the horse very often eats its litter; cows eat similar filth, and hogs eat wood, earth and various other substances. Under such circumstances a tonic needs to be administered, and a dose of muriate of iron, or a little copperas and ginger given with the food often results in a cure. Sometimes a habit which amounts to a vice becomes fixed on the animal, which is known as foul feeding, and is difficult to eradicate.

Mr. Harris Lewis, Herkimer county, N. Y.—When cows chew bones they lack bone-forming material in their food. Whenever lands become exhausted of lime to such a degree that cows chew bones, no time should be lost in feeding bone-meal. Feed it as you would salt; the cows will eat only so much as they desire. If Mr. Ames could afford the outlay and sow 200 pounds of bone-dust per acre on his grass lands his cows would not chew bones again for a lifetime; or if his soil is a sandy or gravelly loam, he can correct the evil by sowing gypsum (sulphate of lime) at the rate of 100 pounds per acre annually.

A Trocar for Cattle.

Mr. Hauser—As the subject of distention has been alluded to I will take this opportunity of bringing to the notice of the Club the tool I mentioned some weeks ago, as used in Germany, for sticking cattle when distended from colic. It is a barb, covered by a canala or sheath, except at its sharp end. The barb is a mere round spike or dagger, with sharp point. The canala is hollow, having a rim or shield at one end, and fits tightly to the barb. The whole is like a straight sword with scabbard, the scabbard being cut off a half inch or more from the point. The canala is put on the barb; the barb and canala are then inserted in the side of the animal. The barb is then withdrawn and the canala left in the hole. Through it the fluids or gases pass out. The shield or rim prevents its dropping in, and the canala itself prevents the hole closing or any foul matters going into the stomach. The name of this surgical instrument is written some times, trochar.

Subsoil Plows and Plowing.

Mr. M. C. Weld spoke upon this subject, and exhibited a plow. He said: The advantages of subsoiling can hardly be too highly extolled, and they have been a favorite theme of agricultural writers for many years; but when farmers come to put these fine theories in practice the cost was too great, and the implement was invariably thrown aside. Of his plow he said: The share or mole is so formed that it enters and passes through the ground easily. In so passing it lifts and cracks the soil on all sides of it, while that portion of the soil in immediate contact with the share is packed hard on each side by the first two-thirds of the share, and this compacted soil lifted by the wings or flanges on each side to form a more or less firm arch after the passage of the standard, thus acting like a horse-shoe tile, and preserving the track of the plow like a mole-track for a long time —an open channel for air and water to circulate.

Mr. P. T. Quinn—I do not call this plow new; I saw the original in Boston sixteen years ago, and have had one in use on my farm for thirteen years. It was invented by the late Prof. Mapes. If anything, mine requires less power to draw it.

The Chairman said that while upon the plow subject, he had a letter asking the Club to recommend a plow. He would state that the Club did not recommend anything, but invited exhibition and competition in farm implements.

Mr. A. S. Fuller—And desired to encourage excellence and improvement.

Black Moths.

Mr. A. C. High, White Deer Mills, Penn.—Our house is most prodigiously infested with the black moth, eating carpets and everything else. What shall I do?

Prof. H. E. Colton—The remedy needed by this gentleman and many others, is sulphurous acid solution; I wish to be distinctly understood—not sulphuric, but sulphurous acid. The sulphuric is intensely corrosive and dangerous; the sulphurous acid is not. A solution of this acid, if sprinkled on carpets that are to be rolled up for the summer, or in clothes or furs or other things likely to be attacked or supposed to be infested with moths, will kill all eggs or insects and prevent their coming. But, to make it of value, the clothes should be rolled up after sprinkling, as the virtue of sulphurous acid rapidly passes off into the air. Clothes which have been thus sprinkled and rolled up, lose all smell upon exposure to the air. I would again warn persons against confusing it with sulphuric acid, as that burns up anything it touches. The sulphurous may probably be bought for this purpose in alcohol solutions, as I have seen it announced that persons were manufacturing it. It is also valuable as a disinfectant.

Mr. D. B. Bruen—My old mother always used Scotch snuff, and with good effect.

Mr. A. S. Fuller—I think the sulphurous acid a good thing. It gives off the sulphur smell, which is well known to be hurtful to insects. Camphor is also good, red-cedar wood, etc., but these only act for a time. The sulphur smell would undoubtedly kill all larvae and insects.

SECOND-CROP POTATOES.

Mr. N. W. Pierson, Mt. Vernon Township, Fairfax county, Va.—There were some practical experiments in raising a second crop of potatoes reported at the recent meeting of the "Woodlawn Farmers' Club" of this township, which are of general interest, showing what can be done on the old neglected fields of Virginia.

At a meeting of the Club, held at the house of one of the members, on the 27th ult., several large specimens of early and late varieties of potatoes were exhibited, which led to a lengthy discussion on the subject of raising potatoes, especially of a second crop. Oscar Baker exhibited six Early Rose, raised from tubers grown this season, and six Monitors, weighing together twelve pounds. He stated that the first crop of Early Rose were dug about the middle of June. On the 8th of July he selected one bushel of the smallest potatoes, cut them, rolled them in plaster, and planted in sandy soil; the second year, from breaking up of an old neglected field, no manure or fertilizers having been used at any time, the crop was gathered the middle of November, and measured twenty-five bushels. N. W. Pierson reported having raised a second crop of Early Rose, planted on the 8th of July, harvested on the 20th of November. From one barrel of second-sized seed potatoes, cut, plastered and planted on a gravelly hill-side, he gathered ten bushels. The ground becoming very dry immediately after planting, caused many of the sprouts to die. T. S. Wright, another member, planted five bushels of small seed potatoes, same variety, and about the same time, on clay soil, which produced thirty bushels. Others reported having planted the same kind, about the same time, but failed to get any return crop; supposed cause, the long-protracted drouth, which continued from the second week in July until the second week in September. Perhaps the rolling in plaster had something to do with the starting of the sprouts. It seems to be a settled fact that we can raise two crops of Early Rose profitably in this section, this being the second season the experiment has succeeded. The specimen of Monitors exhibited were planted the first of July on the same ground as the Early Rose; no fertilizer used. With such specimens and such conditions, we may challenge any portion of the country this side of Nebraska.

Japan Clover.

Mr. C. Montgomery, Kingston, Jamaica—The Farmers' Club, as I see by its record, seems to be doing a good work in conciliating all races and sections of the Union into mutually instructive relations. The wants of southern agriculturists may be weighed with special advantages at this season, when northern tillage is taking its winter's rest. In the semi-tropical belt of Florida and the west borders of Texas and other States, there need be no cessation of out-door work throughout the year; and almost every man who can and will work, may easily acquire a comfortable homestead; but not one in fifty, even of the class who have some means, and would be glad to profit by instruction, know how to make use of their singular natural advantages of cheap land in a superior situation. For example, the value and the use of suitable green crops as alternatives and restorers of land after exhausting it by corn, tobacco, cotton, etc., is but little understood even in those sections where the cost of transportation alarms people out of the application of "imported" fertilizers. The Japan, or, as some style it, the "Georgia clover," may come, perhaps, to the rescue of millions of acres of old land at the south, if their owners but knew what could be done with it, and could get the proper seed. Can any member of the Club tell those who need it so much where the Japan clover can be had, and at what price? The express companies will deliver it even in the West Indies, where something of the kind is needed beyond expression.

In Jamaica, for instance, the superintendent of the Jamaica Botanic Garden would undoubtedly be glad of a small quantity to propagate, and he could give in return some seeds of the new "Gambia grass," on which they are now experimenting. It is noteworthy that the most valuable grass known in the pasture lands of Jamaica, came from Africa, and was introduced, like the Gambia grass, by sheer accident. The seeds of the Guinea grass were thrown out in the refuse of a cargo from Africa, and its strong succulent luxuriance attracted attention, and caused it to be cultivated. The same thing happened with the Gambia grass; and the packing trash of some Japan wares may have introducd the first seeds of the clover which has naturalized itself in Georgia.

The Farmers' Club and its reports may cause it to spread its bounties over the over-worked fields of the south, and possibly extend its blessings to the arable, but of late abandoned fields of Jamaica. If I have not already trespassed too much, let me add that there are thousands upon thousands of acres of once highly productive land now wholly abandoned, and offered in market at four, five and six dollars per acre, for want of some sure, quick-growing grass, that might be pastured a year or two and then plowed under for corn, potatoes, tobacco and sugar cane. Pray put the south, "and the isles thereof," in the way of trying Georgia clover; for if it serve the purpose, 10,000 poor struggling farmers will at once be taught the way to comfort and independence.

Adjourned.

February 20, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

ROOT CROPS AS FEED FOR COWS.

Mr. S. S. Bowman, Astoria, L. I.—How shall I feed mangel wurzels? Are they better than turnips? How much of either shall I feed to each cow? Will they taint the milk? In short, I should like to learn all about feeding root crops.

Hon. George Geddes—These questions come from a man who ought to go to a primary school; for this is one of the first questions on which a farmer ought to be posted. Mangels will make more milk, but it will be weaker than if turnips were fed; with either, there will be a bitter taste to the milk, and it is impossible to prevent this, so far as I know. The best feed for milk is the Silesian sugar-beet; it is sweeter than the common beet, and round like a turnip. I have raised 1,500 bushels per acre. I find roots are not fit to enter into competition with corn. They become soft and stringy when growing, and make poor food generally. For ewes with lambs by their side, the Silesian beet is very good; it causes a flow of good milk, and I can raise early lambs by feeding them better than with any other roots.

Mr. John Crane — There is no better way to feed roots than to cut them and sprinkle some cotton-seed meal on them. I have fed thousands of bushels, and I have found the Silesian beet to be the best.

Mr. Hauser — In Germany turnips are not raised; the mangel is the sole dependence among farmers there for winter feed. Eighty pounds a day, with hay and meal, is the allowance, and I never knew any bad taste to the butter; but they are more suitable to feed when the milk is sold, and not churned, as they make a large quantity of milk, but very weak and poor.

Dr. Isaac P. Trimble — I have had no experience with the mangel wurzel. The bitter taste it gives to milk and butter can probably be avoided in the same way as with turnips. Some years ago I had a very large crop of the common field turnip which I wished to feed to my cows, but knowing the prejudice of the family I consulted an old dairyman in the neighborhood. He told me to begin feeding them moderately, while the cows were still running on the grass, and gradually increase. In a few weeks they had half a bushel or more a day, and this was continued all winter. Of course they had all the hay and stalks they wanted, and with each portion of cut turnips there was a good sprinkling of Indian meal. The consequence was a free supply of milk and butter, and the most sensitive taster never suspected that the cows had been fed upon turnips. The turnips were given both morning and evening.

Peaches in New Jersey.

Mr. D. F. Easton, New York city — Will the Club please tell me what county in New Jersey is best adapted to the growth of such fruit as peaches, pears and cherries; and also where they are grown most largely.

Dr. Isaac P. Trimble — As to the peach crop in New Jersey, I can remember when nearly all the peaches grown in New Jersey, were from the country just round Camden and Burlington. As they failed there, we found them in Monmouth county, then Middlesex; soon after, Mercer and Hunterdon counties, bordering the Delaware river, were the peach counties; now we find them in Somerset and Morris, and next they will be in Warren. The peach tree, since the disease called the yellows has appeared, has no permanent abiding place, as it formerly had. It is, in fact, a migratory crop. Last fall I spent some days among the orchards in Morris county. A part of one planted thirteen years ago was still bearing, although the oldest in the neighborhood; like some of the old trees in our gardens, it seemed to have power to resist the yellows, while all round younger orchards were failing, and I saw several, although bearing their first crop, showed such unmistakable signs of disease that they would not produce a second crop. Young peach trees grown near where orchards have died of the yellows, are found to be short-lived. No peach-grower understanding the business will plant successive orchards on the same land, or even on the same farm. These men will buy farms adapted to the business and plant them all over with peach trees within a year or two. As those orchards fail they go to other neighborhoods. People who did not believe in the yellows, or that a neighborhood will not be tainted by a diseased orchard, have only to ask the peach-growers of New Jersey.

Mr. John Crane—Apples, pears and cherries also thrive in Morris, Somerset and Hunterdon counties, as well as peaches. As to the latter fruit failing to grow upon land lying near that upon which one orchard has died out, such has not been my experience. Nothing of the kind; on the contrary, quite the reverse.

Mr. A. S. Fuller—I don't believe what the doctor says about the yellows, though; I will engage to plant a peach tree on the same spot where one has died or been cut down, and make it bear peaches, and plenty of them.

Mr. John Crane—There is no such disease as yellows. I have an idea it is the excess of cold that injures the tree and causes this weakness called yellows. I have raised thousands of bushels, and never found any trouble in this way. Where there is iron in the soil, peaches seem to thrive better.

Mr. P. T. Quinn—There are localities which are more favorable to some kinds of fruit than others. South Jersey is better for strawberries; they grow better on a sandy loam; not that they will not grow as well on clay land, but the cultivation is more difficult and weeds are more troublesome. Therefore, if strawberries are to be grown, choose the light, sandy soils. As to peaches, Morris county is a good locality; but of late, peaches have revived generally and are doing well. The yellows is a consequence of debility, and is a sort of fungoid growth, which is not so common of late. Apples and pears need a well-drained soil, with a clay subsoil, and any locality where these are to be found will suit these fruits.

Chestnut and Apple Trees.

Mr. I. Chamberlain, Otsego, N. Y., wrote that "a chestnut tree in my yard is infertile. It blossoms, has burrs, but never bears a perfect nut. It is not yet so old as to preclude grafting. Can it be done, and how? Nurseries of sweet chestnuts are advertised. Could scions be obtained? Of the propagation of the apple by cuttings I know only this: In plowing, a small limb, crowded with fruit-spurs, was all but the upper extremity buried deep in the moist soil. Suspecting nothing on pulling it up, some six or eight weeks afterward, I found it vigorously rooted. I have had a similar experience with the peach. What possibilities are suggested by these accidents?

Mr. A. S. Fuller—The chestnut tree can be grafted in the same manner as apple or other trees, but the operation should be performed just before the buds begin to swell. Any one who can successfully graft an apple tree need not fear to try his skill upon a chestnut. I think, however, I should not trouble the tree referred to by this correspondent, because, if it does not bear nuts it is doubtful if grafts upon the same would do any better. Wait a few years and see if the tree will not perfect its fruit. The instances mentioned of apple and peach cuttings producing roots are interesting, and prove that these trees, under certain circumstances, may be propagated by cuttings. Whether this mode is a desirable one or otherwise, is a question which our correspondent, or others who wish to try it, can answer for themselves. It has always been known among horticulturists that such things could be done, but there being many other and better methods of propagation it has never been practiced to any considerable extent.

Drainage in England.

Mr. Henry Taylor again favored the Club with some further records of his observations and experience in regard to the English farmers' practices:

Drainage is of such vast import that no farmer can work to advantage unless this operation is fully and well done. It requires the most careful supervision and attention in all its details; for should drainage be imperfectly done, it is worse for the land than if it had not been drained; for imperfect work destroys the natural leakage that has been going on for generations. When it is necessary to operate, the first consideration should be the nature of the subsoil, and whether intended for permanent pasture or arable. If for the latter, and the subsoil should be of a strong clay tendency, the depth should not be less than four feet, and not more than twenty-one feet apart from drain to drain; on more porous soils, both the depth and width should be increased, and in some instances a single drain will sufficiently dry a whole field. This is the case where a single spring exists, and the residue of the land of a dry nature; but my experience is that drainage does great good in our most apparent dry subsoils, even should no water ever lodge on such land. I have known sandy land in England always foul and rough with couch grass — which is the arable farmer's greatest enemy — till one or two very deep drains have been inserted; and where even at the depth of ten feet no water was visible, still the subsoil if held in the hand a short time would leave moisture upon it; after drainage, the couch grass would entirely disappear in two years. The next important thing is the size of the drain tile. The pipe should always be of such dimensions that never more than half should fill with water, and the other half remain for the admission of air; for should the drain pipe become quite filled with water, and no air admitted, it can never operate, but will become stagnant in the soil. The drains, when freshly cut and the pipe properly placed, should remain open for a week or two, so as to enable the subsoil to become thoroughly pulverized, and should always be replaced in the drain in a dry state; the drainage will at once act upon the land; whereas, if the subsoil should be replaced in the drain in a raw or fresh state, it will take two years before action takes place. I have drained some thousands of acres in England — soils of all descriptions — and I found by experience that it was impossible to drain too deep. The average price per acre on one large estate was from five to eight pounds completed; the work was generally executed by piece or task work, the men earning good wages; and as the winter season is the best time to operate, gentlemen requiring draining to be done cannot better employ their capital than giving such kind of work to the laborer during the inclement weather when little else can be done.

REPORT ON BOYNTON'S LIGHTNING SAWS.

Mr. John Crane, from the committee to examine the lightning saw of Mr. E. M. Boynton, of Beekman street, New York, respectfully report that they have witnessed the operation of one of these saws upon a chestnut log about nine inches in diameter, slices from which were readily cut off by two men in four seconds. The same log was cut through in four and a half strokes of the saw when used without handles. As a rapid slicer of wood they therefore think this patent cutter deserves attention of farmers and eight-hour men, and that it is a labor-saving machine of the first water. For particulars as to the peculiarities and special merits of this saw, they refer to circulars and small bills, forwarded and circulated by the inventor, free of expense.

John Crane,
Joseph A. Slipper,
Norman Wiard,
Committee.

Adjourned.

February 27, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Grubs in Cattle.

Mr. G. C. Flanders, Topeka, Kansas—My herd is sorely afflicted with maggots in the back. They keep poor despite all my efforts to fatten them. The stock of one of my neighbors is similarly afflicted. He told me he had already lost one of his cattle, and he fears others will follow. He noticed they had licked themselves all over on the back and sides, and thought perhaps they were lousy. He examined one yearling and found no lice, but took out 112 large grubs. He then examined the rest, and found they were just as full. What is the cause and preventive?

Mr. R. J. Dodge—I always heard this disease called the warbles. The grubs should be squeezed out.

The Chairman—Dr. Smith stated, at a late meeting of the Club, that a decoction of aloes, with a little carbolic acid, was good for various pests on cattle. I suppose it would have the same effect on these worms. I always heard them called murrains, in my boyhood.

Mr. Henry Stewart—The larvæ of the gadfly is deposited in the back of cattle in July and August. This develops into this worm, according to my knowledge, called warbles. They are very irritating, and, where there are many, will affect the health of the cattle.

Mr. D. B. Bruen--The gadfly deposits its egg in the neck, too. I have seen dozens of sides of leather injured by the holes made by these worms. The tendency is to injure the health of the animal so as to make the leather dry and husky.

Prof. Henry C. Colton—I have seen this worm frequently at this season of the year. In some sections they are called "wolves." The preventive is to rub the backs of cattle with some substance which will keep off the gadfly in summer. It will not do to use carbolic acid where cattle can reach it with their tongues. I have seen common pine tar and grease used with good effect. Mix it well and rub it on the backs of the cattle. It is not likely to improve their looks, but it will keep off the flies.

Dr. J. V. C. Smith—Carbolic acid in its concentrated solution is very dangerous. I paralyzed my hand for a week by merely dipping it into the acid. I may add, rancid oil of any kind is good if put on when these worms are in the flesh; it will kill them by stopping the spiracles through which they breathe.

Mr. Henry Stewart—It will not do to kill them in the flesh. That causes frightful and dangerous sores. They must be squeezed out. Some kill by puncturing; that is equally as bad as Dr. Smith's plan.

Dr. Isaac V. Trimble—Since there seems some confusion about this matter it may be best to explain. The gadfly (*œstrus bovis*) is peculiar to cattle, while the botfly (*œstrus equi*) pursues the horse. The botfly is somewhat bee-shaped, while the gadfly is more like a common fly greatly enlarged. The most interesting circumstances about these insects are their peculiar but diverse instincts. The botfly will always deposit her eggs on such parts of a horse as will be within reach of the tongue of the animal, and these eggs, either before or soon after being hatched, will be licked off by the tongue, and by that means finally reach the stomach, where the young feed till they become full grown as grubs, and ultimately passing through the bowels and falling to the ground with the droppings, where they undergo their transformation to the fly or bee. These grubs have a curious arrangement of hooks, by which they attach themselves to the folds of the upper part of the stomach to prevent being prematurely carried down. Their food is the contents of the stomach; should this become empty for some time they will feed upon the walls of the stomach itself, causing pain, and sometimes death. In other words, the horse dies of what is called bots. The treatment is to fill the stomach as soon as possible with something for them to eat—apples, molasses and water, grass, if the horse is able to eat it. The gadfly, on the contrary, deposits her eggs on those portions of cattle that they cannot reach with their tongues; otherwise the irritation arising from the little punctures she makes, in which to deposit her eggs, would cause the animal to lick the part, and that would be fatal to the eggs. The grubs or maggots feed upon the living flesh, and by the next spring, when they have become large, cause protuberances like boils, many times causing great irritation, especially when the grub is about to emerge. I have seen cattle with heads and tails erect tearing over pasture-fields as if perfectly beside themselves. It is from these frantic capers, caused by the irritation of these maggots, that men who become unusually excited are said to have a maggot in the brain. The cell in which these grubs live has a slight covering like a little scab. Cow doctors, or even bogs on farms, can so pick off this scab as to withdraw the grub; this can be done with quiet cattle. As to other treatment, I find our unprofessional members go at once into the bottomless pit of quackery. One would oil their backs, but he does not tell us when or how often; another would daub them with tar (he is from North Carolina). Another, carbolic acid—one part to one thousand of alcohol—and still another would use snuff. But neither of these gentlemen tells us who are to catch or hold these cattle. Let us imagine the cow doctors of the Club on a visit of mercy to a herd in an Illinois prairie, where there are no fences—the cattle frantic with maggots, each doctor with his carpet-bag, filled with his favorite cure, all in full pursuit, the Chairman leading at the rate of 2.40—I hope I may be there to see.

Long Island Lands.

Mr. A. J. Hinds, Patchogue, urged that persons in pursuit of cheap farms need not go so far from home as some have supposed. In the vicinity of the town named there are heavy loams at light prices. Near the margin of streams the soil is sandy, but manure is cheap; oyster-shells in any quantity for three or four cents per bushel; bunkers, one-half cent per pound, etc. There are several improved water-powers lying idle, where saw-mills flourished in former days; splendid spring brooks, all having more or less trout in them. They can be bought cheap, and it strikes him very forcibly that, with brook-trout selling at one dollar per pound, and feed for fish at one-half cent per pound, there is money in pisciculture at Patchogue.

Abortion in Cows.

Mr. R. Emerson, Coopersville, Mich.—I wish to inform the Farmers' Club that I have no ax to grind, nor am I anxious to get into print, but have noticed in last week's proceedings of the Club the subject of abortion among cows is again called up, discussed and put away in the dark as usual. Now, I think I did not give eighteen years of close attention to the dairy business in St. Lawrence county, New York, without learning something about the business, and I do not know but I am in error, but I think I am about master of the complaint above mentioned, so much so that I am confident that I can take a dairy of forty or sixty cows, and carry ninety-five per cent of them through the year free from the complaint, and I have no secret about my management either; but I fear that if I should put on paper my experience, investigations, and the reasons why I have arrived at these conclusions, my paper would find its way into the waste basket on account of its length; but for your correspondent's benefit (Philip W. Lawrence, of Spring Mills, N. Y.) I will offer a few suggestions or give him a little of my advice: 1st. Never allow your cows to be driven or disturbed by dogs; 2d. Never keep a man or woman in your employ to attend to your cows who is passionate or quick-tempered, and will be likely to break a milking stool to slivers over the small of the cow's back while milking, because she moved a little to frighten off a fly or for some other cause; 3d. Be sure your stables are prepared with sufficient ventilation, and it is used when needed; this is very essential. If you cannot trust your own sense of feeling, put a thermometer in your stables, and keep the mercury as near the freezing point as possible, if you have to take off the siding in some place to do it. Be sure and not keep your cows too close and warm; 4th. Never feed your cows with mouldy corn fodder, straw or hay that is badly mow-burnt, or fodder of any kind that is in bad condition, and give them water, at least every twenty-four hours, that is pure; 5th. Never allow an animal to run with your cows that have sharp horns; 6th. See that your cows are provided, when it is icy, with a chance to get out to water, etc., without sprawling and straining themselves; 7th. Feed salt with a sparing hand. I suppose many members of the Farmers' Club will say — at least, I expect they will — that they cannot believe salt will cause abortion when fed to cows; but I am in possession of unmistakable evidence that it will, and that is enough for me. Never feed more than one table-spoonful per head each week, except from May 1 to August 1; then give the above quantity once in four days. I might write more upon this subject; but I fear that I have written too much now.

This letter having been referred to Mr. Harris Lewis, of Herkimer, he replied:

I like friend Emerson's rules up to rule seven. The first six have

I observed from my youth in the dairy business up. What lack I yet? Mr. Emerson will say, observe the seventh commandment. The instinct of the cow is a better and safer guide for her in regard to the quantity of salt she requires than Mr. Emerson's judgment and mine combined, with the judgment of the whole human family added thereto. If the cow gives as much milk as an ordinary goat, the milk would contain more salt than Mr. Emerson allows, to say nothing of the salt required by the cow for other purposes. Again, cows feeding on salt marshes, or anywhere in Ireland, or on the shore of any body of salt water, would never carry their young the full time, provided salt produced abortion. I never knew a cow furnished with salt at all times, so that she might eat it in just such quantities as she desired, injured by it. I apprehend that neither Mr. E., nor any other man living, fully understands the kind or cause of abortion we have in central New York. We have cows here treated in the most brutal manner, and fed on the poorest kind of food, which do not abort, and we have others treated in the most gentle manner, with the best of food and water, with air as pure as heaven sends it, with every want supplied and every desire gratified, which do abort. Abortion prevails in some of the dairies of Herkimer where no salt is given, and has for years, and in some dairies which have had salt it has entirely died out and disappeared, without any change of stable, food, care, water or treatment. Years ago many dairymen in central New York would turn off all abortive cows and purchase others; but cows which have aborted are no more liable to repeat it, than new ones brought on from sections where the disease does not and has not prevailed. I have expended a considerable amount of time and money to ascertain the cause of abortion, and shall continue my investigations for some time to come, unless the cause is discovered. As the case now stands, brother Emerson knows that salt will cause abortion, and I know it will not.

Inquiries from Puget Sound.

Mr. E. Meekes, Washington Territory, wrote: I wish to compost stable manure for my hop-yard. The soil is sandy, alluvious bottom land. I cannot get muck convenient, but there is plenty of clay within half a mile. Will the clay answer as well as muck for an absorbent, and, if so, what proportion is it advisable to use where water is applied to the mass and the drainage returned, as recommended by Waring? Hops are at home in this climate and soil. One crop of two acres three years ago yielded 5,000 pounds the second crop. The average for five years has been near 1,500 pounds per acre, without manure, and, so far, without disease. The absence of high winds in summer, the equable temperature, and the deep, rich soil of our valleys, all point to this locality as a great hop-growing region, whenever we obtain direct railroad communication with the east, or acquire a dense population of consumers. Nor is this all. We can raise wheat as well as hops, fruit of excellent quality and without stint, and I defy any location on the continent to excel this climate for butter-making. The nights are always cool, the grass green for more than nine months in the year, and roots of all kinds easily and cheaply raised. We have used cans twenty inches high and eight inches in diameter for three years, and like them better each year. We set in a tank filled with water from the well, which, when first drawn, is never above 55° Fahrenheit. When the water in the tank gets above 65°, a few bucketsful of water from the well, added through a spout discharged into the tank at the bottom, and which displaces an equal amount of the surface water, soon restores the proper temperature. This locality will eventually be a famous dairy region. I send you samples of Puget Sound wheat and oats.

Hon. George Geddes pronounced the wheat very fine, and of the variety known as the Soules, a little darker; but would be classed as amber wheat. Mr. F. D. Curtis said the oats were very good and well cleaned.

IMPROVED CHESHIRE OR YORKSHIRE PIGS.

Mr. S. S. Gardiner, Watertown, New York, wrote as follows:

So much has been said through the newspaper press in regard to this breed, that I feel it a duty to give the public the information I have never seen published, in regard to the origin of this popular breed of hogs, and to correct a statement made last spring by F. D. Curtis. T. B. Stanley, of Cambridge, Massachusetts, wrote to the American Institute Farmers' Club: "Sometimes I see the hogs bred in Jefferson county, New York, called the Cheshire, and sometimes the Jefferson county breed. I should like to know which is correct, and if there were ever any hogs imported into this country from Cheshire, England." In reply, F. D. Curtis said: "There is a family of hogs in Jefferson county, New York, which has been bred long enough to be called a breed, which was established by crossing the Yorkshire with the native breed, and subsequently with hogs imported from Canada. They are a good breed of white hogs, and are called Cheshire by a number of the breeders of them. This is a very fanciful name, but when the pretension is coupled with it that they are Cheshire, and descended from hogs imported from Cheshire, England, then the name is very improper. It would be better to call them Jefferson county, and be truthful and consistent, and follow the example of Chester county, Pennsylvania, as they have done with their pigs, the Chester county whites. I do not believe any connection can be shown between the so-called Cheshires and any hog in Cheshire, England. The breeders of Jefferson county have done a good thing, and they need not be ashamed to give their county the credit of it." I think Mr. Curtis must have received his information from breeders in the south part of this county, who breed by crossing the Yorkshire with the improved native hogs, and sell their pigs under the name of Jefferson county breed; whereas the original breeders still adhere to the name of "improved Cheshires," the name given to them at the State fair held in Utica, New York, in 1863. As to the relation this breed has to the Cheshires of England, the public can judge by the statement I have from T. T. Cavanaugh, of Watertown, New York, who is the originator of the improved Cheshire hogs: "Some fifteen or eighteen years ago (the exact date cannot be readily ascertained) Mark Rice, of this county, bought a boar pig of Mr. Woolford, of Albany, New York. Mr. Woolford said this pig was from a pair of hogs he imported from Cheshire, England. Mr. Rice crossed this pig with his native hogs, breeding in for a few years, which made a great improvement in them." In 1860 Mr. Cavanaugh bought a boar pig from the stock of Mark Rice that he crossed with a sow pig he bought of some dealers in stock, who imported from Canada a sow that they called a Cheshire sow. From this pair Mr. Cavanaugh raised one boar and two sow pigs. The improved Cheshires are highly prized by breeders in the west and south. Colonel F. D. Curtis, writing in the New York Republican of the exhibition of swine at our last State fair, very truly states that "some of the breeders of the Cheshire and Jefferson county hogs are in danger of bringing that breed into disrepute by mixing them with hogs of different characteristics and points and still adhering to the name. In this way confusion arises, and a difference which is noticeable and which begets disgust. A breed is a breed, and for why? Because they (the specimens) have characteristics which are similar, and which are perpetuated from parents to progeny; they become thoroughbred when their peculiarities are transmitted in the blood without difference or change. This principle is obviously upset when we see in the same litter of pigs some with upright ears—a distinctive point in the Jefferson county breed—and others with lap ears, which marks the Chester white and large Yorkshire. Humbuggery may flourish for a season, but the end will come." Some breeders in this county are crossing Yorkshire with Chester whites, and others, as before stated, are crossing Yorkshire with the improved native hogs, and are selling them under the name of Jefferson county hogs, for they dare not sell them under the name of improved Cheshires. The above are the principal reasons why the breeders of the original improved Cheshires still adhere to the name of improved Cheshires, and protest against any change of name, but call them the improved Cheshires of Jefferson county. The distinctive characteristics and points of excellence in the improved Cheshires, and which the breeders of the genuine adhere to are these: They are pure white; fine, thin hair; small, thin, erect ears; short, dishing face; short leg, with good length of body; heavy ham and shoulder, light tail, and of very fine bone for a large hog. They are good breeders and take flesh rapidly at any age. The breeders of these hogs claim that they will make more pork, according to the feed, than any other known breed.

Mr. C. D. Bragdon—The statements made in the paper read do not prove but that these hogs may have been Yorkshires. Coming from Cheshire does not make them a Cheshire breed any more than hogs bought in Hamilton county, O., makes them a Hamilton county breed. They may be Yorkshire, Victoria, or anything else. The description answers to Yorkshire. It is well enough to call them Cheshires, or any name the breeders choose, just as well as Jefferson county, notwithstanding our friend Curtis. One thing is important, the breeders should settle on something definite and stick to it, and it is always better to have an appropriate name if possible. I do not recollect of ever hearing of a Cheshire breed of hogs.

Frank D. Curtis—The general statements of the paper read are correct. I have seen the big hogs described and am acquainted with the leading breeders. I knew before, that there was a tradition in Jefferson county that the swine spoken of were descended from Cheshire, England. Mr. A. S. Clark told me years ago that they originated from a sow brought from Cheshire, England, and that he had crossed them upon hogs imported from Canada and improved them, and he gave them the name of "improved Cheshire." Now because the tradition is changed to a pair of pigs imported from Cheshire, that does not prove the breed to be Cheshire, because Yorkshire pigs could be imported from Cheshire, and I am still unconvinced that there ever was a thoroughbred breed of hogs known as Cheshire. There is no objection to the name Cheshire if the pretension regarding the origin and breed be left off. I trust the coming convention of swine-breeders will settle all these vexed questions, and that our Jefferson county friends will be on hand to vindicate their excellent swine.

Exterminating the Wild Violet.

Mr. J. E. Hopkins, Haddonfield, N. J., complained that some roots of the wild violet which his little daughter planted in the lawn six years ago have increased and multiplied to such an extent that the grass is almost exterminated. He has tried guano, marl, lime, stable manure, etc., all of which seem to agree with the violets. What shall he do about it? Mr. Hopkins further said:

Professor Cook, in his address, November 28, before your Club, spoke of the effect of nitrate of soda as applied by Mr. Lawes of Great Britain, rooting out the weeds more effectually than any other dressing. But the clovers did not come in. Will nitrate of soda have the same effect upon wild flowers as upon weeds? If so, how is it applied? I have on my farm a blue marl that will bring in the clovers if we can only destroy the violets. It was on this marl bed I discovered the fossil remains of the Hadrosaurus Foulkii, a copy of which Professor Hawkins has set up for the use of your Central Park. P. S.—Is cockle, ground with rye, injurious to stock?

Mr. A. S. Fuller—I should not think there would be any difficulty in destroying our native violets in grass lands. If the soil is made rich enough to yield a heavy crop of hay, the violets and other small weeds will be smothered. Top-dress the lawn this winter with manure from the barn-yard and in March sow a quantity of timothy and red-top seed, and next mow the lawn until the grass is fit to make into hay, and I think the violets will disappear. Lawns that are kept cut very close for several years in succession are liable to become foul with weeds and mess, and they should occasionally have rest, or, in other words, the grass should be allowed to come to maturity. Do this one season, and the amount of good grass in the lawn can be readily determined, and one can commence renovating understandingly.

In regard to the gentleman's question about cockle in rye, I think his stock will not be injured thereby. Of course I am not certain as to the plant referred to, but suppose it is the *Lychnis Gettrago*, a common weed found in grass fields almost everywhere. Its leaves are somewhat hairy, flowers showy red purple, and seeds black; it is sometimes called corn cockle.

THE HORSE-CHESTNUT.

J. A. Whitney, Natick, Mass., stated that he had tried, without success, to propagate this tree from seed. Should the shell of the nut be opened before planting, and when is the best time to plant?

Mr. Fuller—Horse-chestnuts, although large and coarse seed, are very delicate, and it requires considerable care to keep them safely through winter. If they are spread thickly upon the surface of the ground and then covered with leaves or straw, just enough to keep them from drying, they will usually be in a good condition for planting in spring. The husks should be removed from the nuts; in fact, it will come off as soon as the nuts are fully ripe and dry in fall. If the nuts are allowed to become so dry as to shrink they mould, and if kept wet and warm they rot. Therefore, the proper condition to preserve vitality is cold and moisture combined. I have kept them through winter in pure sand placed in a box, then set it in the open air. In spring sow in drills, not covering the nuts with more than one inch of soil.

THE ALIANTHUS.

Mr. W. E. Kibbee, of Kansas, asked in regard to the alianthus, which, he says, grows very rapidly in his State. Is it worth cultivating; is it a durable timber; had he better plant a large grove of it?

Mr. A. S. Fuller—Alianthus seed grow so readily that there is little need of any preparation. If the seed have been kept dry all winter it may be necessary to soak them in warm water for a few hours before sowing. They should be sown early in spring and not covered very deep—a half inch in depth is sufficient. The alianthus has a few good qualities, but many bad ones. Among the most prominent are, first, the large trees are liable to be broken down in summer by strong winds, as the branches are very brittle; second, if the trees are cultivated, every broken root will produce more or less suckers, which are not desirable either in a forest or orchard; third, the staminate flowers exhale a most nauseous fragrance, and, although this does not continue many weeks, still, where the trees are abundant, one is reminded that the common Chinese name, "Tree of Heaven," is sadly misplaced; fourth, the tree grows rapidly while young but seldom attains a great size, not even large enough for railroad ties. The timber is valuable for fuel, posts and stakes; but there are so many native species of trees possessing more desirable qualities, which will flourish equally well on the prairies, that I would not recommend the alianthus.

Grain to be Named.

Some samples of a supposed new grain were exhibited as sent from Jefferson county, N. Y.

Dr. F. M. Hexamer—This is a wheat called in Germany the *spelt wheat.* It makes a better flour than our wheat, but is harder to grind. Mr. Hecker has raised some near this city.

Mr. Hauser—The spelt wheat grows in south Germany, and has to be ground in peculiar mills. This is the variety called the Emmer spelt. It is somewhat like two-rowed barley. It is sown in the spring, and matures about the same time as oats and barley.

Mr. S. E. Todd—This grain has been grown for some time in Ohio under the name of "skinless barley."

Mr. A. S. Fuller—Persons who want grain named should send a head. The botanical differences are easily determined if one has the head of the grain.

Adjourned.

March 5, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Wind-mills.

Several letters received during the past few weeks indicate that the importance of utilizing wind-power is beginning to be appreciated. Mr. M. E. Reynolds, Mendon, Ill., wrote to express his conviction "that wind-mills can be built so that they will be efficient for almost any purpose, from pumping water or churning to grinding grain, from half man-power to forty horse-power, and at an expense but trifling compared to steam power."

Mr. A. L. Fuller—These correspondents are all correct. There is not a farmer who could not use a wind-mill to advantage, were a cheap, efficient and durable one obtainable. It would be a blessing to the entire country if inventors would turn their attention to this subject. The day is coming when irrigation by means of wind-power will be almost universal, and this is only one of the good results that will follow the general introduction of the wind-mill of the future.

Mr. Henry Stewart—I have made inquiries about the cost and power of wind-mills. A mill costing $125 is only one-sixteenth of a horse-power. A six-horse power costs $1,000. At these prices a steam-engine would be cheaper. A portable self-regulating wind-mill is too light for heavy work. Probably four-fifths of the country mills in Great Britain and western Europe are worked by wind-power. The mills are heavy buildings of stone, of a conical shape, with arms and sails thirty-six feet long, which give considerable power; but such mills are not adapted to the use of American farmers for irrigating purposes, and yet they need a heavy building for the necessary stability in carrying machinery. How they are going to get this in a wind-mill is not very apparent as yet. At present, wind-mills are not satisfactory.

Prof. Henry E. Colton—During a visit to eastern Long Island last winter, I saw a large number of wind-mills doing a great deal of work, and doing it well. One in Easthampton ground corn and wheat, and also had bolting apparatus. It made excellent flour, and the building, as it now stands, is over seventy-five years old. I do not now remember what it cost, but it was substantially built, full twenty-five feet high and fifteen broad at the base. Dr. Smith has alluded to the famous mill at Potsdam, and to the anecdote of Frederick as showing the respect of right and justice in Prussia. This mill at Easthampton ground corn before Frederick William began to reign, and at its base was held the first meeting to protest against the aggression of the British king upon private and chartered rights. The fans or sails of this mill are arranged so as to tack, and the upper part of the mill is fixed on great rollers. I think in a good breeze it would grind 200 bushels of corn per day. I saw others—light, airy structures—which are used for pumping water. The Long Island and Southside railroads have several of them.

Making Barn-yard Manure.

Mr. S. W. Stebbins, Portland, N. Y., wrote: "As long ago as the time of Virgil it was held that the foundation of good farming was to have a big dunghill. I propose to show how we in Chautauqua county are effecting this desirable object. First, our farmers, especially dairymen, find it profitable to buy western corn; the manure thus gained, at least, is clear profit. This alone in time must result in transferring the fertility of the west to the hills of Chautauqua. I have a strip of ground, with a fence on the south, much haunted by the sheep, which has become rich. I intend to move this fence, so this rich piece shall go into meadow, and the sheep may fertilize another strip. We are working gradually toward soiling. Nearly all feed corn-fodder through the latter part of the summer, and many stable their cows nights through the entire summer, feeding meal until something green grows large enough to cut. I stable my cows, using forest leaves, scrapings from the wood-shed, etc., for bedding, which gives a large pile of summer-made manure. In scraping together absorbents for the stable, the great thing is to be thoroughly imbued with the precept "that every little helps make a muckle." I have been feeding each cow two quarts of meal a day this winter, and find they eat hay and even straw clean, and do better than when allowed to pick over and waste it, without meal. So long as butter and meal bear their present relative price, the farmer who keeps cows may fatten both his wallet and his land.

Black Walnut for Woodlands.

Mr. H. C. Smith, North Londonderry, N. H., seeing it stated that "black walnut might be grown in New England as easily as any of our common forest trees," came to the Club for information regarding the successful planting of the nuts and subsequent culture. He says there are thousands of acres of rocky hillside in his State that are nearly worthless, except for the growing of trees for wood and timber, and he very naturally concludes that if the foregoing statement is true, there is "no reason why the black walnut may not become, in time, as common on our hillsides and in our pastures as the white oak, white pine, or any of our hardy but less valuable varieties."

Mr. A. S. Fuller—It is to be hoped that Mr. Smith will take the initiative step towards covering the hills of New England with valuable timber. There are hundreds and thousands of acres of barren hillsides that might, with very little expense, be made to produce almost as great a return as the best of arable lands in the immediate neighborhood. Black walnut trees will thrive in such situations, and all that is required is to raise the trees in nurseries, and, when two or three years old, transplant them into the situations where they can grow to full size. The nuts should be procured in the fall as soon as they fall from the trees, and either planted immediately, or left where they will remain moist and cold until spring. I have always found it best to transplant when the seedlings are one year old; at the same time cut off about one-third of the tap-root. This shortening of the tap-root causes the plants to throw out numerous side or lateral roots, which penetrate the surface soil, and the trees grow more rapidly in consequence.

Mr. Wm. Lawton—Mr. Fuller is right; the tap-root should be cut off. I have trees ten and twenty years old growing on my place; I have transplanted frequently; they are trees of great beauty, and none yield so rich a return to the planter. The seeds can be bought anywhere; they sell well in this market, and go far toward paying for the expense of planting the trees and interest on land.

THE MILK BUSINESS.

John S. Higgins, Flemington, N. J.—The farmers of Hunterdon county have been engaged for the past two or three years in sending milk to New York, and have found many abuses and irregularities connected with the business. These we would like to see corrected, if possible, and, with this end in view, we would ask whether a milk convention could not be called in your city, consisting of milkmen shipping on the several railroads, and some of the principal dealers and consumers in the city. Some of the questions which we would like to hear discussed are as follows: Would it not be better to have milk disposed of in New York, like the majority of commodities, by agents, or on commission, giving a certain per cent for selling? Could all the milk on each road be sent to one place, as far as practicable, and have an inspector to test the milk at irregular times, say every two weeks or monthly, and mark each shipper's milk according to the test? Could not the abuse of selling so much adulterated milk, in this or in some other way, be greatly prevented, and farmers be secured from losing so much money among the (I will not say dishonest, but) small and irregular milk dealers? By selling on the platform, or at milk depots, at cash prices, would not a uniformity of prices prevail throughout the city, and all dealers stand on the same equality as to prices, and healthy competition be secured; and would not the business be thus made more regular in supply and demand than at present?

Mr. Hart — I am glad this letter has been read, for it happens that I have come all the way from West Cornwall, Conn., with the intention of asking similar questions here, and this gives me a good excuse for soliciting your indulgence. I hold in my hand a slip of paper containing a few figures, which I have been at some pains to collect, and which may not be wholly uninteresting. I find that about 8,000 forty-quart cans of milk are consumed daily in this city; that at least three quarts of water are mixed with the contents of each can [A Member — Better say three gallons], or 24,000 quarts per day. This, at ten cents a quart, makes the snug sum of $2,400 daily, or nearly $1,000,000 a year. This is certainly worth saving. Again, if some way could be contrived by means of which the producer and consumer could be brought together, milk could well be afforded a cent a quart cheaper, and this would secure another saving of something like a million more. As the matter now stands, the producer and the consumer have no voice. The middlemen fix the price, and both producer and consumer suffer. I would like the Club to consider whether it is not possible to adopt some system of co-operation, and thereby serve the general interest. Hitherto efforts in this direction have failed, chiefly, I apprehend, for want of light.

The Chairman — As "reform" seems to be the watchword of the period, I see no good reason why the milk producers should not take their turn. But there is something to be said on the other side of the subject. The middlemen seem to be, at the worst, rather necessary evils. They have opportunities and facilities consumers do not have. I admit they make money, but many of them have large amounts invested in their business in teams and wagons. I know one who has over $100,000 thus invested. The saving the gentleman proposes is so slight that it will hardly be noticed. The money these milkmen make comes out of a large number, and spreads over a great surface; no one feels it very greatly. For my own part, I fail to perceive just how the proposed improvements are to be brought about.

Dr. Isaac P. Trimble — Has Mr. Hart any plan?

Mr. Hart — If agitation brings rewards "in ways that are dark and tricks that are vain," one would say it ought to do something in a cause so conspicuously good as the one under consideration.

Hon. George Geddes — In Syracuse there were formerly no less than half-a-dozen milk-carts running through all the streets, and making the early morning hideous. After a while it occurred to somebody that the machinery might be considerably simplified, and so it has come about that the town has been divided up into districts, and there is no such waste of time and crossing of paths. But a plan that might work like a charm in what, by contrast with New York, is only a four-corners, might be of no consequence here. I have in mind a farmer who thought he could do something toward reforming the evils of the milk business. So he hired a shop in Buffalo, and advertised to furnish pure milk from his own farm at considerably less than the milkmen were charging at people's doors. But this best-laid plan failed to work well, and the enterprise was abandoned. People could not afford to send a servant half a mile for the sake of saving two cents on a quart of milk. We may talk about the middlemen as much as we like; but I apprehend they will continue to live and prosper. The whole business of this great city is merely a complicated system of exchanges. The same is true the world over.

Mr. John Crane — In Newark and Elizabeth several families are supplied directly by farmers, who contract to drive past their doors every morning. The plan works well. On the New Jersey Central railroad, a few days since, I met a man who sells his milk in New York, and told him of this talk about middlemen. He replied: "We clubbed together, a number of us, and we appointed one of our sons to go to New York to take charge of the milk and sell it; therefore, we do not get fleeced."

Mr. Hart — That is bringing producer and consumer together — the very thing we desire to do, only on a larger scale.

Mr. Henry Stewart — I am told that very large returns are made by the owners of condensing establishments. I have heard of one where the profits are $1,800 a day from the manufacture of 5,000 gallons of milk. Perhaps the farmers might take a hint from this statement.

Mr. R. J. Dodge — The general public are not educated up to an appreciation of this commodity, and, what is more, they are not likely to be till the system of manufacture is reformed. I have tried three or four different brands of condensed milk and find them all impure. One sort, after standing a while, collects on its surface a kind of greasy butter; another has a smell and taste of arrow-root or starch.

Dr. Isaac P. Trimble — I never found any that did not have a peculiar, and, to me, disagreeable odor and flavor.

The Chairman — I have used condensed milk for five years, and have no cause to complain.

Mr. Simeon Baldwin — I find the condensed milk drawn from a reservoir in the wagon much superior to that put up in cans, and sold by grocers. But the latter keeps best.

Dr. J. V. C. Smith — In Illinois, I had a chance to witness the processes, and I was impressed with the neatness that characterized all the operations.

How to make Maple Sugar.

Mr. E. Mussey, Rutland, Vt., gave his views on this operation, as follows:

The season for making maple sugar is so near at hand that I am disposed to give to your Club the benefit of my experience. First, use Post's metallic spout and bucket-hanger; second, tin buckets; third, an evaporator; and fourth, covers to the buckets. I assume that all good sugar-makers have a sugar-house with two sheds attached, one for the wood-pile and the other for the sap reservoir. Neither sap nor wood should be stored in the boiling-room, for the reason that the dense steam that sometimes cannot be avoided, combined with the heat, have a tendency to sour the sap and dampen the wood to a degree that it will not burn freely. If old wooden buckets and spouts are used, scald and mop them thoroughly, dip into boiling lime-water and rinse in clear water. Treat gathering tubs and reservoirs to the same. I have effectually cleansed sour buckets and spouts in this way. If pans are used to boil in, syrup-off at least twice daily. Sugar cannot be white if made from sap that is boiled in a pan all day long. The quicker sap is boiled down and converted into sugar, the whiter and nicer will be the product. When the sap has reached a point that it will drop from the edge of a dipper in a sheet an inch broad, the syrup may be removed from the pans and taken to the house. Strain at once through a felt bag, and "sugar-off" immediately, in a pan the size of the top of your cooking-stove. If not convenient to sugar-off, strain into a tall, conical tub, technically a "settler," and leave over night; in the morning draw off above the settlings. To clarify, some use a quart of milk to each 150 pounds of syrup; others use eggs, but neither are of any use. The best spouts are Post's; they are made of iron, galvanized half-inch, and require no nail; will not sour; thaw earlier, run later, and do not, like wooden spouts, hermetically seal the outer pores of the tree. Post's indented tin buckets are as good as any. They fit closely to the tree, are deep, with a small diameter, and hang from the spout upon two points, by a hole under the rim, and cannot swing or twist. They hang nearly perpendicular, readily pack into each other, and altogether are a long step toward perfection. The advantages of an evaporator are too obvious to enumerate here, its distinguishing characteristic lying in the fact that the sap is over the fire but a bare half-hour, and runs from the discharge-pipe in a clear, amber, honey-like stream. All who have used them in this vicinity, concur in the opinion that this is an improvement, as marked, as the difference between the crotched stick and kettles of our early remembrance and the sheet-iron pans now so common. For a cover, use a square foot of pine or poplar, three-quarters or a full inch thick, either planed and painted or not, as you please. The points to always keep in mind in sugar-making are, first, keep out dirt; second, keep all receptacles and utensils scrupulously clean and sweet; third, filter, strain and skim; fourth, boil the sap down as soon as possible. Thorough cleanliness and dispatch at each step are essential, otherwise success in producing a product of the highest quality cannot be perfect.

CODLING MOTH TRAP.

Rev. John Weaver—I have received a letter requesting me to inquire of the Club the value of Wier's Codling Moth Trap, and how it is made.

Mr. P. T. Quinn—At the meeting of the American Pomological Society, in Richmond, Mr. Wier exhibited an apparatus for catching the codling moth, which appeared to be simple and effective. It was three pieces of board, of fan-shape, fastened in the small middle with a screw; by this they were attached to the tree. The boards were folded together and fastened to the tree. The moths would seek a hiding place between the folds, and once or twice a week the folds were opened and the moths killed. C. V. Riley and other eminent men of the west approved it. It is a patented article, though; and no farmer has a right to make one for himself.

Dr. Isaac P. Trimble—I have studied the habits of the codling moth very closely, and must say that this trap is a very good thing. It affords just the shelter the larvæ look for. But there is one thing needed which it does not supply. The larvæ fall to the ground with the apples, and by a curious instinct make directly for the foot of the tree and mount it directly, upwards, to seek a scale of bark or some similar shelter beneath which they may hide. Now, here is where this trap fails, and where the hay rope tied round the tree is an improvement on it. The trap only attracts those which directly meet it, and all those which pass up the tree on either side are missed. If the hay rope is property made it will be more successful than this trap; and yet this trap is a very good thing in its way.

Mr. Henry Stewart—Three flour-barrel hoops, one outside the other, fastened with a nail tight round the tree, will furnish a hiding-place for them. The patent trap is useless to be recommended here, because farmers cannot make them and no one knows where to purchase them.

STEAM PLOWING IN ENGLAND.

General J. H. Van Allen, New Hamburg, N. J., read a paper on steam plowing as now practiced in England, full of practical data as to its cost and the great value to the agricultural interests of that country. From his paper we learned that steam plowing, there was conducted by companies, who took contracts and did the work for a whole township. By request of the author the paper will not appear until a future date.

On motion of Dr. J. V. C. Smith the thanks of the Club were unanimously tendered to General Van Allen for his interesting and valuable paper.

Chairman Ely stated that the gentleman who had thus given us his observations was one of nature's noblemen and a gentleman of great ability, as well as devoted to the farming interests of the country.

Fish Farming.

Mr. A. J. Hinds, Patchogue, L. I.—Thirty years ago, when a boy, I was engaged most of my time in Washington county, N. Y., in taking brook trout from the mountain streams for parties living at Saratoga Springs, who came after them once in three weeks, paying thirty dollars per 1,000, or twenty-five cents each for large ones. I find at this time several of my neighbors similarly employed, selling trout in this season for one dollar per pound, while young fry bring fifty dollars per 1,000. In all mountainous and hilly countries there is more or less danger from freshets. As our land is nearly level and quite sandy, there is no danger from this source. Our streams are all made from springs, and quite short, so there is no failure of water in dry seasons. But the great advantages over all large fish farms, to be established in the interior, is cheap food. I have been visited by some of the most noted pisciculturists during the past season, who were looking for a location for future operations in case the time should come when close competition should render such a change necessary. They all admit that we have all the advantage in food. While they pay from five to ten cents per pound for plucks, etc., we get fish minnows, etc., for less than half a cent per pound. But they say, with present prices, they make it pay well. Several of my neighbors do not pretend to hatch any young trout, but depend entirely on catching them from the streams, all of which have more or less trout in them, but are growing less every year. These men sell from 1,000 to 2,000 a year. I know of a lady who has about 500 in a pond only about twenty feet square. She paid twenty-five dollars for them a year ago last August. They will be two years old next Spring. The amount fed the first six months was about one-fourth pound of liver per day, and since that time not over one quart of minnows every two days. The whole cost of food has not been ten dollars. Many of them will weigh over one pound each; they will average one-half pound apiece, and are now well worth $250, while they have furnished a large amount of pleasure in watching them jump and play. I speak of this case in particular to show the Club that this is good business for women, invalids or cripples—in fact, any one with a little capital to build a house, dig a canal, etc. All of our streams have a narrow valley of muck, usually from ten to twenty rods wide. This muck makes excellent manure with the addition of a little lime, ashes, etc. The idea that ponds are necessary for raising trout is erroneous. Ponds are only necessary for Clubs or gentlemen of pleasure. Ponds make the water too warm in summer and too cold in winter, beside the risk of the breaking of dams and losing your trout. They breed some natural food, but that is no object in this country, where food is so cheap. Dig the canals deep, put in the screens, let the current run as rapidly as possible; with no head of water there can be no breaks. I came to Long Island in August, 1860, to recuperate; and by the way, strange as it may seem, I think this just as good a place to emigrate to, even to make money in, as the west or south. As to health, it certainly is far ahead of any malarious country; in fact, I believe the blessings of God are very evenly distributed over this sin-stricken land, and more depends on the man about succeeding in any business than the place he selects. I spent five years in the cranberry business, in which I succeeded very well, making about $1,000 a year. I next bought some 200 acres near the terminus of the South Side railroad. I first built a dam and raised a pond of some four acres, seven feet water. I then placed in my upper flume, which is twelve feet long by four feet wide, boxes suspended six inches below the surface of the water, filled with gravel. In this flume I placed seventy-five adult trout. They spawned in the boxes and began to hatch in February. From this beginning I started my pond, so that in three years I was offered $1,000 a year by a gentleman who wanted to get up a Club at that time. The next fall I made a spawning race, 400 feet long, two feet wide, of boards. In this race I placed galvanized wire screens, one-fourth inch mesh. I wished to try the experiment of extending the race and letting the eggs lay and hatch natural. My first and great mistake was in supposing that the eggs should go through the screens, which were two inches above the bottom of the race. I had about two or three inches of coarse gravel on the screens at first, and after the trout ran up and filled the screens, I found there was a muddy sediment settled at the bottom. Eventually I found I hatched only about 9,000 or 10,000. These were where the gravel was heaped up by the trout, and the eggs never went through the screen at all. So I concluded that the space under the screens should be at least four or five inches, and the gravel on the screens should be at least five or six inches thick; then with one-fourth inch muck, very few if any spawn would go through, while all sediment would settle to the bottom. But to hatch a large per centage of the eggs, flannel strainers, at intervals, would be necessary. I believe that natural spawning races, constructed so that you can shut the fish and everything out, and also keep the young fish in, is all that is necessary for raising trout for market. I wish to say one word about artificial spawning. Some think the fish have feeble constitutions. This depends entirely whether you merely assist or force nature. Eggs taken by a gentle pressure, when the pair are in the very act of spawning, are ripe, and you cannot hold the trout careful enough to prevent them emitting their eggs. Just so with the milt of the male. But it has been proved that they will hatch, under certain conditions, when taken a week or so before they are ready to spawn. In that case they are weak. It must not be inferred from these remarks that it is necessary for one, to make a good business and succeed in raising trout for market, that he should understand all the minutiæ of spawning and hatching trout, as in most cases it will be found best to buy the young trout. Besides, hatching trout is a trade that requires a good deal of experience in order to succeed.

Adjourned.

March 12, 1872.

Nathan C. Ely, Esq., in the chair ; Mr. John W. Chambers, Secretary.

Knobs on Cherry and Plum Trees.

Mr. H. W. Gifford, Lakeport, N. Y.—About six years ago, I cut from my cherry and plum trees some knots and put them in a box in the sun. They remained about two weeks and then hatched out a small grub or worm about half an inch long, which showed to me that this knot originated from being stung by some insect.

Mr. A. S. Fuller—It will not do to jump at conclusions in matters of this kind. If grubs are found in such positions, it must not be taken as conclusive proof that the black knots on plum and cherry trees are of insect origin. If these knots were true galls, we might suppose that they were insects, but they are not; therefore, the finding of the larvæ of insects in them merely shows that they have been used as the nidus for some female insect to deposit her eggs. The female curculio will often deposit her eggs in these knots while they are young and soft, provided there is no fruit upon the tree, which of course would be preferable; but she must lay her eggs somewhere, and a knot will answer if no better place can be found.

I have known a certain species of curculio to deposit its eggs in oak galls, and they hatched and passed through their various transformations; but we know positively that these galls are not caused by curculio. We also find worms in plums, cherries and other fruits, but no one would think of claiming said fruit to be of insect origin. There is another species of curculio which attacks the acorns of white oak, and after the nuts fall in autumn the larvæ leave them and go into the ground, where they pass into the quiescent or pupa state, remaining in this condition until the following summer, when they again become beetles. But when the larvæ leaves the acorn in the autumn, a little gray moth drops her eggs into the vacant burrow, where they hatch in a few days, and by the time cold weather sets in the grubs are nearly as large as the former occupant of the acorn. In winter we may find any number of acorns with these worms in them, which any one unacquainted with the habits of this insect might suppose to be the original cause of the mischief. Careful investigation will show us that the curculio began the work of destruction, and the larva of the moth was only an intruder. The plum and cherry knot is a disease accelerated by the presence of a species of fungus.

KEEPING SWINE.

A correspondent alluded to "the movement of Mr. F. D. Curtis for the improvement of the breeds of swine." He thinks this very good as far as it goes; but when you have succeeded in stocking the country with the best hogs, please make an effort to induce people to keep them in the way they should, instead of confining them in filthy, small pens, too filthy almost for language to describe; horrible, loathsome and disgusting to refined and sensitive minds. Some people have the idea that they can keep hogs in this way, and feed them almost any filthy substance — old sour swill, still slops, beeves' inwards, etc.— and make healthy pork; or at least they can sell it, and let the consumers take the effects of it. It is better, of course, to keep the best breeds, instead of the dirty, filthy, scrofulous-looking hogs that many do; but even if the very best breeds are raised, and in the way they should be, I argue, as heretofore, that it would be far better not to raise them at all. The weight of argument is all against raising and eating them; notwithstanding, 32,000,000 are annually raised. It shows the depravity, ignorance and willfulness of mankind. It is a very great wrong that so much precious grain, which would be so wholesome and nutritious as food for man, should be converted into hog grease, which contains no nutritious element, and, like alcoholic drinks, is not digested, and like them affects the brain, though in a different way, making the mind more dull, stupid and vicious, besides corrupting the blood, and disordering the system in various other ways of those who eat much of it for years; or if they stand it without any apparent ill effects, it may be transmitted to their offspring. Fat pork is not needed to give strength, vivacity and the power of enduring the cold. Moses and Aaron understood what was and what was not suitable meat for man to use as food much better than the majority of people of the present day — even the majority of the New York Farmers' Club.

Profit of Peach Culture.

The Chairman read from the Wilmington Commercial an account of the proceedings of a recent meeting of the Peninsula Fruit Growers' Association, held at Dover, Del., February 20. Some twenty-five or thirty extensive growers were present, and the following summary exhibits the statements made: In 1868 the crop was a total failure. In 1871 it was immense, but prices were very low. A crop, however, may be relied upon three years in four, and the return is as certain as for wheat. There are now six canning establishments, consuming 75,000 baskets, and putting up 750,000 cans.

Mr. P. T. Quinn—I went down to the peach region on the 16th of August, last year, and instead of fancy prices, we found the growers getting the most ruinous rates. Mr. Cummings told me that he sold 1,600 baskets at three and a half cents per basket, and another large lot at fourteen cents. I saw 15,000 baskets rotting because there was no sale for them, and an entire car load came back to Dover, while I was there, because they could not be sold. There seemed to be a perfect demoralization among the peach consumers of New York last year. I doubt if there were many fruit-growers on the peninsula who averaged fifty cents per basket, and think most likely not more than twenty-five cents. Mr. Edwards, the largest peach-grower in the world, who has 1,350 acres in bearing trees, sold his crop at an average of twenty-two cents per basket. (A member—He has since published that he averaged seventeen and a half cents.) John Harris, another large peach-grower, told me that his crop averaged from seventeen to twenty-four cents per basket.

Mr. Henry Stewart—I was in Delaware last year and the year before, and I can corroborate Mr. Quinn's statement. A friend of mine who sent 40,000 baskets to Baltimore did not get enough for them to pay for picking.

Mr. H. T. Williams—Last year was an exceptional season. The section around Dover was glutted with peaches. They came in late and brought poor prices. It was better in the first part, and southern Delaware and Maryland got good prices and made money. I venture to say that even with all the drawbacks many growers averaged thirty-five to fifty cents per basket, and for the neighborhood of Seaford, Del., seventy-five cents to one dollar. It is fair to state that peaches give a good crop every three years in five. The business in Delaware is not so good now because so many trees have been planted, and because it is being entered into so largely in Virginia and North Carolina. From these points they put their peaches into market very rapidly and a month earlier than from Delaware. The farmers are now using much bone manure in their orchards, and have adopted a system of cultivating the ground without planting any crop among the trees.

Prof. H. E. Colton—I can confirm what Mr. Williams says about Virginia and North Carolina. I know of immense orchards that have been planted there, and a friend of mine last year made enormous profits on his crop because he got them into New York so early. The railroads have all low freight rates to encourage this species of farming, as well as to induce immigration. The climate and soil too are especially adapted to the growth of this fruit and vegetables.

Broom Corn.

Rev. D. S. Perry, Urbana, Ohio—Allow me to answer Mr. Ferguson's inquiries in regard to broom corn, as discussed in your session of January 9. First. The dwarf variety has been tried and found wanting in the essential points. Second. I believe broom corn will do better than any other crop on wild prairie, as it is more of a wild nature than other cultivated crops. Third. It should be drilled in rows three feet apart, at the rate of one bushel seed to seven acres, and should not be covered over one inch deep. When it is six inches high, thin to from three to four stalks to the foot. If planted in hills, 4×4, it would be coarse as hazel brush, and not worth the transportation to market. We prefer the Missouri to any other variety, but it inclines to grow coarse and should be planted rather thicker than the other kinds. It should be cut green, as the loss in weight and quality will more than pay for the seed. Green brush is usually worth three to five cents more per pound than red, beside the loss in weight. It should be tabled, cut and scraped as near the same time as possible. If it is tabled forty-eight hours ahead it turns up at the ends and makes more work cutting, and if left in the field too long after cutting the sun bleaches, beside the risk of bad weather. It should be dried in sheds. To give the mode of tabling, cutting and curing, in detail, would require too much space. To be successful, and grow on a large scale, requires experience, and new beginners usually spoil one or two crops. We have been in the business twelve years, and averaged nearly 100 acres per year, and have much to learn yet.

How to Raise Cabbages.

Mr. A. C. High, White Deer Mills, Penn.—Allow me to give a statement of my cabbage raising in the summer of 1871. I planted 600 plants, say on the 1st of July, on very ordinary soil which had been planted in corn the year previous, gave it a light dressing of barn-yard manure at the rate of about ten two-horse loads per acre. After the plants had started I put about three bushels of the contents of privy in a tight barrel and filled with water, and gave my cabbages two doses of the liquid at an interval of about two weeks. The result was I had 599 large, solid heads of cabbage of first quality.

How to Raise Corn.

A letter of inquiry was recently referred to Mr. William Crozier, who submitted the following reply regarding his practices in cultivating corn on his Long Island farm: I plow the land in the fall, furrows straight, seven inches deep and nine wide; in spring harrow well and cross-plow a little deeper; again harrow well; furrow out six inches deep and three and one-half feet wide; put one good shovelful of manure to every two feet, spread or level with back of hoe; drop the corn one foot apart, a single kernel in a place; cover with plow, and then run a brisk harrow over the field; this levels off the tops of the rows, and makes a very even covering, and takes away any small stones, weeds or tufts which might obstruct the growth of the young plants. After the plants are up three or four days, I take a large Scotch harrow and run it over the field lengthwise. This is as good as a hoeing to start with. One week later I use a horse hoe and continue its use until the corn gets so large that I cannot pass through it. The last time of going through I take off the shares and let down the wings so as to raise a little loam around the roots. I cut my corn before fully ripe, shock up in large shocks, which is a great benefit to both corn and fodder, and husk as soon as time will permit.

CLIPPING HORSES.

The following paper was read by Mr. F. D. Curtis: That prince of philanthropists, Henry Bergh, has had a bill introduced into the Legislature to prevent the clipping of horses in winter, urging that this practice is cruel. I agree with Mr. Bergh. It is claimed by the advocates of clipping that the horse perspires less and dries quicker, and hence it is better for him. Let us see about this. When a workman begins a laborious job he usually lays off his coat and begins his work in his shirt-sleeves. When thus lightly attired he moves with more ease and celerity; when he rests or finishes he immediately puts his coat on. Of course, he does not cool off as quick, but he avoids by this precaution taking cold. Now, if the horse could do the same thing, that is, when he halts or has finished his task, it might be all right, but he cannot do it. Without the protection of his hair he cools rapidly, catches cold and suffers, and his days are shortened. In opposition, the clipping theorists urge that they provide for all this by covering the animal deprived of nature's protection, with blankets. This idea would be more practicable if the poor horse could blanket himself, but he is left to the tender mercies of a lazy, unfeeling groom. No blanket can or does protect the animal as well as his own hair. In my opinion, no gentleman who values his horses, if he has not a humanitarian feeling, will allow them to be clipped. I feel sure if the poor brutes could speak, they would cry out strongly against the abuse. It is a specious improvement—a cruelty refined in the same crucible which deprives the fighting bull-dog of his ears, and ornaments the champions of the cock-pit with the gaff. The grand reason why grooms favor the clipping of horses is, because they can be cleaned so much easier. Of course they do not urge this as a reason to their masters; but, ye masters! this averseness to work is the true reason, and I suggest that you no longer be hoodwinked by continuous cruelty and laziness. Mr. Bergh, you are right, and thousands of dumb witnesses would testify for you if God had so decreed.

The Chairman—I heartily approve every sentiment uttered in that paper. I was one of the committee who proposed this law, and I believe that it should be enforced, and my plan was to commence with one of the members of the committee, whose clipped horses were standing in front of Mr. Bergh's office while we were inside; but I was overruled. On record at Mr. Bergh's office is proof of the fact that a horse has lately died from congestion of the lungs caused by this same clipping process.

Want of Care in Wintering Bees.

Mrs. E. S. Tupper, Iowa—I am in receipt of numerous letters asking me to give, through the Farmers' Club, my opinion as to the cause of the great loss of bees the past winter. In many places nearly all the bees have died; in others, a large per cent of the whole number. I have examined some of the dead colonies and gathered all the particulars of others, and am sure that in every case reported to me the bees died from no disease, but simply from want of care in wintering. Some colonies which I have seen died of too much honey. In many parts of the west the honey season last fall was extended into October, and bees were able to fill up their combs with honey after the queens ceased breeding. In thousands of hives there was no empty space in which the bees could cluster, and winter found them thus, clustering upon combs filled with sealed honey as cold as ice itself, and they perished. Had the center combs been emptied by an extractor, or two or more combs been removed from the hive to give them room, they would have been saved. I took twenty pounds of honey from each of fifty hives last October, and left them in far better order for wintering than if none had been taken. By doing it I saved one thousand pounds of honey and saved my bees. Some colonies that were protected died from want of upward ventilation. I saw, last week, many of these. No holes were left open in the top; the moisture accumulated and the combs molded; the bees were uncomfortable, and could not retain the fecal matter, and died of what is erroneously called dysentery. I have found some cases where the trouble was caused by the bees being shut into the hive. They never like this; the entrance should be only partially closed. In other cases, bees were smothered by too much straw and fodder being put about the hives. Not one case has yet been reported to me where bees have suffered that were wintered in dry cellars or properly protected on their summer stands, with due attention to giving them empty space in which to winter. If those interested in this important matter will turn to the United States Agricultural Report of 1861, and read a short paper in it prepared by me, they will find the whole matter made plain. If the principles of winter bee-keeping there laid down be carried out in practice, no colony need ever be lost in winter.

Arbor-vitæ Hedges.

Mr. Rillie Longnecker, Paoli, Kansas, wrote—I noticed, some time ago, that arbor-vitæ was recommended for a hedge by some member of your Club. Will you please inform me where and at what price the seed of that and other evergreens can be had?

Mr. A. S. Fuller — The seeds of arbor-vitæ and other evergreens can be purchased of almost any of our New York city seedsmen. But persons who have had no experience in raising evergreens from seed will do better to purchase the young plants, when one or two years old, than undertake to start them from seed. Arbor-vitæ plants two or three years old can be purchased for three or four dollars per thousand; and spruce, pine and similar kinds for ten or twelve dollars, when one or two years old.

Adjourned.

March 19, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

COOKING FOOD FOR STOCK.

Mrs. L. Smith, Marquette county, Wis.—I am opposed to feeding cooked food to animals. Cattle have a digestive apparatus, assimilating the raw material of food, and when it is cooked, their secretions are not made use of, and they become unhealthy.

Dr. J. V. C. Smith — I do not believe in cooking food for stock. It is slavery for women and boys.

Mr. John Crane—I have been carefully studying the matter of cooking food for stock. I was brought up to believe that it should be cooked. Experience has taught me that it should not. I fully indorse Dr. Smith. I was taught for fifty years to cook food, but I have now learned that it is not best. I feel grateful to Dr. Smith for having started me on the right road. I am convinced, not only by my own experience, but also by the experience of others. One gentleman, who had been in the milk business for fourteen years, had tried steaming straw and cutting up corn stalks and steaming them; he had found that his cattle every spring were demoralized and a miserably poor set. Another, near Newark, had started in farming and the milk business, with all the fixtures for boiling and steaming. He tried it for three years and it did not pay. He had to sell out. Another who didn't cook the food went into the milk business in the same neighborhood and had made money, although he lost largely by fire. This winter I tried feeding corn unground, in fact on the cob, and I found that my horses did more and better work than ever before. I bought a cow which had been fed on cooked food, and she improved twenty-five per cent under my treatment. I think farmers have been humbugged by this food-cooking business, and machines for carrying it out, and I think it is about time it was stopped.

Dr. Isaac P. Trimble—I have no doubt that many farmers have had the same experience as Mr. Crane, and I hope his statement will save some others' expense.

Mr. Hauser—Experiments were made in Germany by a committee of scientific men, and they have determined that there is not so much benefit in cooked food for stock as has been supposed; in fact, that it is no benefit for cattle, but for hogs it is of great value. The intestines of a hog differ from those of other farm animals.

Plaster.

A correspondent spoke ill of plaster and denounced its general use. The day, he thinks, is not far distant when conclusive evidence will be given that, by its application to land, farmers will be annually out just the amount the article costs. Take a field of say ten acres of corn or clover, and apply plaster to it in alternate strips of say ten feet in width, and the field will not produce one bushel of corn or 100 pounds of hay more by the application. Just to the extent that the dressed portion of the field is benefited the undressed portion will be injured by it, showing conclusively that plaster acts on the principle of robbing Peter to pay Paul, which would run them both into the ground; or, in other words, that one-half of the crop cannot be enhanced by the application unless it is done at the expense of the other half. Now, if this be true of one field, why will not the theory hold good for 100, 1,000, a township, a county?

Mr. C. D. Bragdon—I know perfectly well that if I use plaster I grow richer, and my neighbor, who neglects to use plaster, grows poorer. I have had experience, and found the expenditure of five or six dollars per acre, for plaster, money well invested.

Dr. J. Ware Sylvester—Our farmers in Wayne county are very partial to plaster, and hoard it as they would money. It may be called an absolutely essential part of our farming. It is applied to clover and grass land in spring; it is also used with manure to fix the ammonia. I am satisfied that by using it frequently with stable manure the value of the dung heap is increased fully one-third. Alone, or mixed with ashes, it is applied to corn in the blade, and always advantageously.

Experiment in Raising Rye.

Mr. P. S. Beers, Connecticut—We raised the past season twenty-eight and eleven-sixteenths bushels of rye on 117 rods of ground, by actual measurement. Seed sown September 10, one and a half bushels per acre; manured with one barrel of bone meal and 300 pounds horse shavings, costing $1.50 per 100 pounds. A crop of seeds of turnip, parsnip and carrot had just been harvested from the land previous to sowing the rye, for which seeds a light dressing of barn-yard manure and one barrel of bone was used; soil a heavy red, high and dry. It may with propriety be asked if we raise such crops every year. By no means. The season was one of the very best; the summer was cool and dry, which stiffened the straw and made the berry plump; had the season been warm and wet the enormous growth of straw (375 sheaves) would probably have lodged and ruined the berry. It is our aim to use such manure as is best adapted to each particular crop, always having in view the necessity of seeding to grass after cropping two or three years; for by no other means can artificial fertilizers be used with much profit, except where plenty of vegetable mold is in the soil. By any other course, you are killing the goose that lays the golden egg.

TWENTY COWS ON TWENTY ACRES.

A Bourbon county, Ky., correspondent—Experienced farmers say that it requires three acres of blue-grass to keep a single bullock. On this he will thrive from the 1st of May until the 1st of December, save during two months, from the middle of July to the middle of September, during which time he will put on but little flesh. The corn grown upon another acre (say sixty or seventy-five bushels) will keep him in good condition and improving from the 1st of December to the 1st of May. Thus you will see, under our system, it requires four acres of land, worth $100 per acre, to fatten a single bullock. It has occurred to me we might do much better by adopting the eastern system of soiling, as I have been told that by this system an acre of land capable of yielding seventy-five bushels of corn will support one or even two or three head of cattle throughout the year. Will some member of the Club, familiar with the subject, state what amount of such land would be required to support twenty head of cattle or milch cows, in what it should be planted, at what times the different crops should be sown and cut, and how many acres should be devoted to each?

Mr. Henry Stewart—Twenty acres of land, with a proper system of stall-feeding, have often supported as many head of stock, and, on such land as will produce seventy-five bushels of corn per acre, will do it at any time. One-fourth of the land should be in roots, one-fourth in corn, a fourth in fodder crops, as peas and oats, rye for early feed in spring, clover or lucern, and the other quarter in hay. Experience will soon enable any necessary changes to be made to suit such circumstances as will arise from unknown conditions. Read "Quincy on Soiling Cattle."

Grape-growing and Wine-making

was the subject of the first matter commanding the attention of the Club, and was comprised in a paper by Mr. R. H. Williams, of Penn Yan, N. Y., who stated that this interest had become of great importance in the lake region of western New York, and added—The last two years have proved beyond a doubt that we are able already to overstock the raw fruit market; and that the glut causes non-paying results to the producer on the whole crop, including what is appropriated to the wine-press and for distillation within their present capacity to manufacture, which being so meager in comparison to the supply and demand, it is necessary to make large importations from foreign countries, thus the subject becomes one of national pride as well as interest. The solution of this difficulty must be looked for mainly in the extended capacity and number of our wine-presses and distilleries and the improved quality of the fruit produced, to meet the demand of consumers. May we not yet do this, or at least to a vastly greater extent than now? And does it not present a wide field for the advance of this branch of home production both from the soil as labor? It would seem that the wonderful increase in variety of the grape, and the improvement in quality as well, within a decade, holds out a promise to the utilizers of the fruit beyond that in the natural state which should inspire capitalists with confidence in increasing the pressing and distilling, and the grower with renewed energy in the production of the higher qualities of the grape. To the latter there appears one serious obstacle, viz.: the occupation of our best vineyards and grape-lands already by the inferior and non-paying varieties, involving a complete transformation from common to the higher qualities of fruit, and a long and expensive process of uprooting and regrowing, unless the old and established roots can be utilized, as we do with apple and pear, by some process of grafting that is both practical and certain. What say the Club? By favor of Dr. Edward Young, chief of the Bureau of Statistics at Washington, D. C., I find that we imported during the fiscal year ending June 30, 1871, 9,380,266 gallons of still wines, 759,889 gallons of brandy, and 232,963 dozen of sparkling or champagne wines, at a European cost, with duties added, of over $12,500,000; raw fruit and raisins, do., $3,700,000; to which add at least fifty per cent to cover transportation, waste and profits before reaching the consumer, say $8,000,000, and it foots up the snug sum of $24,200,000. Is not this a field worth occupying by home labor and capital?

In this connection, several boxes of Catawba grapes were distributed by Mr. D. S. Wagner. They were in excellent condition; and in answer to questions, he stated that he had preserved twelve tons of a like character. His plan is to keep them on shelves in a dry, air-tight room, keeping up an even temperature, and he regulated the temperature by opening windows. He found that the grapes would stand twenty-six degrees of cold without injury.

Brook Trout.

Mr. S. A. Phillips, Royalton, Wisconsin—Trout are found in the streams flowing into Green Bay, and also in the west part of this State; but on the Wolf and its tributaries none. The water here is pure as crystal, and springs abundant, well stocked with other fish. The water is what is usually termed "hard," and lime is precipitated when it is boiled. Will this fact alone prevent the successful culture of trout, other conditions being good?

Mr. A. S. Fuller—Trout abound in the streams of western New York, all of which flow over limestone.

Dr. J. Ware Sylvester—The same is true in Wayne county.

Mr. Bragdon—I have often caught trout in the limestone streams of Jefferson county. The reason why trout do not exist where the streams become large is, that large fish eat them.

Mr. Henry Stewart—In this gentleman's section the trout are all destroyed by too close fishing.

Prof. H. E. Colton—In the southern Alleghanies, it is generally thought trout will not live in limestone streams. I know that in some streams flowing from North Carolina into East Tennessee, the trout cease as soon as the geological divide is crossed. I suppose the real reason is, that the limestone lands are generally rich and level, and hence from cultivation and wash the water becomes muddy. I believe it is generally conceded that speckled trout do not like muddy water.

The Best Floor for a Cheese Factory.

Mr. Geo. West, Cannon Falls, Minn.—We have failed twice in the attempt to make a cement floor for the manufacturing-room of a cheese factory. We had the floor covered with cement and sand, mixed in the proportion of between two and three of sand to one of cement. It froze before becoming hard, which we considered the cause of failure. We then got some good Kentucky cement and had the work done over again, but it did not get hard enough, but what it would sweep up and also wear into holes above the vats. We would much prefer a cement floor, as being sweeter than wood; but unless we can get a better floor of cement than we have yet been able to do, it is useless to try again. What does the Club advise?

This letter was forwarded to the Hon. X. A. Willard, Little Falls, N. Y., and by him replied to as follows: Cement floors for cheese factories are not common, at least in the dairy district of New York. They can, however, I think, be made a success if properly constructed. In the first place, the ground, where the floor is to be laid, should be thoroughly underdrained, then small cobble stone, or quarry stone, broken up, should be pounded down into the ground, making a perfectly solid bed. This being leveled off is ready for the cement, which is made by mixing eight or nine parts of clean, sharp sand with one of water-lime. The lime should be of the best quality, and fresh, or newly made. Add water and mix thoroughly, and spread it upon the stone bedding, smoothing it off, and do not allow it to be used until perfectly dry and hard. I have seen good cement floors made in this way; floors that would do good service, and were lasting. Probably the trouble with your correspondent arose from an imperfect preparation of the floor bed, a too large proportion of lime to the sand, and in not allowing the cement to harden. Possibly the cement may have been of inferior quality. I do not pretend to give you the best method for laying down cement floors; I only speak of the manner of laying down those which have proved efficient for buildings other than cheese factories.

Mr. Henry Stewart—These directions are excellent. Roman cement is best, if any is used, but I prefer a floor of brick. This costs less than half as much as cement, but I would rather have it if it cost twice as much as cement.

A Simple System of Testing Soils.

Mr. Hauser showed a little apparatus, which originated in Germany, and is indorsed by well-known agriculturists of that country, the use of which, he said, will enable the farmer to arrive at an approximately correct conclusion regarding the character of the soil composing, and the crops and cultivation best suited to any particular field. The apparatus consists of a glass bottle and tube, connected by a piece of rubber tubing. The glass tube is closed by a cork at one end, and is marked off in eighth or quarter inches. It is known that the physical properties of the soil (by "physical properties" is meant the relation of the soil to the atmospherical agents), its consistency, its diminution of bulk on drying, its ability to retain and absorb heat, etc., depend largely upon the per centage of coarse and fine sand, and of clayey and humus substances. It has been found that 6.5 cubic centimeters of coarse sand weigh ten grammes; 8.5 cubic centimeters fine sand weigh also ten grammes. To separate, take ten grammes dry soil, sieve it, mix with some water in a saucer, boil for twenty or thirty minutes if of sandy, forty minutes to one hour if of clayey nature, stirring occasionally. Let the whole cool down, pour it into the bottle, clean the saucer, taking care that all the particles of soil come into this bottle; adjust the tube, shake it a few minutes, then let the mass settle in the tube. The coarse sand, having the greatest specific gravity, will settle first, upon it the fine sand, and at last the clayey and humus portions of the soil. The cubic centimeters of coarse and fine sand are multiplied with the above given figures, and the weight once found, the per centage is quickly calculated. There are other apparatus that will work more accurately, but they are complicated and dear, and cannot be made without the help of skillful mechanics.

Prof. Henry E. Colton—It may be worth while to explain that a cubic centimeter of water weighs one gramme; one gramme is 15.433 troy ounces. A centimeter in length is nearly 394–1,000ths of an inch.

Mr. Henry Stewart—Our forefathers had a way, and I believe the plan is still adhered to, of making similar but perhaps less exact tests, by putting some soil in a bottle of water, shaking it well, and leaving the ingredients of different density to arrange themselves in their proper order.

POTATOES.

A correspondent, Poultney, Vt., asked what kind of manure, next to stable, is best for the Early Rose potato; and is black loam, twelve inches deep, with an underlayer of clay, suitable soil for this crop?

Dr. F. M. Hexamer replied—The best manure for Early Rose and all other potatoes is well decomposed stable manure. Wood ashes are a special manure for potatoes; bone-dust is nearly as valuable, and on heavy land muck is an excellent fertilizer. A black loam with clay subsoil, if naturally or artificially drained, is favorable ground for potatoes.

Mr. J. B. Mordoff, of Mo.—There may be a variety of potatoes adapted to most climates and soils in the United States; and, if so, it is an important matter to agriculturists. Having been raised in the lake shore region, I, of course, know a good potato. Early in life, I turned up in Kentucky, midway between Cincinnati and Louisville. For years and years I tried to raise a potato having the flavor and richness of the lake shore production. Procured seed from my father. They would do tolerably well for one season. I tried every new variety I saw advertised, but all failed to procure anything but a poor watery tuber. Finally, like other Kentucky farmers, I quit raising any for early use, and ceased to wonder why Kentuckians didn't like potatoes. About seven years ago, a neighbor received from a friend in Indiana a few large potatoes, with the request that he give them a trial. He called them the Mammoth something, but they resembled what some call the Irish Cup. In three years he was unable to supply the neighborhood demand at two dollars and a half per bushel. They grew fully equal in every respect to the very best grown on the lake shore. The yield was large, and the quality unsurpassed; they are about six days later than the Early Rose, and equally good for early and winter use. Two years ago I moved to Missouri, and, of course, brought that potato along. Would have paid one dollar per pound freight rather than come without it. So far the variety proves fully equal to my highest expectations. These potatoes are not on the market as anything extra, and I have none to sell.

Dr. F. M. Hexamer—No variety of potatoes succeeds equally well on all soils and in all climates. From this description it is not possible to give the name of the potato mentioned. It may be the Dyright, Shaker, Fancy, Shaker Russet, Prairie Seedling, Hinman, all synonyms of the same kind which is also wrongly called Monitor. This variety succeeds well at the west, where it grows handsome, uniformly large and of good quality, while here it soon degenerates, loses character and becomes more diseased than any other variety. As it is not extensively grown at the east, and but little known, it offers a fine chance to some unscrupulous persons to bring it occasionally before the public under a new name, and sell it at high prices, A few years ago, when the Monitor, a seedling raised by Mr. Bulkeley. was in much demand, this variety was extensively sold under the name of Monitor, and has caused much confusion in potato nomenclature. I would like to see a tuber of the variety in question.

RASPBERRIES.

Mr. A. Rowe, Stoneham, Mass.—I wish to grow raspberries for market and am not sure which variety will be best for this section, ten miles north of Boston. Nice fruit brings a good price in Boston and vicinity. My land is a deep, sandy loam, and I have got it pretty rich with manure. I wish to consider the size and quality of the fruit in connection with its productiveness and hardiness. Which of the three varieties, the "Philadelphia," "Monmouth cluster," and "Clark" would you advise me to plant? Would either or all of the above require to be laid down and covered during winter? What kind, bearing nice and large fruit, will thrive well in this climate without being covered?

Mr. A. S. Fuller—The Philadelphia would probably be hardy in Massachusetts, but the fruit is only of medium size, dark, dull purple color, and only second rate in quality. The Monmouth cluster is a black raspberry, and will not command so large a price as the red sorts. The plants, however, are hardy and very prolific. The Clark is a splendid variety, very large, and of a light crimson or scarlet color. It is also one of the hardiest of its class, but it would not be safe to leave the canes unprotected in the vicinity of Boston. If our correspondent desires to cultivate varieties that will command the highest price in market he will have to give the plants protection in winter. It only costs fifteen to twenty dollars per acre to protect the plants with earth, and that is a small sum in comparison with the increased value of the crop.

Adjourned.

March 26, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

TREE PEDDLERS.

Mr. H. B. Zarnell, Illinois, Penn., wrote concerning a tree-peddler who is perambulating his neighborhood with intent to deceive.

Mr. A. S. Fuller—The Club can give no better advice than to let such questionable characters alone, and if trees are wanted send the orders direct to some one of the five thousand nurserymen who advertise in all the journals.

Mr. P. T. Quinn—The value of a tree depends upon whether or not it is true to name. A man who prepares his ground and sets trees, and, at the end of five or six years of patient waiting, finds he has some poor, worthless fruit, is a great loser, and is justly indignant. Hence the tricks of the tree-peddlers ought to be condemned in the strongest terms. Every nurseryman has a reputation at stake, and he feels the importance of having his trees all named correctly. Sometimes the names are lost from various causes; then they are sold at low rates. Every nurseryman has what he calls "hospital stock." People buy these and peddle them around, and the farmers buy because they buy at lower prices than from a regular dealer. This, of course, is penny wisdom. Nothing is needed so much to be suppressed as the trade carried on by these tree-peddlers. I meet them everywhere, and they never lose an opportunity to sell a tree, no matter by what deception a trade is accomplished.

Mr. F. D. Curtis—No respectable breeder of stock would think of selling inferior animals, if for no other reason than because the act might hurt his reputation. Now, for the same reason the nurserymen should not sell "hospital trees," and when they do, knowing that they will be resold and the farmers cheated, they are the principal parties to a base fraud, and should be held responsible, for if they did not dispose of such trees they could not be resold. An honest breeder of stock butchers his imperfect animals, and an honorable tree grower should regraft or destroy his worthless trees.

Mr. Henry Stewart—Our friend of The Republican, who has just addressed us, is right. The peddlers are not the persons who are chiefly to blame. Farmers are not men who are handy with the pen, and have but little acquaintance with business forms, and if there were no peddlers there would be fewer orchards. But the nurserymen who are behind the peddlers, and who turn off this "hospital stock," are the conspicuous offenders. The rubbish is put upon the farmers in such a way that the nurserymen are hidden, and creep out of the blame. If nurserymen destroy all this poor stock and send out only good trees, the farmers would be benefited, and the peddlers, who are useful in their way, would not be made scape-goats for their sins.

Dr. Wolff—I disagree as to where the blame should rest. If I am fool enough to buy trees or any other article of persons of whose integrity I am not convinced, then the consequences should fall upon me alone, and I would bear them, and not complain to the Farmers' Club.

Mr. Slipper—Our friend from the Rocky Mountains is right. Farmers are credulous by nature or education. They come to New York, for example, and think they can get Geneva watches for half their value. They are too often influenced by the plea of cheapness, and thus they save at the spigot and waste at the bung.

Mr. P. T. Quinn—If trees are bought of nurserymen of standing, they can be held responsible; but there are so many ways of deceiving that it is very hard to determine whether an agent is trustworthy or otherwise. I know perfectly well that if I wanted trees, a dozen or a thousand, I would send my order to a nurseryman I believed to be reliable, and who could be made to pay the penalty of deception.

Mr. Simeon Baldwin—I bought some trees from a man representing himself to be the agent of a respectable firm, and the trees came to me with their names on them, and I sent them a check in payment.

Mr. E. Williams—If the only customers the nurserymen had were the farmers who bought direct from them, they would fare but poorly. More than two-thirds of their trees are sold to dealers and retailed by them.

SMUT.

Dr. Wolff asked the savans to say whether smut in wheat is an effect or a cause, and what is its cure.

Mr. F. D. Curtis—Smut is a fungus, the seeds of which are transmitted from crop to crop with the grain, the straw, in the atmosphere. A favorable season, climatic influences, develop their spores or seed, and we have more or less smut. If the seed is thoroughly washed in brine or strong lime water, much of it can be destroyed and the amount of smut reduced. It is not a "distemper," but a vegetable growth.

TOP-DRESSING.

A correspondent made inquiry as to guano and phosphate of lime, comparative cost and value, as top-dressing for grass land.

Mr. Henry Stewart—For this purpose I would rather use guano and bone dust mixed than super-phosphate of lime alone. Superphospate and guano are both quickly stimulating manures, but not permanent, but bone dust is able to effect a permanent improvement for many years. I would, therefore, apply to grass lands 150 pounds of guano, if of pure Peruvian, and 200 pounds of bone dust, early in the spring. Three hundred pounds of super-phosphate would be a fair quantity. The price of pure Peruvian guano is ninety dollars per ton, bone dust thirty-five to forty dollars, super-phosphate forty-five to sixty dollars per ton, in New York. In any of the agricultural papers will be found advertisements of the dealers.

CHANGING SEED.

Mr. H. C. Dickinson, Sylvania, Penn., asked if it is necessary to change the seed of different kinds of grain, to be sown on the same farm, and how often.

Mr. F. D. Curtis—No change is necessary, provided the land is kept in good heart. Good land makes good seed, and permanent, too. A change of seed will not insure a good crop, unless the land is rich. This is the main thing.

Mr. Henry Stewart—I have found seed to depreciate when grown in a warm climate—oats, wheat and potatoes more especially. New Brunswick oats, which weighed forty-seven pounds to the bushel, in three years depreciated to thirty-two pounds; but when that light seed was sent to Canada, it was restored to its former weight. The same proved true of wheat. Potatoes were also improved by such a change. The general experience among farmers, I think, is similar to mine.

FLAX FOR FIBER AND FOR FEED.

Mr. George Anderson, Mansfield, Ohio—The profitableness of flax raising in the west would depend entirely upon the facilities for transportation and the supply of labor, as well as the adaptability of the soil and climate to the crop. In this State the average yield for 1869 and 1870, according tó statistics, was not only seven and a half bushels per acre. The past season, flax yielded well, and twelve bushels per acre was common, and as high as seventeen to twenty was raised, although the latter was exceptional. In the State of New York and the province of Ontario, Canada, where flax is raised for the fiber as well as the seed, the average yield is estimated by practical men at ten bushels per acre. What the statistics are I cannot say. The quantity of seed sown varies. In this section and further west, where flax is raised mainly for the seed, one-half bushel is generally sown, although there is no doubt that from three pecks to one bushel would give as good results, and if the quality and quantity of the straw was taken into account, the value of the crop would be enhanced very much. In New York and Canada from one to one and one-eighth bushels per acre are generally sown. I question very much if one of your members, who lately advised sowing two bushels per acre, knows of any one who practices sowing so thickly in this country with good results. In the old world, from two to three bushels are sown; but in this country, practical men scarcely ever exceed one and one-eighth, although experiments with two and three bushels have been made; results unsatisfactory. Where flax is raised for scutching, it is best to pull it either by hand or machine, although if the flax is long and cut very low, it may be used for long fiber. A good hand will pull one-third of an acre per day, and there are machines which will pull about four acres. One of the greatest drawbacks would be the scarcity of labor; but if good machines were introduced, there is no doubt that the business would be profitable. In Ohio, Indiana and Illinois, where the flax is converted into tow, flax is either cut by machines or cradled, and the straw is left in the best condition when the seed is tramped out. If thrashed by machines, the fiber will be shortened and its value lessened by at least one-fourth. North river and Canada flax is now worth about seventeen cents per pound. Bagging tow will not average much over three cents. There may be locations where the cost of transportation would be so great that it would not pay to make tow, but the long fiber might pay reasonably well. The books generally tell us that flax is an exhausting crop, but if the testimony of farmers can be relied on, there is not a crop which leaves the ground in better condition for rye or wheat. Some farmers here consider it the best crop they can raise. As to the comparative value of seed and oil, it is about as two to one in this section, viz.: oil, seventy-five to seventy-six cents per gallon; seed, one dollar and fifty-five to one dollar and sixty cents. In New York, two and a half to one. If the agent you referred to would give a detailed report of his steam-rotting process, and could show that it was remunerative for bagging tow, he would confer an immense benefit on the country, as during a dry season the dew-rotting process is very slow, requiring sometimes from two to three months, while with steam the same number of days would suffice. I am aware that the warm-water system of rotting is practiced to a limited extent in Europe as well as in Canada, but it does not seem to supersede the cold-water or dew-rotting process, although it has been in use over twenty years. Anything new and practical on steam rotting would be appreciated by many readers.

Mr. F. D. Curtis—Growing flax will not be profitable unless near a mill, where a good and uniform price can be had. A few years since, in my town, it was started quite extensively, but was soon abandoned. It leaves the ground light and loose, owing to the denser shade of the crop, but it is exhaustive. I am going to grow flax in my oats for the sake of the seed to feed my stock, getting it ground at the grist-mill. I think I can do this cheaper than to buy oil meal, as the latter, now-a-days, is squeezed so effectually that nearly all of the good is gone.

Mr. Henry E. Colton—As regards Mr. Curtis' first point, it is necessary simply, not so much to be near an oil-mill, as to be near certain and cheap transportation to a market where there are mills. The greater portion of the seed used in New York comes from Calcutta, but still a very considerable quantity comes from the south and west. This correspondent is in a thickly settled country, in the neighborhood of several railroads, perhaps near an oil-mill. He can raise flax profitably, and so can any others who have rich lands and are near a cheap line of transportation to a manufacturing market. It is impossible to press flaxseed so as to take out all the oil; but there is now used by some a French process by which the oil is entirely extracted by treating the cake after pressure with light hydrocarbons or with bisulphide of carbon. When treated by the latter, the cake is considered somewhat better as a fertilizer and by some as a food. I very much doubt if the raw flaxseed, ground and not pressed, would be a safe food for any stock. It is a very strong laxative, sometimes cathartic. The great trouble with the linseed meal of the present day is, it is too much adulterated. Farmers can avoid this by buying the cake and grinding it themselves. I think it very probable that further west it is easy enough to get pure cake. In the present perfection of the manufacture of oil from cotton seed, the cake from that is as good as linseed.

In Favor of Clipping Horses.

Mr. Henry Stewart read a paper in favor of clipping horses, as follows—That prince of philanthropists, Henry Bergh, has had a bill introduced into the Legislature to prevent the clipping of horses in winter, arguing that this practice is cruel. I don't agree with Mr. Bergh, nor do many others whose opinion ought to be of equal weight with the Legislature to that of this man, who, because he is a philanthropist, undertakes to control the action and liberty of men of equal intelligence and possessing as great and pure philanthropy as himself. In prevention of cruelty to animals, I would go as far as any man. I have spared the lives of much-abused owls, crows and skunks, and have even encouraged the corn-pulling crows and blackbirds and the cherry-eating catbirds and robins; but I have clipped my horses, and should do it again as a means of securing their comfort and preserving their health, unless prevented by such a law as that with which Mr. Bergh would circumscribe my liberty in so despotic a fashion. Mr. Bergh declares it to be cruel to relieve the horse of the coat which nature has provided for him for his winter covering. And so it would be were horses exposed, as in their natural condition, to all the inclemencies of the weather. But we take the horse and pare his hoofs, and nail shoes on his feet, and put a bit in his mouth, and fetter him with harness, and make him draw heavy loads or carry us at great speed, and thus having brought him into a condition totally different from his natural one, it is necessary for us to act with him accordingly. All horses do not require clipping, and but few are clipped, and those few are horses which are made to draw heavy loads or travel at a rapid rate, which are kept in warm stables, and which possess a heavy, coarse coat of hair. Such horses, brought into a state of profuse sweating by work, are in the condition of a man who has done heavy work while wearing an extra overcoat. Their coats, as his clothing, become saturated with moisture, which is retained, and is unable to escape, except slowly and by evaporation. It is well known that in the process of evaporation the temperature is greatly reduced; hence a severe chill is caused and a cold is the result, which not seldom ends in rheumatism, cramps, colic, congestion of the lungs, inflammation or other severe or fatal disorders. To many men a pair of horses is the sole source of their income, the only capital on which they depend for the means of supporting themselves and their families. To others it represents a large amount of money. Is it consistent with the liberty of the citizen that any of such men, who cannot be charged with designed cruelty to what costs them so dearly, or with utter ignorance of their own business or interests, should be prevented from managing their property in their own way? If it is, I cannot see why I may not be forbidden to clip my sheep just when I think advisable, by the operation of a similiar law to this proposed one, As it has gone forth through the world that this Club indorses the paper read here last week, it is only right that this protest should be made on behalf of all those who think it right and proper to clip their horses as a measure of comfort and safety to them; and who consider their rights as citizens should not be lightly interfered with at the demand of Mr. Bergh or those who sympathize with him, on a question which hinges on a disputed point, and on which the evidence, to say the least, is very contradictory indeed.

Mr. F. D. Curtis—Mr. Stewart is an amiable and kind-hearted gentleman; he would take good care himself of his horse. In this city it is different. Not one gentleman in fifty gives his horses his personal attention, and they are left to the tender mercies of the hostler. I saw a pair of clipped horses standing in the street last week, one of the coldest days, drawn up and shivering, with no blankets on them, and the lazy, unfeeling driver sat in his seat tucked up in robes and comfortable. Now, those horses represent hundreds who suffer in the same way. It is a mistake that because the outside of the horse is wet when drying off after a drive he is chilled. His body is warm and dry, and so is the hair next to his skin, and the vapor thrown off is condensed on the ends of the hair when it comes in contact with the cold. This does not hurt the horse. If a blanket is put on him the blanket receives the evaporation and it is wet, and the horse takes no cold. This is my practice, and my horses are driven very often as hard as they can be and do not take cold. A blanket does not and cannot protect a horse like his own hair. According to the theory of the clippers, if a man fall overboard or get wet in a storm, he must at once strip off his clothes and go home naked. This is nonsense. The person is not apt to take cold with his clothes on, however wet they may be; so with the horse.

The Chairman—As one of the executive committee for the Prevention of Cruelty to Animals, I feel obliged to say that they did not take action in this matter until they were fully convinced that some reform was needed. There are on file proofs of most convincing nature that clipping is injurious to horses and causes congestion of the lungs. As to depriving any of their rights and liberties, the cruel carman who beats his over-burdened horse with a cart-rung might make the same plea.

Dr. J. M. Crowell—I believe in clipping horses. I clip mine and shall continue do so and take the consequences.

Adjourned.

April 2, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

American Wines.

Mr. F. D. Curtis—A great many persons have a prejudice against American wines, and it grows out of the fact that they are put on the market too soon, before they are really wines, when they are simply grape juice. Now, sir, it is no use for our small farmers here to think of making wines at profitable rates, and at the same time making them fit to drink. They put an inferior article before the public, and the tendency is to break down the market, and give a bad name to others which may be good. I have opportunities for knowing something about the amount of wine imported, and there is more wine drank in New York in six weeks than there is actually imported in six months.

Prof. H. E. Colton—Mr. Chairman, there is, no doubt, too much fault in the American wines themselves, but the great fault is in the American people. They won't buy a wine with an American label. They want something with a French or German label. The truth is, too many Americans buy the label on the bottle, not the wine inside. They are generally poor judges of the quality of the latter, and if the former is a name which Europeans, especially Frenchmen, praise as an excellent brand, why they buy it. The trouble is, few men are judges of wine who ever touch any other liquor, and most Americans, who drink at all, do not confine themselves to wines alone. The tastes of our drinkers generally are vitiated by whiskys, gins, and rums. These facts are well known by the wine men; therefore, they buy native wines and grape juice, work them up a little, bottle them, and label as foreign wines. Somebody says "Scuppernong." Well, yes, even that much-abused grape. A friend of mine had a large quantity he could not sell to any one for use as Scuppernong wine, but at last he sold it to a dealer, and that dealer bottled it, and resold it; some as champagne, and some as Rhine wine. The same state of facts exists as to many of the California, Ohio, and other native wines.

At the same time, I know that these native wines might be vastly improved by care in manufacture and age, but the small manufacturer cannot afford to do this, and the large maker has no inducement, as he can sell and realize without all that trouble and loss of interest. Here comes in again another cause — the thirst of all our people for getting rich rapidly, and the high price of labor, and the greater interest value of money in this country. There are a few gentlemen who have means and the patience to wait, and these are now making and storing up wines. From them will eventually be bought wine as good as any in the world.

Mrs. J. H. Barlow—I was, not long since, traveling over the railroad from Wilmington, N. C., to Florence, S. C., and a number of my friends were talking of the poor land when we stopped at a depot. In a few seconds a number of little boys were on board the cars selling wine. My friends bought a number of bottles, and pronounced it excellent. On inquiry I learned that it was made by a German who had settled out there, and that he believed it to be a good wine country, and was making money by selling his wine.

Cotton-seed Cake for Cows.

A correspondent stated that he and several of his neighbors have discontinued the use of cotton-seed cake as feed for cows, under the impression that it prevents pregnancy, and possibly causes abortion. If they are wrong they would like to stand corrected, as the cake has been proved in their experience of value in increasing the flow of milk.

Mr. F. D. Curtis—There has been a general prejudice against the use of cotton-seed meal. I think this arose from the fact that when first introduced it was not decorticated; that is, the skin of the seed was not separated from the meat of the kernel, and the little tufts of cotton fiber adhering to the seed were also ground up in the meal. In this state it is not digestible and should not be fed, but when decorticated there is nothing in the nature of the substance, as the analysis shows, to produce abortion or prevent conception. With the cotton and hulls in the meal it would produce constipation and fever, and the troubles alluded to by our correspondent would naturally follow. Clear cotton-seed meal contains of dry matter, 8.90; mineral matter, 8; phosphate, 7; potash, 3.12; nitrogen, 6.50. It is highly commended to produce a flow of milk and for fattening. It should be mixed with lighter feed, like bran, and fed in limited quantities. Uncleaned it contains about eight per cent of husk and cotton, enough to do considerable mischief with the digestive organs. All condensed food should be used with care and mixed with coarser.

Tapping and Plugging Maple Trees.

Mr. R. P. Wakemant, Southport, Conn., asked if it injures a maple tree to tap it once with a half-inch auger, provided the hole is plugged.

Mr. A. S. Fuller—Of course it hurts any tree to bore a hole or in any other manner to wound the stem. But the extent of the injury may be so slight as to be scarcely perceptible. Maple trees of large size may be tapped for many years in succession without killing them. In this connection I may mention that a recently recorded experiment seems to prove that the use of a very small bit brings as much sap as the old practice of using big augers. It is worth while for sugar-makers to test the matter further.

Chestnut and Fruit Trees.

Mr. J. D. Lyman, Exeter, N. H., inquired "whether or not a lone chestnut tree ever produces nuts?"

Mr. A. S. Fuller—Yes; a chestnut tree will bear just as freely if planted ten miles from another of its kind as near together, for the reason that flowers of both sexes are borne on the same tree.

Mr. Lyman further asked: Will apple and pear seeds, produced upon lone trees standing far from all others of their kind, grow trees producing the same kind of fruit as the trees which grew the seed? Or, in other words, does the same law hold as in pumpkins and squashes?

Mr. A. S. Fuller—No; there is no certainty of pear or apple seed from trees standing in isolated positions producing the same variety as the parent.

BUTTER MAKING.

Mr. John Miller, Slackwater, Penn.—It is folly to expect sweet milk from moldy hay, musty fodder, decaying vegetables and impure water. Let a cow eat garlic, ground acorns, bitter weeds, etc., and next morning we have the aroma of them in the milk. Likewise, set sweet milk, or good butter, in a newly-made pine cupboard, for a few hours, and the very flavor of the wood will be in them. In no other department of our "daily toil" is cleanliness more akin to godliness than in the milk and butter business. We may take our wheat to mill in a dirty sack, keep the flour in an unsightly barrel, knead the dough in a tray that has never been washed or scraped, and yet sometimes have good bread. But milk and butter kept in unclean vessels, and yet be sweet? Never! Soon as the milk is drawn, set it in the cellar for one or two, and never more than three hours. Then remove to a warm room, so that it will sour and thicken a little in from forty to forty-eight hours—a temperature of sixty to seventy degrees will do this; then skim and set the cream in the cellar, no matter how cold, only so it don't freeze. A week in the cellar, and a little added every day, will not damage it. If the weather is cold on the day you churn, remove the cream, four or six hours previous to churning, to a warm room, so that its temperature may rise to about sixty-five degrees Fah. Churn as usual, and, if you are a little expert, in a very short time you may expect good, rich and sweet butter.

Mr. W. E. Huntley, Essex, Vt.—I have seen several times, in the reports, complaints about churning. To all so troubled, I would say, after straining your milk thoroughly, mix with each four quarts one pint of boiling water, and your cream will change to butter with as little churning as in the summer, and I will warrant the butter as good as that of the Virginia gentleman whose wife mixed old buttermilk with her cream.

Poultry Raising.

Mr. C. L. Merry, Norwalk, Ohio, asked many questions. He has not had experience in the care of fowls, but would like to devote two acres of land to this stock. How shall he inclose it, what houses build (to accommodate one thousand head), what breed is best, etc.

Mr. Harry Stewart—On two acres of land it would be folly to attempt to keep one thousand fowls with the expectation that they could be permitted to have any range. If closely penned up, one thousand fowls might be kept on two acres by the exercise of the utmost care and by an experienced keeper. But there would be no accommodation for young chicks and the necessary coops to shelter them. It is possible that four hundred hens could be kept on two acres, but not any more. I have had some experience, and would rather have at the rate of one acre to one hundred fowls than less; but I have no doubt that I could succeed with four hundred on two acres. The ground should be inclosed with a picket fence, and the buildings placed on the north side and facing to the south. The height of the fence should be five feet for Brahmas and nine feet or more for the more active fowls. I have found a roosting house eighteen feet long, twelve feet wide, and eight high at the back and twelve at front, with a single sloping roof and built of common boards, not battened, but with the joints open, quite sufficient accommodation, and quite warm enough for two hundred fowls. Fresh air is of vastly more importance than warmth. In a climate much colder than that of New York, I have never had a fowl's comb frozen in such a house as this on the coldest nights, when the temperature has been below zero, and a strong wind blowing. Too much warmth induces disease: catarrh, roup and dysentery are caused by impure air and warmth, produced by huddling in a close apartment. Artificial warmth is better than sweating in this manner. A setting-house, adjoining the roosting-house and of the same size, needs to be provided, without windows, and with a shelf all round on which to place the nests, raised two feet from the ground. Another shed, adjoining the roosting-house at the other end, open in the front, should be provided for shelter on stormy days and for the fowls to wallow in. Thus these three apartments, adjoining each other in a line, are needed for two hundred fowls, and by adding additional sets the colonies may be increased so long as there is room for them. I have found light Brahmas the best on the whole. They are good layers, very gentle and tame, and easily handled; weigh seven or eight pounds when mature, and are not able to get over a five-foot picket fence. They are hardy. I have succeeded well with Dorkings, but they are more inveterate setters, and not so easily broken up as the Brahmas, are not so heavy at two years old, not so prolific layers, and are more tender. Doubtless the very best fowls for common use, to commence with, are good young native hens, supplied with Brahma and Dorking cocks each year alternately. But there is a great variety of opinion in this respect, and beginners should experiment till they are suited. It is impossible to say here, how a man who is an entire stranger to the business should handle fowls to the best advantage. But it is entirely safe to say to beginners, commence to go into this business gradually, and learn as you go along; and as success comes, increase as may be desirable. A new beginner will inevitably fail if he commences on a larger scale than with fifty to one hundred fowls. Almost any poultry book will give the necessary information, and the "Poultry World" is certainly a good periodical for any one interested in the subject it treats of.

MULCHING MEADOWS.

A correspondent, Reading, Pa.—Top-dressing meadows and winter crops with fine manure or compost is a most useful operation, which is sadly neglected or not appreciated by most farmers. By my own experience, and from considerable observation of others, I have proved three special advantages from this practice, beside others of less value. I found it to cause good and poor meadows to yield twice as much and better hay in a season, and with less injury and exhaustion by frequent mowings; I have found it to prevent winter wheat and rye from killing out by severe winters, while producing a better yield in quantity and quality; and I have found it enabling me to raise good crops of winter grain, in localities and on farms where it was not possible to secure winter crops without this mulching. It shelters the young plants of grass and grain from severe sudden changes of temperature; it prevents the soil from heaving and sinking by these changes; it prevents the moisture from evaporating and the ground from baking by the first hot suns, and helps to smother down weeds which are liable to spring up.

A correspondent, Chapel Hill, Va.—The following experiment convinced the writer of the superior advantages of mulching: The 1st of April, 1871, I planted fifty, one-year-old and ill-grown apple trees in a stiff, rather thirsty soil. A portion of the land had already been seeded in oats. The remainder was well manured and cultivated in potatoes. The trees in the oat land were mulched with rotten straw, nearly a foot deep, and extending about eighteen inches around the tree; the soil about the other trees was constantly kept light and clean. As all were planted with great care, all grew off finely; but a severe drouth, though not very protracted, checked the growth of the cultivated trees, at an average of about one foot. The mulched trees pushed steadily on until September, when they had grown from two to four feet, and stout in proportion. Trees of the previous year standing in a clover lot, but pretty well worked, grew from two to three feet. I lost scarcely any oats, as they too grew finely from the mulching, when not too heavy. Some of the scions planted were not more than a foot high; they are now nearly five, and very thrifty. We should order one-year trees exclusively; and the nurserymen, relieved of a year's labor and of considerable trouble in taking up and packing, and enabled to turn over their capital twice as often as formerly, should reduce prices accordingly. Who will lead off in a movement calculated to benefit both parties so much?

Mr. W. J. Hayes, South Norridgewalk, Mich.—I readily acquiesce in the opinion of A. Pratt, in regard to top-dressing upon grass land or meadow for the hay crop, providing the manure be rotten and thoroughly pulverized, and that the meadow on which it is applied has plenty of roots for the grass to grow from; otherwise, in this section of the country, top-dressing proves of little consequence. But so far as potatoes and grain crops are concerned, we do not realize over two-thirds the benefit from manure spread on top and harrowed in in the spring just before planting our potatoes that we do where we plow it in, especially for the potato crop. Although it may be according to the laws of nature to drop her fertilizers on the surface, yet I hardly think that a shovelful of coarse manure dropped on the surface can be of as great benefit to the soil as it would be if buried three inches deep, especially in a dry season.

What Can be Raised on One-fourth of an Acre.

Mr. Henry P. Thompson, Peapack, N. J.—I have a little less than a quarter of an acre of limestone land. It lies in a parallelogram; its length about four times its width; and along one side are six apple and two cherry trees now in good bearing. In the fall of 1860, the land being covered with stones, briars and foul weeds, I had it cleared, plowed (twice) ten inches deep, and thoroughly pulverized, limed, and sowed with wheat; sowed also with timothy in the fall and clover in the spring. The wheat crop was fair, leaving a heavy crop of grass after it. The ground has never been plowed since. I have mowed it for ten successive summers, and never gathered less than half a ton of clear, bright hay from it. In 1864, the third year of mowing, after a fall dressing of fine barn-yard manure, I had a ton of clear timothy hay or four tons per acre, and about one-fifth of the ground shaded by the apple trees. The average yield for the ten years has been 1,200 to 1,400 pounds of hay, beside the fruit. The only manuring has been lime three times, ten bushels each, and barn-yard manure three times, four loads each. In 1871, after manuring in the spring, I had 1,400 pounds of hay, five barrels of good winter apples, six bushels of cider apples, beside cherries, and two months' family use of fall apples. Here is a summary for 1871: 1,400 pounds of good timothy hay, ten dollars; five barrels good winter apples, fifteen dollars; six bushels cider apples, three dollars; cherries, and other apples (more, but say) three dollars; total, thirty-one dollars. Four loads manure, six dollars; spreading do., one dollar and fifty cents; gathering hay, two dollars; gathering apples, one dollar and fifty cents—eleven dollars; net produce, twenty dollars, or eighty dollars per acre. Thirty bushels of lime and twelve loads of manure, worth twenty-four dollars, is all the land has had for eleven years; but no plastering is allowed on the lands. Every stone is picked off, and every briar or weed pulled before it seeds, so that now, after eleven years from plowing, a clean, smooth sward is presented.

L. A. Morrell, Esq., presented the following paper on the

PHILOSOPHY OF WOOL.

Structure of the Skin.

The skin of the sheep and of animals generally is composed of thin coats or layers. The external one is called the cuticle or scarf-skin, which is exceedingly tough, devoid of feeling, and pierced by innumerable small holes for the passage of the wool and insensible perspiration.

The next layer is termed the mucous coat, a soft structure, its fibers having scarcely more consistence than mucilage, and consequently separated with much difficulty from the coat below it. From the fact that the pulpy substance of this layer uniformly approximates the color of the hair or wool, it is supposed that here resides the coloring matter. This is also the seat of sensation—the nerves, or rather their terminations, ramifying minutely in its substance.

The third or lowermost is the cutis or true skin, a dense, firm elastic substance, in order to fit closely to the parts beneath, to yield to the various motions of the body, and the resistance of external injury. The true skin is composed almost entirely of gelatine, so that though it may be dissolved by much boiling, it is insoluble in water at the common temperature.

Anatomy of Wool.

Although the fiber of wool has been submitted to severe examinations of powerful microscopes, its internal structure is not yet definitely settled—whether solid or consisting of a hard exterior tube, with a pith within. The weight of testimony, however, is much in favor of the supposition of the latter. The fact may be adduced, in support of this conclusion, that the wool of the sheep, when in high condition, is coarser than when in low flesh, the fiber being distended apparently from no other cause than the superabundance of the secretive matter designed for its growth. Could it be otherwise were it not tubular in its conformation? It may, however, proceed from another cause, for it has been satisfactorily ascertained that the fiber is vascular, being supplied with vessels which convey nourishment from the pulp, which seem to accompany it to a considerable distance from the root, if not through its whole extent.

The learned Dr. Good says: "The plica-polonica—a disease whose existence is doubted by some, but of the occasional occurrence of which there is abundant testimony—completely establishes the vascularity of the hair, for it is an enlargement of the individual hair, so much so as in some cases to permit the passage of blood, for the hair will bleed when divided by the scissors." Admitting it to be true that hair is vascular, it follows that the fiber of wool is also; and, hence, if a sheep is in more than ordinary condition, the consequent repletion of the fluids would cause an increased bulk of the fiber, without the necessity of a tubular conformation. But leave is taken of the question, with the repetition that the preponderance of testimony is in favor of the theory that the fiber is hollow.

Each fiber of wool is composed of a number of filaments of smaller hairs, ranged side by side, which can be perceived without difficulty, from the tendency it sometimes has to ravel at the point. Mr. Bakewell, the celebrated English sheep breeder, says: "Hair is frequently observed to split at its points into distinct fibers; a division has also been seen in the hair of wool. This seems to prove that they are formed of distinct long filaments united in one thread or point. In one hair I distinctly perceived fifteen of these divisions or fibers lying parallel to each other, and in some of the fibers a further subdivision was distinguishable. Probably these subdivisions were each composed of others still smaller, which the limited power of our instrument may prevent us from discovering. If such be the structure of the hair of some animals, it is at least probable that the hair of all others may have a similar conformation, although the fibers of which they are composed may be too minute or adhere too firmly together to permit us to separate or distinguish them."

Chemical Composition.

The fact has long since been established that the chemical composition of nails, hoofs, horns, hair, wool, and even feathers, is substantially the same. According to Henry, they are made up of an animal substance resembling coagulated albumen and sulphur, silica, carbonate and phosphate of lime, and oxides of iron and manganese. The similarity of the odor of hoofs, horns and hair, perceptible when burned, is within the experience of all. It is also well known that the horns of cattle are made up of elongated fibers of hair, which will be obvious to any one who will take the trouble to examine with the aid of a microscope. Indeed, without this instrument the fact can be established, as exemplified in the horns of the deer at certain stages of the growth, and also those of the giraffe, on the surface of which hairs can be distinctly traced. Other testimony may be found in the circumstance, uniformly the same, that the horns conform in the degree of their twist or curve to the hair or wool of the animals on which they respectively grow. Thus, in the Angora goat and wild sheep of the Rocky Mountains, the horns are, like the hair and wool they produce, comparatively straight, while the horns of the Saxon and Merino sheep resemble the beautiful curves of their wool.

Yolk.

This peculiar substance is so called, abroad, from its adhesiveness and color, but with us it is termed gum, an appellation derived from its glutinous properties quite as appropriate. It is apparent in the fleeces of fine-wooled sheep, especially so in the Merino, at all seasons of the year, but very much so in the winter and spring; and although diffused through the entire fleece, yet such is its profusion in the Merino, that it is observable in detached concrete particles resembling ear-wax. According to the chemical analysis of Vauquelin, it consists principally of a soapy matter, with a basis of potash, a small quantity of carbonate of potash, lime in an unknown state of combination, and an atom of muriate of potash. Its peculiar odor, well known to those familiar with the fleeces of Saxon and Merino, is derived from the infusion of a small quantity of animal oil, and is in every respect a true soap, which would permit of the fleece being thoroughly cleansed by the ordinary mode of washing, were it not for the existence of this uncombined fatty or oily matter, which remains attached to the wool, and renders it glutinous until subjected to the process of scouring by the manufacturer. There are some, from ignorance, who imagine the yolk or gum to be, if not absolutely a detriment to wool, at least a useless concomitant. This, however, is a decided mistake. It is a peculiar secretion from the glands of the skin, acting as one of the agents in promoting the growth of the wool, and by its adhesiveness matting it, and thereby forming a defence from the inclemency of the weather. From accurate observation, it has been ascertained that a deficiency of yolk will cause the fiber to be dry, harsh and weak, and the whole fleece becomes thin and hairy. On the contrary, when there is a natural supply the wool is soft, plentiful and strong. The quantity depends on equability of temperature, the health of the sheep and the proportion of nutritive food it receives.

Although it is found in greater or less quantities in the fleeces of almost every variety of sheep, such is its excess in the Merino breed, that it causes dirt to collect on the surface to such a degree as to form an indurated crust, with a hue resembling the thunder-cloud. This excess, although, as already remarked, no way injurious to the fiber, yet in one sense it is so to the manufacturer, from the uncertainty as to the amount of loss by cleansing. Hence it is that the European manufacturers refuse to purchase Spanish Merino wool without its being thoroughly washed with soap, which is always performed after the fleece is shorn, and even then the wool shrinks, by the manufacturer's mode of cleansing, generally about ten per cent. It has been observed that temperature has an influence in determining the quality of yolk; hence, the equable and mild climate of Spain is favorable to its production, and although the Escurial Merino is for the most part the parent stock of the famous Saxon sheep, yet, from the opposite character of the climate of Germany, it is found in a greatly diminished quantity in their wool. The Saxon Merino, however, when kept in fair condition, has the requisite supply to give additional softness, pliability and strength to the fiber. The famous English breeder, Mr. Bakewell, says: "An intelligent manufacturer in my neighborhood, who kept a small flock of good wooled sheep, informed me he had adopted the practice of rubbing the sheep with a mixture of stale butter and tar. He could speak decidedly to the improvement the wool had received by it, having superintended the whole process of the manufacture. The cloth was superior to what undressed wool could have made if equally fine; was remarkably soft to the touch, the appearance of thread being nearly lost in a firm, even texture, covered with a soft, full nap."

The additional value, then, the yolk imparts to the wool, affords a useful lesson to the wool-grower to take such care of his sheep as will best supply the needed quantity. Equability of temperature being one requisite, he should protect his flocks during the winter season; and good condition being another, wholesome and nutritious food should not be spared.

Form of the Fiber.

The fiber of the wool is circular, differing materially in diameter in the various breeds, and also in different parts of the same fleece. It is generally longer toward the point and also near the root, in some instances very considerably so. Mr. Youatt's description cannot be simplified or improved: "The fibers of white wool, when cleansed from grease, are semi-transparent; their surface in some places is beautifully polished, in others curiously incrusted, and they reflect the rays of light in a very pleasing manner. When viewed by the aid of a powerful achromatic microscope, the central part of the fiber has a singularly glittering appearance. Very irregularly placed minuter filaments are sometimes seen branching from the trunk, like boughs from the main stem. The exterior polish varies much in different wools, and in wools from the same breed of sheep at different times. When the animal is in good condition, and the fleece healthy, the appearance of the fiber is really brilliant; but when the sheep is half starved, the wool seems to sympathize with the state of the constitution, and either a wan, pale light, or sometimes scarcely any, is reflected." His closing paragraph is especially true. The wool of half-starved sheep can be detected at a glance by the wool-stapler and experienced buyer, and its consequent deterioration affects the price. The fiber of such wool is finer, it is true, but numberless breaches injure every manufacture for which it is used. This is another illustration of the bad policy of farmers in neglecting to keep their sheep in uniform good condition. Healthy sheep will produce healthy wool, both being always the most valuable, and consequently paying the largest dividends.

Elasticity.

A writer observes: "There are two antagonistic principles continually at work in every part of the frame of every animal, and it is on the delicate adjustment and balance of power between them that all healthy and useful action depends: the disposition to give way or submit to some alteration of form when pressed upon, and an energy by means of which the original form is resumed as soon as the external force is removed." These two principles are beautifully exemplified in the fibers of wool, obviously much dependent on the numerous and minute spiral curves so manifest in the Saxon and Merino. Take, for instance, a single fiber of wool of these varieties of sheep; if it be stretched to its full length and then suddenly set free at one extremity it will resume its ringlet form; and hence upon the union of pliability with the elastic principle depends the usefulness and consequently value of clothing wool.

The play of these powers is differently adjusted in wools. In the Saxon, celebrated for our finest fabrics, the action of these opposing principles is beautifully balanced. Hence it is so easily shorn of its superfluous nap, the facility with which it yields to pressure, and covers the threads of cloth with a dense, soft pile. Notwithstanding the injury the elastic power may receive by the process of manufacture, yet by the aid of a microscope the nap presents innumerable minute curves closely hugging the texture; and to this much of the beauty of our finest cloth is owing. To these opposing powers of the fiber the felting principle is not a little indebted, as will be explained hereafter.

Spiral Curve.

The spiral curve or ringlet form of wool has been referred to. This is one of the distinguishing qualities between wool and hair, the latter being comparatively straight. It is remarkable in all short-wooled sheep, but in no other varieties is it so conspicuous as the Saxon and Merino. It is observable in the Southdown and other English varieties, but in a far less degree; and with some species of the goat, under the hair of which is found a perfect wool, having the true felting property and fiber curved.

There is an intimate connection with the fineness of the wool and the number of the curves, or, otherwise, in proportion to the number of the curves in a given span is the diameter of the fiber. It should be stated, however, that this is more generally true of pure Saxon and Merino. It can be easily demonstrated, if the experiment is fairly made, with the micrometer, care being taken not to destroy the curves by extension, but the fiber placed in the instrument as it naturally grows upon the sheep. From M. Lafour's work on German management of sheep the following is extracted bearing on this point:

"Those breeding pure Saxons inspect their flocks three times in the year; before winter, when the selection of lambs is made, in spring, and at shearing time. Each sheep is placed in its turn on a kind of table, and examined carefully as to the growth, the elasticity, the pliability, the brilliancy and the fineness of the wool. The latter is ascertained by means of a micrometer. It being found that there was an evident connection between the fineness of the fiber and the number of the curves, this was more accurately noted, and the following table was constructed. The fleece was sorted in the manner usual in France. The fineness of the superelecta or picklock is represented by a span corresponding with the number seven on the instrument."

Name.	Curves in an inch.	Diameter of fiber.
1. Superelecta	27 to 29	1.840 inch.
2. Electa	24 to 28	1.735 inch.
3. Prima	20 to 23	1.660 inch.
4. Secunda prima	19 to 29	1.588 inch.
5. Secunda	16 to 17	1.534 inch.
6. Tertia	14 to 15	1.510 inch.

The above table will show the necessity of more care with wool-growers in breeding from such sheep only whose wool approximates to the principle laid down, as it is on this curled form of wool one of its most valuable uses depends. It is an agent, though not the principal, in producing the phenomenon of felting. A writer says: "It materially contributes to that disposition of the fibers which enables them to attach and entwine themselves together; it multiplies the opportunities for this interlacing, and it increases the difficulty of unraveling the felt."

The numerous and minute curves, as observed, eminently characteristic of the pure Saxon and Merino, will serve as a sure test, in all cases, of the purity of blood, and therefore a certain and unerring guide in the selection of breeding sheep. If it is rigidly adhered to, the every-day attempts to dispose of grades for high-bred sheep will be frustrated.

Fineness.

This term, when applied to wool, is wholly comparative, various breeds of sheep producing wool essentially different in quality, the same breeds varying much, and all breeds exhibiting qualities of wool of unequal fineness in the same fleece. It is also sometimes the fact that the extremity of the fiber, as ascertained by the micrometer, is five times greater in bulk than the center and root.

It is, then, a matter to be studied by the wool-grower who is desirous of propagating sheep of the fine-wooled varieties, for grades will often exhibit seven and eight qualities in the same fleece, whereas unalloyed breeds show but four qualities. Individuals have occasionally been found in original Saxon flocks whose fleeces would divide into only two sorts, but this is very rare.

The refina, or the picklock wool, begins at the withers and extends along the back to the setting on of the tail. It reaches only a little way down at the quarters, but, dipping down at the flanks, takes in all the superior part of the chest and the middle of the side of the neck, to the angle of the lower jaw. The fina, a valuable wool, but not so much serrated or possessing so many curves as the refina, occupies the belly and the quarters and thighs down to the stifle-joint. The third quality is found on the head, the throat, the lower part of the neck and the shoulders, terminating at the elbow; the wool yielded by the legs, and reaching from the stifle to a little below the hock, and procured from the tuft that grows on the forehead and cheeks, from the tail, and from the legs below the hock, is the fourth quality.

Length of the Staple.

Formerly wool of short staple only was thought by the manufacturer indispensable to make a fine cloth with a close pile or nap, but the improvements made in machinery within twenty years have superseded this consideration, and now long-stapled wool is most valued. This, in part, proceeds from the fact that short wools have more "dead end" proportionately than long. Again, the manufacture of delaines calls for a long, tough staple. The Australian wools, which are of Merino and Saxon blood, from the mildness and equability of the climate are very much longer than formerly, and are most used for the above fabric. It is a query, however, whether a fine and very compact fleece, possessing a long fiber, can be produced on the same sheep. Very close, fine fleeces are always comparatively short in staple, and close fleeces are indispensable in our rigorous climate to protect the sheep from the effects of cold and wet. On the contrary, open fleeces are long in staple, but a poor defense against a low temperature. It is, therefore, a question for the wool-growers of the northern States to consider whether, in obliging the manufacturer, he will not adopt a policy injurious to the constitution of his sheep. In a more southern latitude this consideration is not so important.

Color.

The alteration of the color was the first recorded improvement of the sheep, and its purity, its perfect whiteness, should never be lost sight of by the sheep-master of the present day. It is not, however, so much considered as it should be. Manufacturers desire none other fine wools than those of the purest whiteness, for the reason that those of a black or dun-colored hue do not receive a perfect fancy dye, and therefore can be converted only into black cloths; hence, they are valued accordingly. Flock-masters should never breed from individuals that are otherwise than purely white, for, independent of the above consideration, black or smutty sheep mar the appearance of a flock.

Trueness.

The quality of the trueness of the staple especially enhances the value of every grade of wool in which it is found. It comprises an equality of the diameter of the fiber from the root to the point, and uniformity of the fleece generally. When the filament greatly lacks in this particular, it may be ascribed to an irregular and unhealthy action of the secretion of wool, which in turn must be attributed in general to abuses in management of the flock. For instance, if the animal has fared kindly till the winter season, and then exposed to storms and cold, and withal ill-fed, the growth of that part of the fiber during this period will be considerably diminished in diameter, proportionately weak, and when examined by the microscope presents a withered appearance. On being turned to pasture—the fare being better and the secretions again becoming healthy and abundant—an enlargement of the fiber follows; but it is greatly destitute, from the causes stated, of the quality of trueness, and, therefore, debases the value of the whole fleece. The weak and withered parts of the fiber are termed breaches, and injure materially every manufacture in which it is employed, the felting property being deteriorated, and the fabric having less strength and softness. The skillful stapler and wool buyer will easily detect this serious fault and prize the wool accordingly. Although this description of wool is generally, as remarked, the result of bad management of the flock, yet it is common to all good sheep. With the Saxon and Merino, after the ewes, particularly, pass the age of eight or nine years, the yolk lessens in quantity, which is followed by comparatively a hard, inelastic, unyielding character of the wool, with the strength and weight greatly diminished. Therefore, notwithstanding the singular longevity of these breeds, it is better to pass them over to the butcher when arrived at the age mentioned. Intimately connected with producing a sound and true staple is the

Influence of Temperature.

It cannot be doubted that equability of temperature is an important agent in perfecting the several properties of wool. The Spanish custom, continued for centuries, of driving the sheep in the spring of the year to the northern and mountainous parts of the kingdom, which are there kept until the approach of winter, originated in part from the conviction that this theory is sound. Indeed, it is founded in the natural instincts of the animals. Every one knows it is impatient of heat. In the midst of summer, in all latitudes where it is found, it will seek the most elevated point for the sake of the cooling breeze, and retire to shades to guard itself against the burning rays of the sun. In winter it will flee to a place of refuge from storms and cold. This testifies strongly in favor of the correctness of the premises. But the question may be asked, what has the bodily comforts of the animal to do with perfecting the several properties of the fleece? The answer is, everything. If health and thrift are promoted by equability of temperature, the cutaneous glands are alike healthy, and regular and even growth of the fiber follows.

But, strictly speaking, equability of temperature is nowhere to be found; therefore, in our rigorous and changeable climate, the fiber of wool must ever present a greater or less irregularity of diameter between the extremes. It is a remarkable fact that the point has always the largest bulk. This is the product of summer, after shearing time, when there is a repletion of the secretions which produce the wool, and when the pores of the skin are relaxed and open, and permit a larger fiber to protrude. The portion near the root is the growth of the spring, when the weather is getting warm, and the intermediate part is the offspring of winter, when, under the influence of cold, the pores of the skin contract, and permit only a fine fiber to escape. A writer remarks: "The variations in the diameter of the wool in the different parts of the fiber will curiously correspond with the degree of heat at the time the respective portions were produced. The fiber of the wool and the record of the meteorologist will singularly agree, if the variations are sufficiently distant from each other for any appreciable part of the fiber to grow."

In confirmation of the general fact as to the influence of climate on wool and hair, the remarks of Mr. Hunter, an English author of high authority, are quoted: "Sheep carried from cold to warm climates soon undergo a remarkable change in the appearance of their fleece. From being very fine and thick, it becomes thin and coarse, until at length it degenerates into hair. Even if this change should not take place to its full extent in the individual, it will infallibly do so in the course of a greater or less number of generations. The effect of heat is nearly the same on the hairs of other animals. The same species that in Russia, Siberia and North America produce the most beautiful and valuable furs, have nothing in the warmer climates but a coarse and thin covering of hair."

The above must be received with some limitation. Mr. Youatt makes the following remarks: "Temperature and pasture have an influence on the fineness of the fiber, and one which the farmer should never disregard, but may in a great measure counteract this influence by careful management and selection in breeding. The original tendency to the production of a fleece of mixed materials existing, and the longer coarse hair covering and defending the shorter and softer wool, nature may be gradually adapting the animal to his new locality; the hair may increase and the wool may diminish if man is idle all the while, but a little attention to breeding and management will limit the extent of the evil or prevent it altogether. A better illustration than this cannot be found than in the fact that the Merino has been transplanted to every latitude on the temperate zone, and some beyond it—to Sweden in the north and Australia in the south—and has retained its tendency to produce wool exclusively, and wool of nearly equal fineness and value." M. Lasteyrie, a distinguished advocate of the Merinos, uses this language: "The preservation of the Merino in its purity at the Cape of Good Hope, and under the rigorous climate of Sweden, furnish an additional support of this my opinion; fine-wooled sheep may be kept wherever industrious men and intelligent breeders exist."

Notwithstanding the above is so consolatory, and withal so very encouraging to our brethren of the southern States to embark in sheep husbandry, yet it is undeniable that in northern latitudes the finest wools are produced; but this has arisen much from superior skill in breeding and great assiduity in management in every regard. If sheep are properly selected from high-bred Merino and Saxon flocks, and taken to a latitude not south of twenty-eight degrees, if rightly managed, will suffer little deterioration for many years, and will produce wools of a like description of the Australian—soft, of even and long staple, fit for felting, and also admirably adapted for the finest and most beautiful delaines and other worsted fabrics. I know of an instance of an imported flock of Saxons having been taken to Tennessee some forty years ago, and, judging from the samples of their wool, the conclusion is inevitable that little or no deterioration has been produced by the climate. If sheep are provided with suitable retreats for shade during the summer months, there are many districts in the southern States unsurpassed for wool cultivation. If there is a tendency to coarseness it will be retarded or wholly prevented by an occasional recurrence to Northern stock-getters.

Many imagine that the climate of the southern States is wholly unsuitable for the production of a fine fleece, because of the inferiority of the wools of South America. The degeneracy of the Merinos taken there has not arisen so much from the climate as because "industrious men and intelligent breeders" were not present to manage them. Furthermore, very many of the sheep transported there from Spain were of the Chunah breed, producing very coarse wool, and these were promiscuously bred with the Merinos. The conservative power over the fleece lies in good management far more than climate.

Felting.

The phenomenon of felting long remained enshrouded in mystery. This gave rise to numerous speculations as to the primary cause or causes, some of which, although plausible at the time of their publicity, now that the true cause has been discovered, appear quite ridiculous. But the keen sagacity of man at length mastered the subject by surmising the correct theory, without the means, however, to demonstrate it for want of microscopes of adequate power. To M. Monge, a distinguished French chemist, are we indebted for the first correct view of the structure of the fiber, upon which, from its peculiarity, mainly depends the process of the felting principle. He asserted "that the surface of each fiber is formed of lamellæ or little plates which cover each other from the root to the point, pretty much in the same manner as the scales of a fish cover that animal from the head to the tail, or like rows placed over one another, as is observed in the structure of horns;" and he accounts for the felting process in the following way, very true and very graphic:

"In making a felt which is to constitute the body of a hat, the workman presses the mass with his hands, moving them backward and forward in various directions. This pressure brings the hairs or fibers against each other, and multiplies their points of contact. The agitation gives to each hair a progressive motion toward the root, but the roots are disposed in different directions—in every direction—and the lamellæ of one hair will fix themselves on those of another hair which happens to be directed a contrary way, and the hairs become twisted together, and the mass assumes the compact form which it was the aim of the workman to produce. If the wool is in cloth and subjected to the process of fulling, the fibers which compose one of the threads, whether of the warp or woof, assume a progressive movement; they introduce themselves among those of the threads nearest to them, and thus, by degrees, all the threads become felted together, the cloth is shortened in all its dimensions, and partakes both of the nature of cloth and felt." No language can be employed which will convey a more correct and vivid impression of the process of felting than the foregoing.

Through the indomitable perseverance of Mr. Youatt, the author of a valuable treatise on British sheep-husbandry, Monge's theory was finally demonstrated, although he was often frustrated, and almost yielded to despair, from the imperfections of his instruments. The construction at last of a superior achromatic microscope by Mr. Powell, of London, enabled him to realize his ardent wishes, and his description of the scene, and the conclusions to which he arrived, are of too much interest to admit of any abbreviation.

"On the evening of the 7th of February, 1855, Mr. Thomas Plint, woolen manufacturer, resident at Leeds; Mr. Symonds, clothing agent, of London; Mr. Edward Brady, veterinary surgeon; Mr. Powell, the maker of the microscope; and the author himself, were assembled in his parlor. The instrument was, in Mr. Powell's opinion, the best he had constructed. A fiber was taken from a fleece of three years' growth; the animal was bred by and belonged to Lord Western. It was taken, without solution, and placed on the frame to be examined as a transparent object. A power of 300 (linear) was used, and the lamp was of the common flat-wicked kind. The focus was readily found, there was no trouble in the adjustment of the microscope, and after Mr. Powell, Mr. Plint had the first perfect ocular demonstration of the irregularities in the surface of the wool, the palpable proof of the cause of the most valuable of its properties—its disposition to felt. The fiber thus looked at assumed a flattened, ribbon-like form. It was of a pearly gray color, darker toward the center, and with faint lines across it. The edges were evidently hooked—or, more properly, serrated; they resembled the teeth of a fine saw. These were somewhat irregular in different parts of the field of view, both as to size and number. The area of the field was now ascertained; it was one-fortieth of an inch in diameter. By means of the micrometer we divided this into four, and then we counted the number of serrations in each division. Three of us counted all four divisions, for there was a difference in some of them. The number was set down privately, and it was found that we had all estimated it at fifteen in each division. Having multiplied this by four, to obtain the whole field, and that by forty, the proportionate part of an inch of which the field consisted, we obtained a result which could not be disputed, that there were 2,400 serrations in the space of an inch, and all of which projected in the same direction, viz.: from the root to the point. Then, before we quitted the examination of the fiber as a transparent object, we endeavored to ascertain its actual diameter, and proved it to be 1-750 of an inch.

"We next endeavored to explain the cause of this serrated appearance and the nature of the irregularites on the surface, which might, possibly, account for the production of those tooth-like projections. We, therefore, took another fiber and mounted it as an opaque object. There was considerable difficulty in throwing the light advantageously on the fiber, so small a space only as one-thirtieth of an inch intervening between the lines and the object. At length Mr. Powell perfectly succeeded, and we were presented with a beautiful glittering column, with lines of division across it, in number and distance seemingly corresponding with the serrations that we had observed in the other fiber that had been viewed as a transparent object. It was not at once that the eye could adapt itself to the brilliancy of the object, but by degrees these divisions developed themselves and could be accurately traced. All these projecting indented edges pointed in a direction from root to point.

"Whether these, like the cones of the bat, are joints, or at least points of comparative weakness, and thus accounting for the pliancy and softness of the fiber, or regulating the degrees in which these qualities exist, may be better determined by and by; these serrated edges in transparent object, produced by the projecting edges of the cups or hollow bases of the inverted cones, afford the most satisfactory solution of the felting principle that can be given or desired. The fibers can move readily in a direction from root to point, the projections of the cups affording little or no impediment; but when they have been once involved in a mass, and a mass that has been pressed powerfully together, as in some part of the manufactory of all felting wool, the retraction of the fiber must be difficult and in most cases impossible.

"If to this, the serrations, is added the curved form which the fiber of the wool naturally assumes, and the well-known fact that these curves differ in the most striking degree in different breeds according to the fiber, and when multiplying in a given space increase both the means of entanglement and the difficulty of disengagement, the whole mystery of felting is unraveled. A cursory glance will discover the proportionate number of curves, and the microscope has now established a connection between the closeness of the curves and the number of the serrations. The Saxon wool is remarkable for the close packing of its little curves; the number of serrations is 2,720 in an inch. The Southdown wool has numerous curves, but evidently much fewer than the Saxon and Merino, and the serrations 2,080. In the Leicester the wavy curls are so far removed from each other that a great part of the fiber would be dissipated under the operation of the card, and the serrations are 1,860; and in some of the wools, which warm the animal but were not intended to clothe the human body, the curves are more distant and the serrations are not more than 480. The wool-grower, the stapler and the manufacturer can scarcely wish for better guides.

"Yet there is no organic connection between the curves and serration; the serrations are not the cause of the curve, nor do the curves produce serrations; the connection is founded on the grand principle that the works of nature are perfect. The curves of the smooth fiber might entangle to a considerable degree, but some of the points would be continually unraveling and threatening the disssolution of the whole felt. It is by the curved form of the fiber that the object can be accomplished certainly and perfectly."

You will readily perceive, gentlemen, from the general tenor of my paper, that it is a fit prelude to one on the right selection and skill in breeding of that class of sheep whose wool is adapted for clothing purposes; and if it is your pleasure that I should prepare one, I will most cheerfully do so.

Dr. J. V. C. Smith said the paper just concluded was one of the ablest ever read before the Club, and moved that the thanks of the Club be tendered to its distinguished author, and that the paper be requested for publication in the American Institute Transactions; which motion was seconded by several and unanimously adopted.

Adjourned.

April 9, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Poultry Raising.

Mr. George T. Pratt, Homer, N. Y.—I have seventeen hens. Between the middle of December last and March 15 I sold forty-eight dozen eggs. Many more were laid, some of which were frozen, others used in the family, of which no account was kept. My hens are a mixture of Poland, Black Spanish and Brahma. I consider Polands the best layers, but the eggs and chickens are small for the table. The Brahma cross makes them better size, and the Black Spanish makes them more hardy and active. My hen-house is on the south side, and opens into the barn, where the hens have the range of a warm underground stable. The feed has been corn and oats, with the scraps from the table. They have also eaten half a bushel or more of old air-slaked lime, and what gravel they wanted, once a week or oftener. I have chopped up old bones; for these they were very ravenous, flying at me as soon as I came in sight with them, and trying to pull them out of my hands. The best way I have found to cut and break them is with a hand-axe on the end of a block of hard wood. I believe most people burn the bones for their hens, but that spoils them for my hens. Something is burned out, so they don't care much for the shell that is left. If any one can beat this "lay" of the hens, let them report.

Mr. J. Flomerfelt Peapack, N. J.—My hens began to hatch about the middle of January. Having some coops eighteen inches square, I placed them in the ground in quite a steep bank facing to the south, and put a hen in each coop, with an egg or two to accustom them to the change from the nest in which they had laid. After about one day they will remain quiet upon the nest, and the eggs (one dozen) can be put in, and thus I have succeeded in hatching eleven-twelfths of all the eggs set. The first hen was set January 22, and we have to-day, April 2, 206 chickens remaining at large, their mothers being confined in coops similar to those in the bank. We have not lost a chicken. The coops in which they hatch have slats across the front. One of them is movable. The hen is taken out once each day to feed, and, thus managed, the eggs will hatch in the very coldest weather. When the chickens were about one week old, they were found to be full of vermin upon the head and under the throat; these we removed immediately by rubbing the parts affected with kerosene; this kills the nits also, and does not injure the chicken in the least. The oldest chickens now are about like quails in size, and very healthy. We find poultry-keeping an agreeable and profitable employment in connection with farming.

The Chairman—These statements are not only interesting and valuable as affording further proof of what may be done with poultry, but they are also models for conciseness. I wish every person who addresses the Club (and we can't have too many of these records of experience) would say what he or she has to say in as condensed and straightforward a way as possible; and then let them further imitate Messrs. Pratt and Flomerfelt, and write on one side of the paper only. A sheet with writing on both sides provokes profanity in the printing office; and, beside that, I notice that the gentlemen of the press (who are generally models of patience, but who always seem hurried and overworked, and without whom the Club would soon be very dead indeed) not infrequently cast aside such objectionable manuscripts.

A member asked the broad question, what breed or cross of chickens is most profitable, all things considered?

Mr. D. B. Bruen—I repeat what I have been saying, off and on, for the last fifty years, that it is more in care than in crosses. I have kept fowls almost from my youth up, losing few by disease, and having always plenty of spring chickens and omelet timber in abundance. My hens bring me each, on an average, 147 eggs a year. From fifty-seven, in one year, I got 667 dozen and eight eggs. I have never bothered my brains about breeds. I fight shy of the fowl dealers in eggs at six dollars a dozen. Feed well, keep clean quarters, give plenty of range, give water three times a day, supply pounded oyster shells, in winter a dust heap, fumigate with sulphur, if by any chance lice appear, and, my word for it, you will have eggs enough and to spare. I have a neighbor who keeps nothing but white Leghorns, and when he wants chickens he puts their eggs out to be hatched by a Dorking, or other good getting breed. He has no trouble about deterioration, but he breeds well. The reason people do not make chickens pay is because they make them shift for themselves.

Mr. Henry Stewart—I kept a Dorking hen setting steadily till she hatched out 100 chicks. This took her about three months. At the end of that time I moved away from that part of the country. My successor may have kept her at the same business till this day, for all I know to the contrary.

Dr. J. M. Crowell—When certain things are to be accomplished, certain requisites are necessary. The white Leghorns lay a great many eggs and are good to eat; they are tender and juicy. The poultry raisers of Monmouth prefer a cross of some English breed with the Brahma. Some think the Dorking is the best extant; they give good, rich eggs. If it is intended to raise capons, Dominick is the best.

Mr. Dodge—In my opinion, for eggs, the best breed is Black Spanish and White Leghorn; for the table, Dorking and Bolton Grays; for market, coarse, fast growers, as Cochins or Brahmas.

The Chairman—I took great pains to have all breeds, and keep them, as the sexes at the Shaker Community are said to live, "strictly apart." This was troublesome and didn't pay, so I let down the bars, and since this amalgamation have had good success. But I follow brother Bruen's practice, and give good care and good feed, and oyster shells and dust, and so forth.

Dr. J. V. C. Smith—Dr. Trimble has accomplished notable results with poultry on a city lot. Let us hear from him.

Dr. Isaac P. Trimble—I keep poultry for but one object—unmistakably fresh eggs the year round—and in this I have had satisfactory success. With some breeds the setting propensity is a great annoyance, and I have been trying many breeds, so as to find the least of this propensity. The Black Spanish, the Hamburgs, and some of the French varieties answer well, but for the last two years I have had several well-bred white Leghorns, and so far I prefer them to all others. I keep a pretty exact account with my hens, and I find they average about a bushel of grain each a year, and give me near 130 eggs in return. Corn and wheat are the chief food; sometimes buckwheat, cracked corn or barley are given by way of variety. The grain is always sound and sweet. I do not approve of giving hens damaged grain because they will eat it. I never feed them; they feed themselves from feed-boxes always plentifully supplied. I have now thirty hens, and during January, February and March they supplied us about seventy-five dozens of eggs. Of course, they are comfortably housed, and the floors of the stables are covered about a foot deep with earth—here they can dust themselves in all weathers. I once took home from this Club a contrivance for watering poultry. It is perfect and saves much trouble. A constant supply of broken oyster shells is another requisite of a well-managed poultry-yard. As to the setting instinct, I certainly should not keep hens at all if we had none but the old kinds. I have tried many ways of breaking up this propensity. I have placed snow balls in their nests; they would patiently melt·

them away, and be thankful for a fresh supply. Lately, I put them in old fruit-crates—slats all around—and by placing the crates so as to stand at an angle of forty-five degrees, they cannot set. Biddy is really out-generaled, and shows temper.

Cleaning Bolting Cloths.

Mr. Fred Weber, Los Angelos, Cal., wrote—Will the silk anchor bolting cloth (such as is used in flouring mills), which has become wet by water, so that the particles of flour adhering to it have assumed a hard, pasty nature, be liable to shrink and render it unfit for further use, were I to cleanse it by washing?

Mr. J. M. Molleson, of Croton Flour Mills, N. Y., replied—Our miller informs me that we can never use it to any advantage after being wet. Soda in cold water will clean the flour out very nicely, but we have been obliged to throw away cloth that has been wet.

Mr. Henry Stewart—I have had some practical experience in milling, and we always had to throw away our bolting cloths when they by any accident got thoroughly wet.

Oil Meal for Sheep.

Mr. William Erwin, Bourbon, Ind.—Is oil meal a suitable feed for ewes having lambs, with a view to increase their milk?

Mr. F. D. Curtis—Oil meal is good for any kind of stock in any condition, if fed sparingly. It keeps the bowels and pores of the skin open. It is also nutritious. A gill a day to each sheep is enough. Oil meal with oats or wheat bran would be excellent to produce a flow of milk. No stock will thrive for a length of time on any kind of dry concentrated food. The bowels must be fed as well as the stomach, or they will get out of order. Food must not be selected solely on account of its nutriment. There must be waste or there cannot be health; hence, some coarse feed like bran should be mixed with the oil meal.

Neosho Valley, Kansas.

Mr. James Brown, Center, Ala., wrote for information as to the climate, soil, wood, water and Indians, in the valley of Neosho river, Kansas; also, as to the prospect of completing the railroads which advertise land for sale in that valley.

Mr. Henry Stewart—The Neosho Valley is in south-eastern Kansas, and consequently the climate is milder than in other parts of the State. The soil, timber and water are all that can be desired for agricultural purposes, except stock raising, for which it is considered too warm. The Osage Indians are a peaceable race, and, having been removed to their reservation, have no interference with settlers. The Neosho River railroad, now the Missouri, Kansas and Texas railroad, is completed 187 miles south of the Kansas line, and is expected this year to reach Texas. There are three railroads in Neosho county. This county had, in 1871, over 10,000 inhabitants. The Neosho river is not navigable; it has several dams across it, which furnish water-power. Lands are getting scarce there, and spring is the best time to visit that country.

To Renovate a Pasture.

Mr. H. W. Field, Dutchess county, N. Y.—I have fifty acres of rolling land, clay; has produced fine crops; no seed for twelve years; grass a good deal run out. I want to seed it down; cannot get manure; am advised as follows: First, to plow it early in spring, and seed it down with rye in fall; second, to cut what grain it produces in July, and then plow and seed with rye in fall; third, to cut in July, and then harrow it over four times with a sharp-toothed drag, in place of plowing, and then seed down. It is held that the latter course is best for clay soil, and that the drag will kill the weeds, moss, etc. Would fine pulverized stone divided by the weather into minute cubes, or leaf mold from the woods, help the land? If not, what is the cheapest fertilizer for clay soil?

Mr. Henry Stewart—I would advise that this land be plowed when in good condition, early in June, plowing under everything growing on it; that it should then be harrowed with a heavy harrow lengthwise of the furrows, once a week for six weeks; then allowed to rest till the middle of August, and then cross-plowed a little deeper than at first, and harrowed until mellow. About the 10th of September, harrow once more to destroy weeds, sow the field to rye with five pecks of seed per acre, and cover the seed with a fine-toothed cultivator. In spring, sow a peck of red clover seed per acre, and harrow the field with a light grass-seed harrow, and in two years afterward plow the clover-sod under and repeat. If a sample of the pulverized stone were sent, it could be judged of what value it would be, but leaf-mold from the woods is good, when rotted, anywhere.

The French Way of Preserving Green Fodder.

Professor James A. Whitney presented the following translation from Les Mondes:

The leaves and crowns of the beet-roots (harvested for sugar-making) are piled close to a tub containing hydro-chloric acid diluted with water to four degrees of Beaume hydrometer. The leaves are placed in baskets (of such size as, when filled, to be easily handled by one man or two boys), and these are plunged in succession into the tub. After this immersion in the acid bath, which is made as brief as possible, the baskets are placed on wooden supports over an inclined channel or trough, which conducts the excess, of liquid, as it drains from the leaves, back to the tub. After a short time the leaves may either be taken direct to the trench where they are to be buried for preservation, or placed in a heap for further and subsequent attention. To wilt the leaves, they are laid in heaps as soon as they come from the acid bath, each heap containing about a wagon-load, and are allowed to lie for two or three days before removal. They are then closely packed in a trench or pit, care being taken to heap them so compactly that air shall be excluded from the interstices between them. The heap in the pit is then closed over with earth, tightly beaten down. In treating the leaves in the field there exists, of course, the necessity of transporting the acid and water, but this causes less trouble than the carrying of the unwilted leaves. The quantity of water required may be materially reduced if, instead of making the heaps for wilting on the ground, use is made of a plank platform or floor so arranged as to cause the liquid draining from the heaps to return to the soaking tub. This draining should be allowed to continue for two or three days, the same as when the heaps are made upon the ground. As a portion of the moisture natural to the vegetation is drained off with that originally derived from the bath, it dilutes the latter, so that it is necessary to add more acid. When this plan is adopted, the bath should be kept at a strength of about six degrees of Beaume hydrometer. While the draining is in progress, the pits or trenches may be dug, and as soon as the surplus liquid has passed off, the pits should be filled and closed in. If this is delayed, it will become more difficult, and it is always essential to exercise great care in the work, for the reason that air allowed between the leaves has always a hurtful effect upon them. The quantity of acid used has been about one and one-half per cent of the weight of the green leaves, 2,500 pounds of leaves requiring from thirty-seven to thirty-eight pounds of acid, which costs in France about twenty-five cents. As concerns the labor involved, two men and two boys can work 20,000 pounds of leaves per day. Estimating the wages of a man at forty cents and that of a boy at twenty cents per day, the cost of manipulation in France is about $1.20 for the quantity just mentioned. But as the weight of a given quantity of leaves diminishes one-half in consequence of the elimination of a large per centage of the water naturally contained in them, these figures must be doubled when reference is had to an equal weight of the preserved leaves. (Here, of course, the expense of labor is greater.) M. Dumont states that he prepared many thousand pounds at the close of the beet-root harvest of 1870, and experimented on a sufficiently large scale to secure exact data of their value as food for milch cows. He concludes that in quality and quantity the yield of milk is superior to that obtained from an equal weight of unprepared beet-root leaves fed at the usual season and in the ordinary manner; the butter made from the milk is, moreover, finer in flavor, of a more yellow color, and of a somewhat richer character. But it must be remembered that the quantity fed represents a much larger quantity of the original forage in the one case than in the other. During the whole time of feeding with the preserved leaves the health of the animals was excellent, and none of the drawbacks commonly experienced from full feeding with unprepared beet-root leaves was observed. During the experiment, continued through several months, the cattle invariably consumed the prepared leaves with avidity. M. Andre certifies to the fresh odor of the preserved leaves, proving them exempt from decay or alteration, and further expresses the belief that the process is destined to render great service, especially in moderate and minor agriculture, where sheep are not owned, to provide for the feeding of the beet-root leaves, and in which there is almost always some scarcity of forage for the winter.

In comment, Prof. Whitney said it will probably be some years at least before beet-root culture will be sufficiently extended to render the method of much value in this country in the preservation of the materials upon which it is used abroad, while the greater expense of labor and acid will much reduce the economy of its application as compared with the results of foreign practice. But there are innumerable instances in which any probable increase in the cost of milk is as nothing to its value as a healthful article of food. In such cases the crop from an acre of heavy grass, clover or sweet corn, kept green and succulent, and combined with oil cake and dry feed enough to correct any hurtful tendency of its watery character, would furnish feed by which a milch cow should be kept in full yield of milk throughout the winter months.

LONG ISLAND LANDS.

Mr. A. J. Hinds, Patchogue—When I speak of cheap lands I mean of course relatively; for instance, $100 will buy eighty acres out west. Twenty-five years' experience in the west satisfies me that $500 a year is more than an average to clear from this land when well improved. One hundred dollars will buy five acres here; this into cranberries, and some kinds of garden truck, will clear from $1,000 to $2,000 a year; and if a man is fortunate enough to get hold of a spring brook, from $2,000 to $5,000 can be cleared yearly from one acre or even one-quarter of an acre of water. There are individual cases in this neighborhood which would satisfy any man, interested enough to come here, of these facts. The natural advantages on Long Island for trout propagation are these: The fact that most large fish-farms are now located in the interior, where feed costs five or six times as much as it does here, precludes all danger for some time to come of injurious competition. Secondly, our streams are short and fed by springs, and never fail in dry weather. Thirdly, the surface being nearly level, and loose, secures us against any danger from freshets. I will simply say, that this island is quite thickly settled near the waters and railroads. Some four or five miles from the larger railroads, heavy loam soil can be bought for from ten to fifteen dollars per acre, according to growth of timber.

SECURING A HOMESTEAD.

Prof. J. D. Butler, Lincoln, Neb.—Nills Nysten is a Swede, and was born where his forefathers, even to the years of many generations, had been content with only this, and nothing more—

> "To draw nutrition, propagate, and rot."

He aspired higher; but so low was his birth, and so strong the barriers around him, that he was three score years old before he could work his passage to America. A year ago he reached Iowa with his wife, and penniless, stopping first in Mount Pleasant. While working there at his trade of wagon-making, he became convinced that his best means of further advancement was to secure a Nebraska homestead without delay. His mode of making this boon his own is worth telling, "to encourage the others." He walked from his home to Lincoln, 307 miles, along the track of the Burlington and Missouri River railroad. This journey he accomplished in about fifteen days. At Lincoln he found shelter at the Immigrants' Rest, a building provided by the Burlington and Missouri railroad, where land-hunters may lodge and live without charge while seeking farms. Looking at the maps of public lands in the United States land office there, he fixed upon York county as affording desirable homesteads. He therefore walked on thither, seventy miles further. Having picked out the farm which suited him best of all those still vacant, he returned to the land office and filed his claim to it September 2, 1871, paying fourteen dollars in fees. His homestead consists of eighty acres. Repairing again to the farm of his choice, he made sundry improvements for a month. He made him a dug-out, and stacked twelve tons of wild hay. His purse was now empty, save one dollar and a half; but he walked to Lincoln and thence home, as he had walked thither, daily laying behind him about twenty miles. Soon after reaching home, at the end of a nine hundred mile walk, he learned that his hay-stacks had been burned by a prairie fire. Having no plow, he had been unable to make a "fire-break" around them. But throughout all, he seems to have lost nothing of heart or hope, but to have remained as jolly as Mark Tapley. Through all winter he worked at his trade, sometimes beginning his toil at two o'clock in the morning. Thus he finished three good wagons; two he traded off, each for a mule and harness. Then putting on board his wife, a barrel of pork, a harrow, all of wood, made by himself, and some other needments, he drove westward by the same route which he had last fall traversed on foot. He took with him three other Scandinavian homestead-hunters, each with a wagon and family in it. Nills Nysten is sixty-two years old, though he declares himself only forty—when just shaved. His example shows what others can do.

Adjourned.

April 16, 1872.

NATHAN C. ELY, Esq., in the chair; Mr. JOHN W. CHAMBERS, Secretary.

WHAT VARIETY OF POTATOES TO PLANT.

Gerard C. Brown, Croton Falls, N. Y., wrote as follows—The query "What shall I plant?" reaching me constantly from potato-growers in all parts of the country, has led me to endeavor to communicate with these inquirers through the medium of the Farmers' Club. As I have quite exceptional opportunities for learning results in various sections, I have the more confidence in the conclusions to which these facts and my own experience have led me. I do not suppose that the same advice will apply to all, but I will suggest a few of the worthy and reliable varieties for the greater part of our potato districts. Beginning with the earliest, the "King of the Earlies," Breezee's No. 4, I can report that dug and marketed the last of June; they netted me seven dollars per barrel in New York market; yield, forty-four barrels per acre; quality, unimpeachable.

Early Rose comes next, turning out from forty to fifty barrels to the acre, though more hurt by the drought, quality No. 1. With proper care the Early Rose will not disappoint reasonable expectation. They market as well as any variety, a most important point in potato culture. This planting sorts which do not command a ready sale—merely size, beauty, yield or quality—is "played out." Excelsior is, to-day, the best early potato before the public, as any disinterested man acquainted with it will allow. But it has no one to sing its praise and puff it into the popularity of some other kinds. Though the stock in the country is small, there is no speculation in it. Worth five dollars per barrel; yield, sixty-six barrels to acre. In all desirable points, as a late potato, the No. 6, or Peerless, "has no peer." It ripens in September, is enormously productive, averaging with me this year, as a field crop, 160 barrels, or 460 bushels to the acre. A small plot with the highest culture attained a yield much greater even in proportion. Maturing with this is the "Late Rose," so-called "sport," of the Early Rose, an accidental variety, originating in a habit peculiar to these tubers. Among my Rose I have, for the past three years, noted various specimens of this class bearing a general resemblance to each other, with a characteristic difference of ripening later. Owing to the severe drought of last spring, the later kinds obtained a better growth than the earlier. Thus, the Late Rose reached fifty-four barrels to the acre. I regard their present reputation as fictitious and unsound, and I do not expect to hear much noise made about them after this season. The White-eye White Peachblow is strictly first-class, and is much the best Peachblow I have ever seen. I plant no other kind, having entirely discarded for it the favcrite New Jersey White Peachblow. The London White is a lovely potato, and good as it looks; if used early, it rather leads the Rose in point of time. Like in appearance, but so far superior in all other points, a seedling which was exhibited at the Institute fair, and known as the White Rose, deserves mention. It yielded at the rate of 100 barrels to the acre with careful culture, but is, as yet, too young to demand confidence. These above mentioned I have recommended as most likely to give satisfaction, out of nearly 100 kinds which I have cultivated and experimented with, primarily for my own personal knowledge and benefit, as well as for that of my correspondents and fellow-agriculturists.

Mr. Fuller—These records of personal experience with varieties are valuable, provided persons who communicate them have no pet interest to advance, as, unfortunately, is too frequently the case. As for myself, on my light, sandy soil in New Jersey, I have settled upon three out of the 137 sorts of potatoes I have tried, namely: Early Rose, Peerless and Peachblow. If I were restricted to one kind, I would choose the Early Rose. If one could be sure that the spring would not be too dry, nor too wet, there would be no special necessity for later varieties, that is, if the crop is stored in a cool cellar.

Mr. J. S. Peacock, Porter's Corner, N. Y.—Last spring I planted half an acre of Peachblow potatoes upon the mulching plan of Mr. Thompson, and with the following result: I plowed the piece (the ground was planted to potatoes the year before, and highly manured in the hill with barn-yard manure), marked it out three and a half feet one way; cut the potatoes, put one piece in a hill eighteen inches apart the other way, covered them two inches deep, and mulched them with three two-horse loads of coarse interval hay; used four bushels of potatoes for seed. I did no more to them until I commenced digging. After working diligently for about a day and a half in getting them out, I measured up my entire crop. I had eight and a half bushels, good, plump measure. The land adjoining was planted in the usual way, manured in the hill, and yielded about 150 bushels per acre.

Mr. E. Thompson, Louisville, Ky., April 5—The farmers here are now busy getting in their potato crop, which is a very important one, as they planted a large breadth of land, and grow uniformly good crops of good quality. Potatoes have been grown largely in this State for the last thirty years, both for home use and the southern market, where they rank higher, and sell for twenty-five per cent more than other western grown potatoes that I know of. The variety mostly grown now is called Shaker Russet, which is an early, strong-growing potato of good quality, which yields from 100 to 200 bushels per acre on ground that will produce forty bushels of corn without manure. The price received for the corp of 1871 has averaged two dollars and fifty cents per barrel, or one dollar per bushel, clear of barrels. Potatoes are largely grown on the Ohio river, between Louisville and Cincinnati. There are hundreds of barrels received here daily from that section, which sell readily, and are of as good quality as Lake Shore. I have grown potatoes here for the past thirty-seven years. My crop this year will be between thirty-five and forty acres, consisting of White Sprout, Buckeye, Early Rose and Shaker Russet. I will finish planting to-morrow. There are thousands of barrels of potatoes shipped from this place to Chicago, Pittsburgh. Cleveland and Cincinnati, and the dealers in those places know all about Kentucky potatoes.

CULTIVATION OF ASPARAGUS.

A number of letters from various parts of the country, making inquiries in relation to this esculent, were referred to Mr. D. B. Bruen to give his experience.

Mr. D. B. Bruen.—The best soil in which to cultivate asparagus is a heavy, sandy loan, without stone, located where it can have the advantage of clear sunshine. The bed should be laid out systematically; oblong is most desirable, with cross beds sixteen to twenty feet long, and as much length as will be necessary to produce the quantity wanted; the entire bed should be covered most liberally with well-rotted manure, and dug up with a long-bladed spade, driven well down; the length of the blade is sufficiently deep; then lay out the first bed at right angles with its length, wide enough to take four rows of roots; trench four or five inches deep, seven or eight inches from the edge of the bed, wide enough to spread the fibers of the roots evenly their whole length from the crowns, and place the crown of each root fourteen to sixteen inches from the crown of its next root, each root to be placed carefully with the hands. When the roots are placed the length ot the trench, cover it up and place boards over it, so as not to disturb the earth in the covered trench. Dig out the next trench as before, so that the crowns will be the same distance from the crowns in the first trench as they are in each trench, and so on until they are four rows in a bed, always covering each trench with boards, so as not to tread the earth after the trench is filled. Then make a path three feet wide, and commence the next bed, and plant as before, giving three feet for a path between the beds until completed. In procuring roots, do not under any circumstances get them from seed stores. One of the great failures of new beds is from using roots that have lost their vitality. When already dug up and exposed for sale they are put in lands in a mass, and are about as likely to vegetate as a bunch of rope yarns tied in a large knot in the middle for a crown. The roots should be freshly dug; two-year roots are preferable. Asparagus should not be cut until the second year after planting. In the fall, after the stubble gets brown, it should be cut off down to the ground and covered liberally with a coat of well-rotted manure, and in the spring the first work to be done in the garden is to fork up the asparagus bed with a spading fork, but not so deep as to disturb the roots. Walking on each side of the bed it can be forked up without treading on it, which never do if possible to avoid it. Asparagus should not be cut later than July. Beds embracing a surface of twenty-four by forty feet require, when the weeds begin to grow, about one and a half bushels of salt sowed evenly over the whole surface, to be repeated with same quantity twice afterward, when the weeds grow again. Asparagus beds should be put out as early as the ground is warm enough to do so—in April if possible.

FLORIDA.

Mr. W. E. Molar, Uniontown, Fayette county, Pa., asked where in Florida was best for him to go for health and good, cheap land; have lived on a farm and have $250. How warm is the climate compared with Pennsylvania? Is Florida subject to fevers? When is the best time to go, the best route, and the probable cost from New York city? What is land worth 100 miles south of Jacksonville? and would you advise me to go?

Prof. Henry E. Colton—East Florida is the section for him, and in that region up the St. John's river, north of Pilatka, there are frosts almost every winter; from Pilatka to near Enterprise occasionally slight frosts. The east side of the St. John's is milder than the west. For health he should leave the rivers and go inland. There are several hundred thousand acres of good land in Florida subject to the homestead act. He can find large quantities between the St. John's and the ocean. The heat in summer is not so great as at many places north, but it is long continued. Florida is a healthy country to those who do not expose themselves to rain and late night air. The inlands are all healthy. The soil is a peculiar mixture of sand and lime, and only needs vegetable matter to make it yield abundantly. The darker the soil the richer, but not so healthy. Sugar is to be the great crop of Florida; next peanuts. Money may be made from oranges, bananas, etc., just as money is made here from apples, pears or other fruit. With his $250 he may pre-empt 160 acres. First, he must go there in the fall, and he must expect to buy his provisions for one year. By spring he can have a good log hut on his claim and twenty acres deadened and cleared. In some localities the logs will pay him for clearing. He must fence in two or three acres for a cow-pen, sow it in peas and pasture on it. He must plant some sweet potatoes, onions and other vegetables for food, and peanuts for sale. Suppose two acres in potatoes and vegetables, three in peanuts, five in cow-pen, and five in sugar-cane and any other crop. He must set out a hundred or more orange trees right in the woods. He can expect from two to three hundred bushels of sweet potatoes per acre; from thirty to fifty bushels of peanuts per acre, and a crop of sugar-cane which will yield him from 600 to 1,000 pounds of sugar to the acre. The peanuts sell on the spot at one dollar and a half per bushel, and the sugar at ten cents per pound—the molasses always pays the expense of gathering, grinding and boiling. Hence his first year's salable crop, at lowest estimate, is worth $425; and he can make much of his own living. In the fall he must plow in the peas and cattle droppings, and have another five acres ready for a cow-pen. The next year he plants his former cow-pen with sugar-cane, and may expect a yield of at least 1,000 pounds of sugar to the acre; in a few years this may be doubled. A man who is willing to work can make more money in Florida than any other part of the United States I have ever seen. The great trouble is that too many go there thinking to live without work. I would advise him to take a steamer from New York to Savannah, and thence by rail to Tallahassee. There look over the land-office maps and see where there are vacant lands between the St. John's and the ocean; then go down there and look at them and locate. Avoid all land agents as long as Uncle Sam has a foot of territory for his children. The fare from this city to Jacksonville, via Savannah, is twenty-seven dollars. I would advise him and all others who wish to learn something accurate of Florida, to buy Hank's Gazetteer, for sale by the American News Company. With strict economy, a man can get a good start in Florida on $250, and he can be comfortable on $500.

JAPAN CLOVER.

Mr. Andrew Post, Angelica, Allegany, N. Y., wrote to ask if any one had tried Japan or Georgia clover in western New York, also as to Gambia grass, and is there anything better than timothy for our soils.

Mr. Henry Stewart—Japan clover is not adapted to the northern States, and at best is only suited for a poor makeshift pasturage. It is not a cultivated plant. There is no better forage or leafy plant possible for almost every part of the country than red clover, and this, with the help of plaster and a mellow, well-prepared soil, will thrive on comparatively poor lands, and rapidly enrich them. Timothy will not thrive on poor land ; it needs a rich clay soil for its best development.

Prof. H. E. Colton—Mr. Chairman, I suppose I am somewhat to be charged with stirring up the excitement about Japan clover. I found it at the south doing a good service in rooting out the old broom sedge, and I wrote from Macon, Ga., stating that fact. It is not to be compared with red clover as a forage crop or to plow under, yet it grows spontaneously on the old fields of the south, and is much liked by cattle. Whence it came no one knows positively, but it will be of great value to the south, for it may be plowed under on the old fields, thus enriching them to some extent. But even at the south I would not advise, in fact would speak against, its cultivation, for in many parts of the south, red clover, orchard grass and timothy will grow, and they are far better for all purposes. This Japan clover matter is an instance of the wide-spread influence of this Club. I have received numbers of letters about it, some from foreign countries. I heard the Gambia grass spoken of in Florida as likely to be of some value. In writing of these things our correspondents should remember that there are many things which will grow or are of value at the south, which are useless in the north or west.

Prof. J. A. Whitney—I think a crop of buckwheat would be an excellent crop to turn under. It loosens the top soil and prepares well for other crops. I would top-dress with nitrate of soda. A crop of rye would also have much value.

Mr. Henry Stewart—The buckwheat cannot have the value as a green crop to turn under as the red clover, and if the people of the south are commencing to use it, we should say nothing to turn them from it. They do not need to try any experiments — the great value of red clover has long ago been demonstrated by practice.

Report on Mr. D. Magner's System of Training Horses.

The committee appointed by the New York Farmers' Club to report upon the merits of Prof. Magner's system of training and educating wild and vicious horses, respectively report :

That we attended Prof. Magner's exhibition on Tuesday, April 9, in connection with a large number of gentlemen, including a commitee appointed by the horsemen of New York.

The better to test the merits of this treatment, four of the most vicious and unmanageable horses that could be found were selected for him to experiment upon, comprising :

First. A fourteen-year old horse, owned by Mr. L. C. Popham, of 945 Broadway, would kick and run away, and could not be controlled or driven in harness.

Second. A twelve-year old thorough-bred horse from Red Bank, N. J., owned by H. L. Herbert, would balk under saddle and kick in harness, and had resisted all efforts to be controlled or driven in harness.

Third. A star mare, owned by R. L. Pell, Esq., of Fifth avenue and Twenty-sixty street, would kick and run away in single harness, and could not be driven single.

These with several other horses were subjected to treatment in our presence with the following results:

In eighteen minutes (without throwing or any cruelty), he made the Popham mare so docile that she could be driven with the greatest freedom without breeching, demonstrating the most wonderful change in her character. The Herbert horse was driven with equal success in twenty-seven minutes, submitting to all kinds of handling, even from strangers.

Mr. Herbert stated that he had owned that beast, having once paid $2,500 for him, but finding him so obstinate and unmanageable under the saddle and before a sulky, that he actually sold him for fifty cents. After which he bought him again for twenty-five dollars; and that he did not believe it possible for any human skill to render that horse at all manageable.

The Pell horse was next handled and driven gently in ten minutes, and all the others with the same marked success.

Mr. Magner's system of subduing and educating horses is in principle entirely different from that of Rarey, or any other treatment we have witnessed.

It is remarkably simple; not requiring the use of anything complicated. A noticeable feature was that any of the horses experimented upon were not in the least excited or warmed.

There was present a number of the most critical horsemen of the city, and the universal verdict of all was that the results shown were in the extreme surprising, and that a knowledge of Mr. Manger's treatment is indispensable to all who are interested in or use horses, and that his humane efforts to introduce reform in the education of horses cannot be commended too highly.

We have studied the merits of Mr. Magner's system of treating horses with an honest regard to the true interests of the public, and have no hesitation in stating that it is as important in its way to the interests of the farmers and horsemen of the country as the mowing-machine, telegraph, or other means of economizing time and labor. It reduces to the lowest degree cruelty and abuse. It secures the most positive docility in a few moments of even the most vicious horses, as can be seen by the results of the above experiments. It is entirely impossible to convey a proper conception of the great value of the treatment unless shown by practical demonstration.

We would, therefore, state that Professor Magner has even more than sustained the high position he has assumed before the Club, and that he is a reformer of great merit, and deserving of the encouragement and the assistance of all who desire to promote the true interests of society in the humane and skillful treatment of horses.

S. E. TODD.
J. W. CHAMBERS.
D. S. MOULTON.

Adjourned.

April 23, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

The Quince Borer.

Samuel Seeley, Trumbull, Conn, whose quince orchard had suffered severely by the attacks of these insinuating pests, asked advice regarding the proper warfare to be pursued, and "are these the same as the borers that molest the apple trees?"

Mr. R. J. Dodge—Extermination is the word, and a wire the weapon.

Dr. Isaac P. Trimble—The borer in this man's quince orchard is what is usually called the apple-tree borer (*Superda bivittata*). There are probably few owners of quince trees aware of the presence of this enemy till too late. Some years ago several quince orchards were planted in my neighborhood, and, although well cared for in other respects, the trees are now all dead, except in one orchard; in that the borer was discovered in time, and being faithfully hunted out and killed, the trees are healthy and productive. The borer is more fatal to the quince tree than to the apple, because, being smaller and of slower growth, the wounds are not so soon healed. Another thing. The chips or borings so readily seen, and proving the presence of the borer in the apple tree, are not so visible in the quince, because the entrance is generally under-ground. But, when large-sized gimlet-holes are perceived within a foot of the ground in your quince trees, as in apple trees or mountain ash, you may suspect borers. These holes are where the beetles have escaped, and they naturally deposit their eggs on the same or neighboring trees. This borer or grub is three years in coming to maturity. The first season it works only on the bark, just at the surface, or a little under the ground. During this period, like the peach worm, it is girdling the tree. The next two seasons it is boring in the wood about half or three-quarters of an inch from the outside and working upward. When full grown as a borer, it makes a short turn toward the outside and terminates at the bark, the long perpendicular gallery ending horizontally, leaving only the bark as a door-way to the outside world—instinct teaching that when a beetle it will no longer have the boring apparatus necessary to work through wood, but enough to bore through bark. Many nurserymen pay but little attention to guard against this enemy and send out trees infested by them. All trees should be most carefully examined before being planted. Many remedies have been proposed, but the orchardist would save time and trouble by letting them alone. Kill the borers. If you see fresh borings in the spring or summer, take an annealed wire and punch away until it will go no further, and you will probably find on the end of it when taken out a cream-looking fluid, that proves you have crushed the enemy. Go over the orchard soon again, and, if fresh borings, repeat. With quince trees, it is better to take away some earth from the tree, so as to be sure. Mechanical appliances and washes to prevent the female beetle depositing her eggs on the trees may be useful, but it is still better to kill all the grubs before they become beetles. The man who permits borers to molest his orchards will, if he puts his faith in quinces, prove a victim of misplaced confidence.

PRESERVATION OF WOOD.

Mr. P. Linton, Newton, Penn., desired information as to the use of sulphate of copper in the preservation of building material and wood for general purposes on the farm.

Prof. Henry E. Colton—There are various processes, patented and otherwise, for this purpose, which have attracted more or less attention from time to time. I think the best is to season thoroughly and then paint well; if a common, cheap job, use coal-tar or crude petroleum; if any nice work or farm implement, pure linseed oil and some of the mineral or lead or zinc paints. Fence posts should be painted above as well as below ground. The processes for using sulphate of copper and zinc or the chloride of zinc, require apparatus somewhat costly and difficult to manage. There is no good reason why any farmer should pay for a patented process of preserving the woodwork about his farm. Most of them are humbugs. The costly processes preserve without seasoning; they cannot be worked profitably on a small scale. A good way to preserve shingles is to boil in lime-water and a little salt; some also use a little alum or potash. A simple way of seasoning is to put the wood in a nearly tight box or cask, and let in steam from the exhaust of an engine or from a boiler. I have thus, in a short time, seasoned hickory spokes and ax-handles. I have also seen fence posts thus seasoned. Subject to the heat of the steam from six to twenty-four hours, or longer, as may be the nature of the wood; then dry in the air. All woods may be preserved, if seasoned and thoroughly soaked with coal-tar, dead oil, or petroleum. These substances also have a great effect in preventing the attacks of worms. A little pure verdigris mixed with them will make this faculty perfect. A mixture sold by all paint dealers under the name of copper paint is very good for this purpose; it is merely an oxyde of copper in tar solution. The southern pine tar, thinned with spirits of turpentine, is also a good preservative of wood, or even put on hot without thinning. But in all cases it is necessary to have the wood well seasoned. There are no patents on the use of these materials in the manner I have indicated.

Mr. F. D. Curtis — I lately learned by accident a thing I would have given $100 to have known last summer, namely, that, when laying down floor timbers which are likely to gather dampness, as are those of stables, barns and other outbuildings, it is an excellent practice to cover them an inch thick on the upper side with fine salt. A gentleman in Brooklyn tells me that he always does this when constructing piers, and that actual experiment proves that it increases their durability a hundred per cent.

The Chairman — It used to be customary, and is yet, I suppose, to salt every ship while on the stocks, for the purpose of keeping away dry rot.

Prof. Henry E. Colton — In some places they bore holes in sticks of timber, fill with salt, and plug close; but I am satisfied that it is just as well, if not better, to season thoroughly and soak in tar.

THE CHAYOTE, OR BREAD FRUIT, OF MEXICO.

Dr. G. Naphegyi, having been invited by a unanimous vote of the Club to address them upon the chayote plant, or bread fruit, of Mexico, read as follows:

Some time ago I had the honor of a call from Chief Justice Charles P. Daly, and, while drawing his attention to the chayote plant, he promised to bring it before the notice of your Club; and I feel highly flattered to have now the opportunity to demonstrate to you this most interesting plant, which, for many years during my rambles through South America, and especially during my long residence in Mexico, has engaged my interest to such a degree that, as soon as I arrived in New York, and having had the opportunity to build myself a conservatory, I made it my object to have this plant imported, with the view to introduce it into this country and procure its propagation. The bread tree, which is known to naturalists under the botanical name of "rima," is one of those vegetables which nations possessing colonies in the torrid zone transport with difficulty to their lands; but in Central America, although "rima" does not abound, there is a fruit similar to it, namely, the "chayote," which is a rare and admirable production of nature, and was early mentioned by Fra Clyvijero, the historian, who accompanied Fernando Cortez in his expedition to Mexico. The fruit is formed in the shape of an egg, about six inches in diameter, more or less; the skin is of a strong consistency, and covered with thorns; there are also some classes which have no thorns. The interior is composed of a juicy pulp, in the center of which is the kernel, elliptic in form and about one inch in diameter. The plant is curious, not only on account of its fruit and beauty, but also for the means provided by nature for its propagation. When boiled, it closely resembles the rima or bread fruit; and while growing may be compared to a species of pumpkin, presenting a beautiful aspect, the sprouts extending to a length of many yards, which, when trained in a horizontal position, completely cover the bed, so as to form an impenetrable barrier to water, as the leaves, which are in abundance, form a roof after the manner of tiles. This plant possesses the prerogative of not only fructifying in warm climates, but also in the north, and, when once planted, sprouts every year over the bed, or climbs trees which may be in its vicinity. On all the knots of the plant there shoot out fibers which enable the vine to cling to the object which sustains it in an elevated position, while, when it does not meet with this object, it forms a spiral line which it winds around itself, and thus furnishes an evidence that nature destined it to form a support for the buds, which are easily broken. The chayote is a plant which may be characterized as hydroptacal. If a sprout be cut, immediately a large portion of the juice is to be seen running down, which is not the case, however, in dry situations, which proves that this plant requires a humid soil to grow with vigor and extend its sprouts to a large circumference. The chayote is preferable to the rima or bread tree, because the first year it is planted it fructifies, which is not the case with the rima, which, being a tree, does not bear fruit until after a certain period of time corresponding to that which nature has assigned to fructify. The "rima" produces fruit solely, while the chayote, after having given an abundance of fruit, gives, at the same time, a quantity of roots which make good flour for bread, and a fecula appropriate for making starch. The roots are tuberous; and from the principle ones, which are those which sprout annually, there extend others, formed like potatoes, from one to two feet in length and from three to four inches in diameter. These roots propagate in circles of from three to four or even, sometimes, six yards (or eighteen feet) around the central or principal roots. From the extreme ends of these roots sprout a filament nearly the twentieth part of an inch in diameter, from the extreme end of which again grow other roots, and so on to the above mentioned distance. These secondary roots are those which serve for food, because it would ruin the utility of the plant to touch the principal roots in respect to the propagation for the ensuing year. Is there another plant in creation which produces fruit, and during the same year roots, which man can thus use to advantage? I have known, by experience, that one chayote plant has given eighty fruits and some five fanegas or bushels of roots, and continue producing for the term of seven years. If this plant is admirable as an alimentary production, it is much more so in its mode of propagation, and is, probably, the only instance to be found in the vegetable kingdom where the fruit is planted with the seed. The mode of planting is the following: The fruit is taken in the month of October and placed in a hot-house or suspended on a wall in a room of, at least, sixty degrees. In November the germ commences to sprout, and increases according to the quantity of juice contained in the fruit. In such a situation the stem grows from a half to three-quarters of a yard in length, until the beginning of May, when the fruit, with its branch, is then planted in soft, humid ground, taking care that the sprouts are not injured. This short description which I have given of this wondrous production of nature, is merely for the purpose of bringing into notice its utility to the north and affording an opportunity to make experiments as to the use to which it may be best applied. In conclusion I will call your attention to one of the curious properties of this plant, and that is its cooling influence upon the system while partaking of it after a long and fatiguing walk in the sun, and it has been said, by those who have so experimented, that a certain degree of cold was felt coursing through their frames.

Now, if it be true that all objects in a room manifest the same degree of heat, is it not strange that this sensation is experienced upon partaking of this fruit? To test this an experiment was tried with a thermometer, one being placed in a room and another inserted in a chayote, the following being the result obtained: The thermometer placed in the room, showed 15°; that in the chayote, 12½°; at 9 o'clock at night, the first, 14½°; the second, 13°. This experiment is, however, in direct contradiction to what naturalists assert, that all bodies in a determinate atmosphere receive an equal degree of heat, and I am convinced by this experiment that the cold manifested by the chayote is not apparent, but real. It presents, also, another curious feature, and that is, that when the fruit is flavored with sugar, in a few days it changes from sweet to sour, while the surface is covered with microscopic plants. Prepared with vinegar, it may present other phenomena. Of what substances is it composed?

After concluding his written remarks, Dr. Naphegyi made some interesting statements concerning the jalap root and other plants, and said that he had no interest to serve, no money to make in any way out of this matter, but had an ambition to be the introducer of this plant into this country, and if the Chairman would appoint a committee of such gentlemen as would make careful trial of it, he would present, to each, one or more plants.

Prof. H. E. Colton—Mr. Chairman, one of the curses of our agricultural system, is the too slavish devotion to one or two crops; a change is healthful to the soil, and also a relief to our eyes. In climates suited to it, this plant may be grown with great benefit, and not in the slightest interfere with any of our ordinary field crops. The introduction of any new thing, especially one which adds to our food sources, is a matter to be encouraged; hence, I have heard with great pleasure the interesting paper of Dr. Naphegyi, and move that thanks of the Club be tendered to him, and that it be requested for publication.

Mr. Henry Stewart seconded the motion, also Dr. J. V. C. Smith, who said he regarded the paper as one of great importance. The motion was unanimously adopted.

Shearing Sheep.

The Hon. L. A. Morrill, author of "The American Shepherd," favored the Club with the following practical and timely discourse:

There are shearers, but they are few, who can do their work quickly and yet do it well; but these have acquired the art correctly at the beginning, and have wisely adhered to its rules. Bad habits are very easily acquired by a shearer. Here is the root of the evil: urging shearers to do more than they can do well, and thereby confirming the old and truthful saying, "Haste makes waste." The wool-grower must cease to entertain the false notion that by hiring his shearing done by the job, he is the gainer, for the very reverse is the fact. In nine-tenths of such instances, owing to the slovenly and half-way execution which follows, the sheep carry away wool enough to doubly pay the ordinary wages. Those who can shear a large number in a day, and perform it skillfully, are very few; but nothing precise can be stated, as it depends entirely on the breed. If they are Saxons or Merinos, or grades of these breeds, it will be safe to say from twenty-five to forty, taking the average of a flock; of grown sheep fewer than of yearlings. In general terms it may be said that he is a good workman who will shear the largest number, cuts the wool with one clip of the shears, and not in twain, as one shearing too fast will do, shears even and close without cutting the skin, and holds his sheep in those positions both easy to it and himself. The following instructions are intended for the novice: Supposing that the floor of the shearing-house has previously been thoroughly cleaned, the pound containing the flock littered with staw, the shearer proceeds to catch his sheep. This he must avoid doing after a common method, which resembles, rather than anything else, the rough-and-tumble efforts of a dog dragging a woodchuck from his burrow; but, after catching it, to throw his right arm round the body, grasping the brisket with his hand, then lift it, and with his left hand remove dirt or staw, if any adhere to the feet. If the sheep is filthy about the tail, or perchance any burrs are attached to the wool, at the threshold of the door let all be cut off by a suitable pair of shears for such purposes only. Then he may place the sheep on that part of the floor assigned him, resting on its rump, and himself in a posture with one knee on a cushion and the back of the sheep resting against his left thigh. He grasps the shears about half way from the point to the bow, resting his thumb along the blade, which affords him better command of the points. He may then commence cutting the wool at the brisket, and, proceeding downward, all upon the sides of the belly to the extremity of the ribs, the sides of both thighs to the edges of the flanks; then back to the brisket, and thence upward, shearing the wool from the breast, front, and both sides of the neck—but not yet the back of it—and also the poll or fore part and top of the head. Now the jacket is opened of the sheep, and its position, as well as that of the shearer, changed by being turned flat upon its side, one knee of the shearer resting on the cushion and the other gently pressing the fore-quarter of the animal to prevent any struggling. He then resumes cutting upon the flank and rump, and thence onward to the head. Thus one side is completed. The sheep is then turned on the other side, in doing which great care is requisite to prevent the fleece being torn, and the shearer acts as upon the other, which finishes. He must then take his sheep near to the door through which it is to pass out, and neatly trim the legs, and leave not a solitary lock anywhere as a harbor for ticks. It is absolutely necessary for him to remove from his stand to trim; otherwise the useless stuff from the legs becomes intermingled with the fleece wool. In the use of the shears, let the blades be laid as flat to the skin as possible, not lower the points too much, nor cut more than one or two inches at a clip, frequently not so much, depending on the part and compactness of the wool. The above instructions being designed for a beginner, we will suppose this to be his first and only attempt. Let his employer, when he is about it—and it will be a good while—have an eye on all his movements, kindly and carefully directing them. After the pupil is through his maiden effort, you will see him smoothing out the crinkles and aches from his back and hips, for thus the poor fellow will feel; and if the weather is warm—and of course it should be—wiping the dripping sweat from his brow. But be easy; let him blow awhile before he catches another sheep; for if you hurry him, long before night you will hear murmurs from his lips that "shearing is a back-breaking business—not what it is cracked up to be," etc., etc., indicating that he is already disgusted with it; and if so, adieu to his ever arriving at skillfulness. But if he has time afforded to straighten himself, and is patted with kind compliments upon "his unexpected well-doing—that he improves with each successive sheep—and that he will be sure to make a first-rate shearer," you will bring him under the yoke without rebelling against its hardships. He will probably shear eight or ten the first day, and possibly a few more the next; at all events, guard him all the while, and hurry him not, or slight his work in any respect. In this way, and no other, can we properly educate shearers to do their work with tact and increased profit to the flock-master. The above is a transcript of my own course, followed for many years.

Adjourned.

April 30, 1872.

Nathan C. Ely, Esq., in the chair; Mr. John W. Chambers, Secretary.

Pipes for Under-drains Choked by Grass.

Dr. J. N. Riggs, Hartford, Conn., was present, and made some interesting remarks regarding his agricultural experience and experiments. He said he was a thorough believer in the advantages of under-draining; that many of his fields had been greatly benefited thereby. One, however, had proved very refractory, and it was partly for the purpose of asking advice regarding it that he visited the Club. He explained that tile were put in in the best way; but a long, fine, silky grass or root has gained a foothold, and during the growing season clogs the passage, and almost wholly prevents any outflow of water.

Prof. Henry E. Colton asked if the ends of the tile were closely joined and capped.

Dr. Riggs replied that he placed strips of tin carefully over the junctures, but the enemy would creep under and thrive vigorously. Speaking of tin, he explained that it was his practice to send his team into the city now and then, and his man gathered up such rubbish as might prove useful on the farm, where most anything comes handy one time or another. In fact, he had had occasion to use almost everything except a mast of a ship but expecting that there would, sooner or later, occur a necessity for this, he was on the lookout. The tin, he resumed, was from a discarded roof, and cut in strips of the proper size and shape for the purpose named. He had an idea that if the water were turned off by a pipe he purposed to put in, for the sake of conveying a portion of the water to a still lower field for drinking purposes for his stock, the foul growth would be deprived of sustenance, and, therefore, die a natural death.

Canning Corn.

A correspondent asked to be informed concerning the process of canning corn.

Mr. A. S. Fuller—Very few persons are successful in canning corn, as it requires boiling several hours and must be put into strong tin cans and hermetically sealed. Ordinary glass jars will not answer.

Dr. Isaac P. Trimble—It is, I think, a mistake to say that sweet corn should be boiled several hours. Twenty minutes would be enough; but I do not believe in the canned corn. I never approved of its taste or smell.

The Chairman—It is very hard work to boil sweet corn for canning so as to prevent fermentation. I have tried it in all ways, and kept it on a shelf in a dry, cool place, but in two or three months away it would go, bursting off the tops. I succeeded well with some dried.

Mr. R. J. Dodge—My experience is the same. Corn is the hardest vegetable to keep, and the only way to keep it is by drying.

Mr. F. D. Curtis—My wife, who succeeds in making corn a very palatable dish for us in winter, cooks it, not too much, but done; cuts it from the cob and dries in an old-fashioned brick oven made only moderately warm. There are many disadvantages in drying this or any other vegetable in the sun. A partial decomposition is apt to take place, and there is the nuisance of flies and dust.

Dr. Isaac P. Trimble—I have heard the Alden process highly commended.

Prof. Henry E. Colton—The other day, at a friend's table, I was induced to taste some corn which proved to be remarkably true to nature and palatable. I learned that it was not canned, but prepared by this process of evaporation to which Dr. T. alludes.

CULTIVATING HUCKLEBERRIES.

Mr. J. P. Lunan, Madison, O., asked if the Club would be so kind as to state whether the huckleberry will succeed under cultivation; also if it was a profitable crop to cultivate.

Mr. A. S. Fuller—There have been very few experiments made in cultivating the huckleberry, but I do not know of any good reason why it should not be cultivated with profit. I hope those who feel interested in the subject will make experiments with the different species and report the results.

Mr. D. B. Bruen—They grow best in the shade.

YELLOWS IN PEACH TREES.

Mr. J. A. Donaldson, St. Joseph, Mich.—Will Mr. Fuller please state whether his opinion " that he can make a peach tree flourish on the site of one that has died with the yellows" is based on experience or not?

Mr. A. S. Fuller—Yes; my opinion is based on experience; and, further, I have taken buds from a tree dying with the yellows and produced a healthy tree by inserting it into a healthy stock. It may not be a judicious plan to plant a young orchard on the site of an old one, but I should not have any fears as to the result if the means were at hand for thoroughly renovating the soil. Yellows is a disease which may be produced by widely different causes, such as a soil exhausted of lime, potash, humus or other essential ingredients, or it may be caused by cold; in fact, anything that weakens the vigor or health of the tree, will cause yellows. In this respect it is very similar to the mildew on our native grapes. Excessive cold during the growing season, or heat, moisture, or dryness of the atmosphere check growth, and mildew follows.

Dr. Isaac P. Trimble—I question if any peach-grower of experience would indorse this doctrine.

Mr. D. B. Bruen—I am sure the disease would be conveyed to the healthy stock. I know some growers who would not use on healthy trees a knife with which they had pruned diseased ones without cleaning it carefully.

MUSHROOMS.

Mr. L. G. Wilson, Mt. Gilead, Ohio, asked desired information regarding mushrooms, the varieties, culture, etc.

Mr. A. S. Fuller—There are several species of edible mushrooms, but the one chiefly cultivated for market is the *agaricus compestris*, a species to which the gentleman's description might be applied, but we cannot say positively if it is the same. Any good work on gardening will give the gentleman the information he desires. To produce mushrooms quickly, and of the desired species, requires a careful preparation of a mushroom bed, and the planting of what is termed mushroom spawn, which can be purchased in the form of bricks at any of our large seed-stores. To tell exactly how to raise mushrooms, would require a lengthy paper, and those who desire to grow them can afford to pay $1.50 for a book on gardening.

Mr. R. J. Dodge—The mushroom usually eaten is short and thick. I am of the opinion that there are many varieties now unknown to us, which are good as food. Those which are edible, smell sweet and turn black a short time after being picked or broken. I have seen edible mushrooms of very large size.

OSAGE ORANGE AND OTHER HEDGES.

Mr. G. W. Pell, Jenkville—I would like to ask whether osage will grow on wet land or not; where I can get the seed, and what it will cost a bushel. How much will it take for 100 rods?

Mr. A. S. Fuller—No; osage orange will not succeed in wet soils. The seed can be purchased at any of our large seed-stores. The price is variable, some years much higher than others. A bushel contains fifty to sixty thousand seed, and the plants should be set six to eight inches apart. The gentleman can determine for himself how many is required for 100 rods.

Mr. William Curstead, Uniontown, Fayette county, Pa.—Will the Club please inform me how to raise the common wild rose (the larger kind) from the seed? Also, if it has ever been used as a hedge plant? It is a vigorous grower (in our locality), perfectly hardy, and if it can be raised from the seed I see no reason why it would not make a fence.

Mr. A. S. Fuller—Gather the seed-pods in autumn, as soon as ripe, and put them into some vessel where water can be added, and allow to remain there until the pulp is rotten. Then wash out the seed and mix with sand, and bury where they will freeze during the winter. Very few of the seed will germinate the following spring, therefore there need be no haste about sowing. I have usually kept them in sand until the autumn of the second season, and then sow in the open ground. The following spring, if everything has gone aright, they will grow readily and rapidly. If the gentleman thinks the wild rose will make a good hedge let him try it.

CHICCORY FOR HORSES.

Mr. A. J. Hinds, Patchogue, L. I., wrote—Several years ago I raised about 1,800 bushels of chiccory—a root our sandy soil is well adapted to if highly manured. As the tops were very rank, I often turned my horse in, and he needed no watching to keep off from good clover and timothy growing in the same field. In winter I fed him the trimmings of the roots. I had about one ton that was moldy and unfit for market (not properly dried). I fed this to him next summer in place of grain, with so much success that I think of trying it again for that purpose only. Have others tried it for that purpose? If so, with what success? How do you get lucerne to come up? How do you sow and what time of the year?

DAIRY NOTES BY HARRIS LEWIS.

Mr. Harris Lewis, Frankfort, N. Y.—I will answer Mr. C. C. Sherril as follows: First. There is no churn that will make better butter than the old dasher churn, but there are several which will make good butter in less time and with less labor. The churn known as the revolving-barrel, or the revolving-box churn, and the Blanchard, I regard as good churns. Second. In using any of the workers, care must be taken not to work the butter too much. Third. Cream will rise through a shallow mess of milk in less time than it will through a deep mess, and where there is no cold water, or not a sufficient quantity to cool the milk and control the temperature, shallow dishes not over two and one-half or three inches deep will furnish the most cream and butter. But where an abundant supply of cold running water can be had, by which the temperature of the milk can be controlled, and kept sweet a long time, there is quite a saving of labor and money by getting the milk in deep or large dishes. A large pan like the Jewett pan, capable of holding one mess of milk, is beyond question the most economical of any arrangemeut we now have for setting milk. Four of these pans are sufficient for any dairy.

WASHINGTON TERRITORY.

Col. Mercer, eleven years resident on Puget Sound, occupied half an hour with a map of Washington Territory, indicating the characteristics of that remote but highly-favored country, as relates toc limate, soil and productions. Its temperature is equable; no sudden changes from hot to cold, and *vice versa.* The highest point in summer is ninety-two degrees, and no rougher winter weather than eight degrees above zero. There is no chills and fever, and persons who go thither with this disease are soon restored, and that too without medicine. The lumber is abundant and large; varieties: spruce, alder and cotton-wood; grain: wheat, oats, barley, rye. No corn, except a few sorts for roasting. Don't house stook in winter, but ought to, and will. Lumber is already sent to Japan and China, and it might go to Australia fifteen dollars per thousand cheaper than from any point on the Atlantic slope. On the Pelouse is a region of rich prairie land equal to any in Illinois, and almost as extensive as that State, where thousands of farmers will soon locate and contribute to the advancement of our commerce. Another wonderful feature that seems to be little thought of is the stock raising interests of that region between the Rocky mountains and the Cascade, and ranging from South Oregon to Frazer river, in British Columbia. Cattle can be raised for a mere trifle, and the cost of shipping a barrel of beef from the Columbia river, east of Puget Sound—where in winter it is cold enough to pack—by rail to the Sound, and thence to Liverpool or London by ship, is but two dollars and fifty cents, allowing for insurance and transhipment. In fact, it will cost less per bushel to ship wheat from the Pelouse country to Liverpool than it does from Western Illinois or Iowa, and in the former place, with the same class of culture, thirty bushels to the acre may be had as against fifteen to twenty in the latter. Col. Mercer showed specimens of wool which were pronounced first quality by Mr. F. D. Curtis.

Adjourned.

TRANSACTIONS

OF THE

POLYTECHNIC ASSOCIATION.

The Polytechnic Association, an organization under the control of the American Institute, holds weekly sessions for the examination of new inventions and discoveries, and for the discussion of questions relating to applied science. Its officers for the year 1871–2 are Samuel D. Tillman, LL.D., Chairman, and Robert Wier, Esq., Secretary.

May 11, 1871.

The Chairman, Professor S. D. Tillman, opened the proceedings by making the following notes on scientific progress:

I. Sulphur Mine.

The lands of the American Sulphur Mining Company are located in the parish of Calcasieu, in the south-western part of the State of Louisiana, comprising 400 acres, immediately adjoining the lands of the Calcasieu Sulphur Mining Company of Louisiana, who have penetrated the sulphur upward of 100 feet, at from 428 to 446 feet below the surface, disclosing a fine quality of crystallized sulphur, which by analysis is shown to be from seventy to ninety-six and a half per cent pure—a supply and purity unheard of in the world's history, more than sufficient to meet the demands of commerce for centuries to come, and 350 feet nearer the surface than in central Italy, where they go 800 feet.

While all other mines heretofore discovered yield scarcely thirty per cent of sulphur from the ore, and refined by sublimation at a heavy cost, the sulphur mines of Louisiana have the advantage of yielding sulphur nearly chemically pure in a crystallized form, and which can be mined in any desired amount as easily as coal, which in the mines of Illinois is now being mined at a depth of 500 feet, and sold at the mouth of the shaft at three dollars per ton.

The average cost of transportation of sulphur from Sicily to the United States is about seven dollars per ton, and allowing the cost of raising the sulphur of Louisiana to the surface to amount to five dollars per ton, the total cost of placing it in any market, either foreign or domestic, could not therefore exceed twelve dollars per ton. It is plain to be seen that the State of Louisiana may furnish the markets of the world at a price so low as to suppress its production elsewhere and yet receive a vast profit. The sulphur, purer than that of commerce and in untold abundance, exists in the State of Louisiana, and the world demands it for the arts and agriculture.

The report of Mr. Granet, chief engineer of the Calcasieu Sulphur and Mining Company, states that toward the end of October last the Calcasieu Sulphur and Mining Company undertook to drill an artesian well, in order to ascertain the location, the bearings and the true richness of a layer of sulphur accidentally discovered scarcely two years ago whilst boring for a petroleum deposit.

The first boring had just gone through a petroleum deposit containing too little oil to be worked profitably. It was therefore being continued, in the hope of finding, at a greater depth, a large quantity of petroleum, when, at the depth of 443 feet below the surface, a layer of sulphur 108 feet in thickness was reached.

Unfortunately, the parties who were in charge of the boring operations, being unacquainted with the full value of the precious metalloid which offered itself to them, went through it entirely without paying much attention to the discovery they had just made, and contenting themselves with designating rather loosely the layer they had found as "pure crystalline sulphur." They continued to bore still deeper in search of the petroleum deposit they hoped to obtain lower down, when, in fact, they had long since gone through it.

The sulphur layer was discovered, its thickness was approximately ascertained, but its real richness was completely unknown. For this reason the Calcasieu Sulphur and Mining Company, established principally for the purpose of extracting the sulphur discovered, resolved, before undertaking to sink a large extracting well, to explore the entire layer by means of a new boring, and to ascertain the exact value in sulphur of the mineral constituting the sulphur bed.

A vertical well struck the sulphur bed at a depth of 428 feet, and went through its entire thickness of 112 feet.

The sulphur appears in compact and amorphous masses, of a pale color, interspersed here and there with yellow crystals.

It is surrounded by a calcareous crystalline matrix, of a whitish color and rather considerable hardness, but which, nevertheless, is easily reduced to powder under the stroke of the hammer.

The well it will be necessary to sink, in order to reach it through the various strata which underlie it, can be constructed without any really serious difficulty.

The means of transportation are excellent, either by the Chattanooga railroad, which will pass within half a mile of the mine, and to which an auxiliary branch could be made, or by the Calcasieu river, which is navigable and flows at a distance of five miles from the works.

As for the working of the sulphur bed, it will not present the slightest difficulty, for the rock, without being too hard to disintegrate, is yet sufficiently compact and resisting to sustain, without any wooden scaffolding or coating, all the galleries to be constructed.

In Sicily, pre-eminently a sulphur producing country, the art of working mines is yet in its infancy.

The sulphur strata are met at average depths of 120 to 150 feet below the surface, and they are reached by means of very sloping galleries, supplied through their whole length with steps dug in the soil itself.

All the mineral extracted by the miners is brought up to light by children from twelve to sixteen years. They take upon their shoulders one or two stones, which they bring up with much trouble to the surface, after overcoming untold obstacles in ascending these steps, always roughly made and partly crumbling. Having reached daylight, they lay down their load, and at once descend again to the bottom of the mine to repeat the same operation.

The mode of manipulating the mineral is still worse; it is barbarous and even absurd.

The proportion of sulphur in the mineral is from twenty to thirty per cent, or an average of twenty-five per cent.

Of this twenty-five per cent, the Sicilians scarcely extract from ten to fourteen per cent of sulphur; for owing to the lack of fuel, they are compelled to use the sulphur itself to operate the melting; in other words, to burn one-half in order to melt the other half, obtaining thereby a very impure product, which has to be manipulated again and refined before being delivered for consumption.

The means of transportation of sulphur in the interior of Sicily are also very costly; it has to be carried first by mules from the mine to the road, where it is taken up in small carts to the nearest port, often more than forty miles distant from the point of departure.

Sicily and the south of Italy furnish nearly all the sulphur that is employed in the arts and agriculture. In central Italy, near Bologna, there is a vein of sulphur ore about fifteen miles long, but the mineral is not rich, and it is necessarily taken from a great depth, sometimes over 800 feet About 12,000 tons are produced here annually, which is almost entirely consumed in the neighboring country for diseases of the vine. The Papal States also produce sulphur, but the quantity is small, not exceeding 500 tons. Sulphur has also been found in small quantities in Gallicia, near Cracovy, Corinthia in Hungary, in the Grecian island of Milo, in Tripoli, isthmus of Suez, on the borders of the Red Sea, province of Rio Grande in the north of Brazil; but, as already stated, it is from Sicily that we obtain the great bulk of sulphur used in the arts. In this island the strata of sulphur extends over a length of about 170 miles, superimposed one on the other to a depth of from three to twenty-five feet, and containing about thirty per cent of sulphur.

Dr. P. H. Van der Weyde—When I was in New Orleans, a year ago last winter, I saw some of that sulphur. To my mind it is very doubtful if it will pay. We must take into account that it is found 400 feet under water. We may bore for oil, or for petroleum, or for salt that can be brought up in solution, but I do not believe that that sulphur can be got out at a price to compete with the Italian sulphur. For sulphuric acid, iron pyrites are used now instead of sulphur.

The President—The point suggested is very important. Two years ago we had specimens of lignite presented from New Jersey, not more than thirty-five miles from this city; but it turned out that it was under a bed of sand, and that it would cost more to dig it out and brace up the sand with timber than the lignite was worth. In mining coal, where the roof is of rock, there is not this difficulty.

Dr. Van der Weyde—In mining there are thousands of instances of this kind. In Philadelphia, there is gold in all the clay and all their bricks; but it will not pay to take it out. So there are millions of dollars worth of silver in sea-water, but it will not pay to take it out.

II. Improved Microscope.

Dr. Royston Pigott has made a series of investigations which seem to show that objectives of high power sometimes give distorted appearances, and he has been led to employ lower powers which give greater clearness of detail, and to increase the magnifying power at the other end of the microscope, that is, the eye-piece. With an objective as high as a fifth, or even less, he uses a very deep eye-piece, and to correct residuary aberrations of the objective, and at the same time amplify, he introduces an important adjustable combination between the eye-piece and the object glass. He claims to obtain greater excellency, and with less cost than can be reached by using very expensive high powers. A careful comparison of his instrument with the best American and European microscopes should be made by a competent committee, and the result of the test be reported to the Microscopical Society.

Dr. Van der Weyde — Whatever you can see with a weak eye-piece, in a microscope, may be magnified by a stronger eye-piece, but you cannot see any more.

Prof. John Phin — The test employed in this case was forming convex mirrors from small globules of mercury, and magnifying the image. But there are tests so much more severe than this, that this test is really worthless. I consider the old plan of magnifying by the eye-piece perfectly useless.

III. The Bat's Wing.

Dr. Joseph Schöbl, of Prague, has recently repeated the experiments of Spallanzani, who, long ago, discovered that bats which had their eyes put out were able, nevertheless, when allowed to fly about in a room, to avoid threads stretched across it. This faculty Spallanzani attributed to some highly developed sense of touch possessed by the wing. Schöbl covered the eyes of bats with sticking-plaster, and after assuring himself that the bats were guided by some other sense than sight, made a careful examination of the structure of their wings. His researches have led him to ascribe the phenomena to the power of peculiar nerve-endings in the wing. Of the five layers of nerves, two are connected with the Malpighian layer of the skin. To one of these, which is united with every fine hair found on the upper and under surface of the wing, he attributes a highly exalted sense of touch, and to the other the appreciation of temperature, pain, etc. Dr. Schöbl believes he has discovered similar nerve-endings in peculiarly sensitive parts of other mammals, an account of which will soon be published.

Prof. Phin — A curious experiment of my own in the central part of this State may be worth repeating. I was out fishing with flies. Bats were quite numerous, and I wanted one for the purpose of examining his wing under the microscope. I expected, if I caught them with flies, to catch them by the mouth. I caught five, and every one was caught by the tip of the wing. This would indicate that the bat makes a peculiar use of his wing in procuring his food.

Dr. Van der Weyde — Comparative anatomy proves that the wing of the bat is built after the plan of the hand; and it is probably used as a hand in catching its food.

Prof. John Phinn — In angling for swallows in Italy, where it is a common sport, they are caught by the mouth.

The President — It may turn out that the bat has some new sense governed by electric forces. Before he comes to a thread he receives a warning, and turns out of the way. What sort of a warning is that?

Dr. J. W. Richards — I have seen a blind man who would never run against a post. So acute was his sense of touch that on the approach of a solid body he would perceive it. It may be that the bat, instead of a new sense, has merely an exaltation of the senses that are common to other animals.

Prof. John Phin — I knew a blind man who could steer clear of objects by his keen sense of sound.

Dr. J. W. Richards — That is another instance of the exaltation of a common sense.

The President — That would not explain this case of the bat; for sound would not be reflected from a fine thread.

IV. Printing Chronograph.

The President remarked, that during the last month he visited Professor G. W. Hough, at the Dudley Observatory, at Albany, N. Y., who exhibited and explained his new printing chronograph—an automatic apparatus destined to work an entire revolution in the manner of recording astronomical observations where the utmost accuracy of time is of the highest importance. The inventor has successfully solved one of the most difficult problems, that of recording, by means of electricity, division of time as minute as the hundredth part of one second without sensibly affecting the regularity of the clock movements. It will be remembered that Professor Hough is also the inventor of a self-registering barometer and thermometer, which expresses in figures the changes in the pressure and temperature of the atmosphere as often as every five minutes, if required; the total number of changes during twenty-four hours being recorded on the same sheet, thus forming an annual volume of

365 leaves, in which the errors of eye and hand, necessarily made in recording personal observations, are avoided. All these devices are of the highest order of merit. A complete description of the automatic barometer will be found in the American Institute Transactions for 1865.

A Printing Chronograph.

By Prof. G. H. Hough, of the Dudley Observatory.

About the year 1848, the idea of recording astronomical observations, by the use of galvanic electricity, was put in successful operation by different individuals. Since that time chronographs of various forms have been constructed for recording in a legible manner on a moving sheet of paper the time of any phenomenon observed. The great superiority, in point of accuracy and saving of labor over the old eye and ear method, formerly used, led to the almost general adoption of the new plan. During the past ten years the idea of constructing a chronograph, which should print with type the time of the observation, has been entertained by a number of persons. About five years since, Prof. Hilgard, of the Coast Survey, read a description of an apparatus designed for this purpose, and about the same time Prof. C. A. Young, of Dartmouth College, published a proposed plan for one, in Silliman's Journal of Science. But, so far as we are informed, the mechanical construction of such an apparatus has not heretofore been attempted by any one. The construction of a machine which shall carry a type-wheel capable of giving impressions, with uniform velocity for a number of hours together, without sensible variation in its motion, is a problem which is not easy of solution.

Some five or six years ago, in a paper read before the Albany Institute, I gave an account of the method I proposed to adopt, and in the construction of the machine, now to be described, the plan then proposed has been generally followed. My plan, which is radically different from any other proposed, is based on the principle of using separate systems of mechanism for the fast moving type-wheel, and those recording the integer minutes and seconds, regulating each with electro-magnets controlled by the standard clock. For a clear understanding of the mechanism, elaborate drawings would be necessary. We shall, therefore, merely give a general account of its construction and peculiarities:

I. A system of clock-work carrying a type-wheel with fifty numbers on its rim, revolving once every second; one, two, or parts of two numbers being always printed, so that hundredths of seconds may be indicated. This train is primarily regulated to move uniformly by the Frauenhofer friction balls, and secondarily by an electro-magnet acting on the fast moving type-wheel, and controlled by the standard clock. This train is entirely independent, and can be stopped at pleasure, without interfering with the other type-wheels.

II. A system of clock-work consisting of two or more shafts, carrying the type-wheels indicating the minutes and seconds. The motion of this train is also governed by an electro-magnet, controlled by the standard clock, operating an escapement, in a manner analogous to the action of an ordinary clock; every motion of the escapement advancing the type one number. There are three type-wheels, indicating minutes, seconds and hundredths of seconds. The integer seconds are advanced at every oscillation of the standard pendulum; and the minute, at the end of each complete revolution of the seconds wheel. The type-wheels are constructed of brass disks, around the circumference of which is soldered a strip of electrotype copper, holding sixty numbers.

Presuming now we have this system of type-wheels in operation, it is necessary to print without disturbing their motion; especially is this true for the fast moving wheel. After a long series of experiments, during which the fast moving wheel was detached and stopped in various ways, we finally made the impression from the spring of the hammer only; not allowing the blow to fall directly on the type, but arresting it about half an inch before it reached the top of the type. By this device, which is regarded of the greatest importance, the motion of the type is not disturbed an appreciable amount. Any number of impressions following each other in rapid succession does not disturb the fast moving wheel the one-hundredth part of a second. By this plan, none of the type-wheels are stopped, or locked in the act of printing, and records of observations may follow each other as fast as the hammer can be made to deliver the blow.

If the record is made while the type-wheel indicating integer seconds is in the act of escaping, two numbers, or one number and part of another, is printed, so there is never any ambiguity about the record; this condition, of course, only occurs when the fast moving wheel indicates 0.95 to 0.00 seconds. If two numbers are printed when, for example, the hundredths read 98, the smaller of the integer seconds is the correct one. The time required for the action of the escapement is about 0.06.

The blow for printing may be struck directly, by means of a strong electro-magnet; but the cost and trouble of keeping up a large battery for this purpose, led us to do all the work mechanically, only using electricity as the governing power. Accordingly, a heavy running gear was built for raising the hammer, capable in its present form of delivering 800 blows without winding; and it can be readily modified to give ten times that number, if desirable. This gearing is entirely detached from the hammer when elevated, but is unlocked just before the hammer reaches the type, immediately raising it again. The time consumed for this operation is about three-tenths of a second, allowing, therefore, observations to follow each other at a minimum interval of one-half second. When the hammer is elevated it is locked by an electro-magnet, the operating of this magnet allowing it to fall and print. The armature time of the hammer is about 0.07 seconds, being but little in excess of our ordinary chronographic recording pen.

The type are inked by means of small rollers, covered with cloth, resting against their rim, and revolving with the wheel by friction. These rollers require inking every two or three days. If desirable, the inking rollers may be dispensed with, and impression paper used instead. After numerous experiments made with both methods, we have preferred the ink.

The paper fillet, two inches in width, is wound on a small spool, holding about forty feet, and drawn between two rollers, the same as in a Morse Register. Every time the hammer falls, the fillet is advanced about one-quarter of an inch, by the action of an escapement driven by a weight. One spool of paper will hold about 1,200 observations, including the spacing for different objects. The same escapement is also operated by an electro-magnet, under the control of the observer, who by pressing a key is able to make spaces of any width between the prints.

The train carrying the minutes and integer seconds will run eight hours; the gear for elevating the hammer will deliver 800 blows; and the train for moving the paper fillet will go 1,200 times without winding. The fast moving train runs one hour and thirty-six minutes; but since this train can be stopped at pleasure, without changing the zero of the type, its comparatively brief running is not a serious inconvenience.

To recapitulate, we claim the following principal points: 1st. Separate movements for the integer seconds, and the hundredths of seconds; 2d. The method of regulating the hundredths of seconds wheel, by an electro-magnet in connection with the standard clock;

3d. The method of printing double or single numbers without stopping the type-wheels; 4th. The method of striking the blow, indirectly using the spring of the hammer; 5th. The method of elevating and locking the hammer. The minor details for paying off the paper fillet, inking the type, etc., may be accomplished in various ways.

The battery power required is about the same as for an ordinary chronograph. Three Grove elements or six Hill's elements, work the two electro-magnets well. A separate battery of about the same size is used for the hammer and fillet magnets.

In point of accuracy, this machine leaves nothing to be desired, and is much beyond what we thought possible. From a vast number of experiments, made by recording automatically the beats of the standard clock, both at the middle and end of the oscillation, the mean error for a single print is found to be about 0.013 seconds, equal in this respect to the recording chronograph. The maximum difference in the records of the beats seldom exceeds 0.03 seconds; and we believe this is as much due to the irregularity in the clock connection as in the running of the machine, since the same thing is found in ordinary chronograph records, when the measures are made from second to second.

During the building of the machine, which was accomplished by my assistant, Mr. Foreman, and myself, the past winter, as we could find the time, a great many experiments were tried in the method of regulation, printing, etc. The fast moving train was used to propel the integer seconds and minute type-wheels, dispensing with the auxiliary movement, but the disturbance of its motion was considerable, especially at the end of every minute, when it had double duty to perform. We think, however, by taking the power from the shaft turning once in a minute, and giving uniform motion to the type, it might be successful; but nothing would be saved in the amount of machinery, and the liability of losing integer seconds from accidental disturbance would be a serious imperfection in the method. As now constructed, there is hardly a possibility of error in the integer seconds without a serious disarrangement of the mechanism. If the fast-running train is stopped entirely, it only requires about six seconds to bring it again in coincidence with the clock pendulum.

The saving of time and labor by the use of a printing chronograph is very considerable. At the lowest estimate, it does work equivalent to the labor of one person where three are employed at the same time. In our zone work in former years, when the zone extended two hours in right ascension, it usually requires the labor of two persons a whole day to convert the chronographic records into numbers and copy them on the blank forms. With the observations printed, the labor is only that of copying, and can easily be done by two persons in two hours.

In regular transit work, where five or fifteen wires are observed, there will be no necessity for copying the separate wires, as the mean can readily be deduced from the printed fillet, or it may be cut and pasted in the record book. The machine is readily adjusted to indicate the same numbers as the clock's face, the type being so set as to point zero-hundredth when the pendulum is at its lowest point where the magnet circuit is completed. In the construction of the apparatus, provision was made for attaching engraved rings to the type-wheel shaft, showing at a glance the time. But these are found not essential, as they would but little facilitate the setting of the type, which is accomplished as follows: The minute type-wheel, which is free to move in either direction, is revolved to correspond to the correct minute. An impression may then be taken and the machine started, when the clock indicates the same, the seconds being readily counted from the beats of the magnet regulating the fast moving train. The whole time for this adjustment need never exceed two minutes.

In the observation of zone stars, the type may be set to give the integer seconds of mean right ascension, so that the final reduction will always be a small quantity.

Prof. John Phin—That is exceedingly interesting, and a wonderful achievement of science. The next thing must be to make the telescope record its own observations.

Dr. Van der Weyde—There is a small error which every observer makes in the time of his observation, which is nearly constant to the individual, and which is called the "personal equation." Prof. Hough has invented an apparatus to determine that personal equation, by which the observer records the time when he sees a ball crossing the field of view, and the ball itself records the actual time. But it will not do for the observer to attempt to correct his personal equation. If he finds that he records the time too late, he must not attempt to record it earlier, or he will be all wrong. He must still make the record when it appears to him to be the exact time; and then apply the personal equation. Then the telescope has been made to record its own observations. Mr. L. M. Rutherfurd, of this city has taken many photographs of the Pleiades, with his large telescope; and by means of an instrument constructed specially for this purpose, the relative positions of the several stars can be measured with the utmost accuracy. These photographs have been thus tested at the Observatory at Cambridge, Mass., and have been found to yield results equal in accuracy to those obtained by direct observation in the best telescopes. By these photographs the relative motions of the different stars in this group can be ascertained.

Mr. J. K. Fisher—It is not unreasonable to expect that the passage of a strong light may be made to record itself. That has been done in the firing of a cannon at noon by the rays of the sun. It is not impossible that it may be done at some time with all the precision possible in human observations.

V. Deep Sea Life.

Dr. Carpenter has returned safely from the third trip in deep sea dredgings. His results quite bear out the conclusions drawn from the two previous ones. Some new facts, however, of extreme interest have been discovered, the publication of which we may expect shortly. It is hardly possible to exaggerate the importance of these investigations in their bearings on the most important general problems of biology, physical geography and geology. They teach us that the bottom of the deep ocean is the home of many creatures, who live there in the absence of light, under great pressure, in water often excessively cold—just above freezing point—abounding in carbonic acid and in organic matter. Of these influences the one which makes itself most felt is that of cold. It is this, and not the pressure, not the bright sunlight that stunts the creatures and makes them reproduce at the bottom of equatorial seas the fauna of arctic surface regions. Nor is the life at these depths confined to low-born Foraminifera, or to that wonderful protoplasmic Bathybius which Professor Huxley told the British Association, at Exeter, he had now found in soundings from many quarters of the globe, and which therefore seems to be a vast thin sheet of living matter, enveloping the whole earth beneath the seas. Where, as in certain regions, the deep waters are warm, highly organized beings of bright colors and well-appointed eyes are brought up by the dredge. These researches press upon us the question: "Is it possible for living matter to be born and nourished in the absence of light, in the presence of carbonic acid, and in the absence of any heat higher than the temperature of about 32° F., in the absence, that is, of almost any force which can be transmuted into vital force?" At these great depths there is no vegetation, properly so called, and Professor Wyville Thomson, who is associated with Dr. Carpenter in these researches, is of opinion, that here the lowest living beings feed on the lifeless organic matter which exists in so large a quantity in the water. We seem here to be near the transition from complex lifeless protoid matter and living protoplasm. The exact condition and nature of this organic matter is of extreme importance, and we understand a distinguished chemist is about to make it the subject of an inquiry. There is another point of no less interest. These organisms, which are thus building up chalk strata (for this deep Atlantic ooze is nothing but incipient chalk) at the bottom of the ocean are, to a very large extent, identical with many of the remains found in the chalk formations. This is so much the case that we may speak of races of animals building the old hills of millions of years ago, and laying now the foundation of the chalk-hills of times to come, themselves remaining unchanged all the time between.

Dr. Van der Weyde—The pressure at these great depths is no inconvenience to the animals, for it is equalized. It is interior as well as exterior. With regard to the absence of light, the fishes we find in the Mammoth cave are as lively as other fish, and appear to be happy and contented. I found in those fishes rudimentary eyes, with the skin grown over them. They are probably descended from fish which have made their way into the cave through subterranean passages, and which have not had their eyes developed from the want of the stimulus of light. Those fishes grow fat, but are very pale, and the skin is very transparent. They look very different from other fishes. It is not wonderful that there should be life in the depths of the sea. It appears to be a law of nature that wherever life is possible, there is life. The deep sea life to-day seems to be identical with that of the cretaceous period; and cretaceous deposits are now forming in the bottom of the ocean.

Prof. John Phin—Some years ago I made some experiments to ascertain the effect of the primeval atmosphere, which was supposed to contain a large amount of carbonic acid, upon animal life. I found that the lower forms of life could bear with impunity a large amount of carbonic acid. A lizard would live for a considerable time in an atmosphere containing enough carbonic acid to kill a mouse almost instantly. Of course there is oxygen present even at the bottom of the ocean; and much of it escapes as it is brought to the surface. The lower the form of life, the greater is its power of resisting the action of carbonic acid, whether it is in the atmosphere or in the water.

VI. Unsown Crops.

The sudden and apparently spontaneous appearance of unsown crops on a slight change in the condition of the soil, or of plants entirely new to the neighborhood, when fresh ground is tilled for the first time, is a well-known phenomenon. In particular, farmers are familiar with the fact of the universal appearance of sufficient white or Dutch clover completely to cover the ground when heath-land is first plowed. It is very common also for railway embankments or cuttings to be covered, for the first few years after their construction, with plants indigenous to the country but new to the neighborhood. The usually accepted explanation of these facts is that the soil is everywhere full of buried stores of seeds of all descriptions, which require only favorable circumstances of warmth, light and moisture to bring them to life. In his anniversary address to the Linnean Society, the distinguished president, Mr. Bentham, points out the objections to this theory, which rest rather on circumstantial than on direct evidence. Where the seeds are not very small, as in the case with the white clover, they ought to be easily detected by a careful search, if present in sufficient quantities to form a complete crop. Mr. Bentham doubts also whether there is any satisfactory evidence of seeds retaining their vitality for any considerable length of time unless kept perfectly dry, as in the case of the grains of wheat preserved in Egyptian mummies; and calls attention to the rapidity with which large numbers of seeds may be transported to a given spot of earth in an exceedingly short space of time by the agency of birds. The interest and importance of this subject would amply reward a careful series of experiments and observations.

Prof. John Phin—Dr. Lindley, the botanist, obtained a quantity of matter from the stomach of a man that had been buried in England a great many years ago in an old Danish or Saxon tumulus; and he found in it several seeds which he identified as the seeds of wild fruit which formerly grew in England; showing the man had eaten the fruit, and the seeds, although not kept dry, had preserved their vitality, for these seeds were afterward sown and plants grown from them.

The President—How do you account for the fact that when a forest of pine trees is cut down, oak trees take their place?

Prof. John Phin—I do not account for it. A great deal that is said about the age at which seeds will die is untrue. I had at one time a quantity of old seeds that had been put away for fifteen or twenty years, and many of these that all authorities pronounced worthless grew. Climate has a great deal to do with it. In Egypt or in this country seeds may last longer than in England. The equal temperature found in the soil tends to preserve the vitality of seeds.

Dr. L. Bradley—I see nothing mysterious in the appearance of a crop of oaks in the place from which a pine forest has been cleared off. Everything is changing, appearing and reappearing. We have a succession of crops; why not of forests? May there not have been, previous to the pine crop, beech, maple or oak crops? It seems to me reasonable to suppose that.

Dr. P. H. Van der Weyde—We don't get a wheat crop after rye without sowing it.

Dr. J. W. Richards—Some classes of seeds will preserve their vitality longer than others. Oleaginous and aromatic seeds retain their vitality; and so do the lower grades of vegetables. Mosses will grow after having been dried two or three hundred years. With regard to the seeds never having been found, it is no evidence that they were not in the soil. The germ is very small, and the other portions of the seed may have been destroyed and the germ may be preserved. In the Mohawk flats, a furrow cannot be turned up without producing an enormous crop of mustard. It would be interesting to search for the mustard seeds, which, being aromatic and oily, would resist the ordinary influences of moisture and temperature for a long time. The facts referred to have given rise to vague ideas about the creation or formation of new plants without seed. While it is easy for me to conceive that the hand that created the first plant could create another, we have no proof of such creation; and it would be very interesting to make a search for the existence of seeds in the soil.

Prof. Phin—I question whether the oak would grow from the germ alone, without the pabulum furnished by nature to sustain it. It was the suggestion of Henry Thoreau that it was the squirrels which brought the acorns from a distance and buried them in the pine forests, in such quantities that you could not cut down a forest of pine trees beneath which a crop of oaks had not been sown by the squirrels within a few years.

Dr. Richards—It has been found that seeds which would not germinate when exposed to the ordinary influences of the atmosphere, would grow on being moistened with preparation containing chlorine. Some change of circumstances may revivify a germ which, under ordinary exposure, would be destroyed.

The President—Probably, the reason why the pine does not grow so well where it has just been cut down is, that the soil is exhausted of the peculiar qualities required for pine; and from that very fact it is better adapted to other trees, which, therefore, take the place of the pine.

Dr. Van der Weyde—It is the "struggle for existence." Seeds are present everywhere, and where there is a chance for them they will develop. When the soil is exhausted of the nourishment suited for the pine, of course other seeds not requiring that particular nourishment will develop more rapidly, and give the pine no chance to grow.

VII. The Dragon of Lyme Regis.

The British Museum has lately received the fossil remains of a flying dragon, measuring upward of four feet from tip to tip of the expanded wings. The bones of the head, wings, legs, tail, and a great part of the trunk, with the ribs, blade-bones, and collar-bones, are imbedded in dark lias shale from Lyme Regis, on the Dorsetshire coast. The head is large in proportion to the trunk, and the tail is as long as the rest of the body. It is extended in a straight, stiff line, the vertebral bones being surrounded and bound together by bundles of fine, long, needle-shaped bones. It is supposed to have served to keep outstretched, or to sustain, a large expanse of the flying membrane or parachute which extended from the tips of the wings to the feet, and spread along the space between the hind-limbs and the tail, after the fashion of certain bats.

The first indication of this monster was described by Buckland in the "Transactions of the Geological Society," and is referred to in his "Bridgewater Treatise," under the name of *pterodactylus macronyx*. The subsequently acquired head and tail give characters of the teeth and other parts which establish a distinct generic form in the extinct family of flying reptiles. The animal, as now restored, will be described and figured in the volume of the Monographs of the Palæontographical Society, for the present year, by Prof. Owen.

Adjourned to Thursday next, at half-past seven o'clock, P. M.

May 18, 1871.

Prof. S. D. Tillman, in the Chair; Robert Weir, Secretary.

The President, Prof. S. D. Tillman, presented his summary of scientific news as follows:

I. The Theory of Atmospheric Germs.

Dr. A. E. Sansom has given, under this title, in The Quarterly Journal of Science, a brief statement of the positions assumed by the opposing parties in the learned societies of France, who have long mooted the question as to the cause of putrefaction and fermentation, and who appear to have arrived at that stage at which each prefers to remain unconvinced. In both processes there is observed the occurrence, growth and multiplication of living organisms, either amid the particles of the moist decomposing substance, or upon the surface, where these frequently make their appearance as ordinary mildew. How are these results explained by the two theories? According to the one, the molecules of a putrefying or fermenting body are in a state of motion, tending to the disruption of their elements. The living particles observed are the results of the communion of certain non-living elements with the physical forces with which they are in relation. Thus there is a strict analogy between crystallization and creation. As in the one case certain molecules, under certain conditions, assume definite crystalline forms, so certain molecules under other conditions assume the appearances and attributes of vitality. According to the other theory, there is a single cause for all the phenomena. This cause is the presence of living matter. The organic elements of a putrescible or fermentable compound undergo disruption by no inherent tendency of their particles to motion, but by the influence upon them of living, growing and multiplying organisms which, by their very acts of life and struggle for existence, superinduce this disruption. The living beings which are acknowledged to be present are the intimate causes, and not the adventitious signs, nor yet merely intermediate agents, of the decomposition of the material. Dr. Sansom investigates the question from the stand-point of the second theory. After presenting the principal positions which have been established by experiment and observation, he takes up the only real objection to the reception of the germ theory—the resistance to the destructive agency of heat—and then alludes to the defects of other physical agencies which may contribute to a solution of the question. It is not by the results of a single method of investigation that this question is to be judged, but rather by the collective evidence of many methods.

Heat is not the only destructive agency which may be employed in the inquiry; others, fraught with much valuable teaching, may be put in force, though these have been apparently in the recent controversies entirely ignored. Such are the evidences derived from the destructive influences of chemical and of poisonous agents. It has been known from time immemorial that the addition of certain compounds prevents both putrefaction and fermentation. The belief being that these processes were essentially chemical, it was naturally probable that the agents which suppressed them should be susceptible of a chemical classification. If the processes were, as asserted, those of oxidation, it would surely be not unreasonable to expect that the agents which arrest them should also arrest oxidation; but common experience taught an absolutely contrary lesson—that oxidizing agents were the most efficient in arresting the processes. Again, on the chemical theory, there ought to be some quantitative relation between the amount of a chemical agent employed and the degree of its influence; but the fact is that an agent present in such feeble quantity as to be capable of no appreciable chemical effect on the mass of putrescible material, is yet capable of stopping all putrefaction. Furthermore, agents, such as carbolic acid, which are proved to exert no influence whatever on processes purely chemical, are among the most efficient of all means for preventing putrefaction and fermentation. A large series of observations show, on the other hand, that the agents arresting these processes exert their influence precisely in so far as they are *poisonous* agents to low organisms. If at any stage of the process these microscopic organisms are rendered lifeless, the process, with all its attendant phenomena, ceases; on the other hand, the overt signs grow with their growth, strengthen with their strength, subside when they languish, and cease when they die. Hitherto experiments have usually been made with the view of ascertaining the effects of antiseptic agents when mixed with putrescible material; but the author has attempted to ascertain the results which occur when air alone is influenced by certain agents, the materials being left intact. In this way the heat may be tested by the evidence of other agents of vital destruction. The results obtained may be thus briefly summarized:

I. Putrefaction, mildew formation, and the appearance of organisms can be checked or absolutely prevented by the existence of certain agents in the air supplied to a putrescible body.

II. The power of such agents can in no sense be measured by their chemical constitution or characters. From many experiments the following expresses their order of efficiency, from weakest to strongest: (1.) Chloride of lime. (2.) Sulphurous acid, ammonia, sulphuric ether. (3.) Chloroform. (4.) Champhor. (5.) Iodine, phosphorus, creosote, carbolic acid.

III. Tne agents which stop fermentation are vegetable, not animal poisons. Fungi will grow in the presence of hydrocyanic (prussic) acid and of strychnia.

IV. Comparative experiments show that a given volatile agent is far more efficient when it is contained in the air supplied to a putrescible solution than when an equal quantity is mixed with the solution itself.

V. All fungoid organisms can be prevented by the presence of a minute proportion of creosote, carbolic acid, ammonia, hydrochloric acid, or sulphurous acid in the air, though beneath the surface of the fluid are found numerous bacteria and vibrios.

There seems to be no escape from the conclusion that the germs or fungi exist in the air and are destroyed by the volatile, poisonous agent.

Mr. R. D'Heureuse said that the phenomenon of putrefaction was very generally confounded with that of fermentation. Some agents would prevent the one process and assist the other. Atmospheric air actively promotes fermentation, and at the same time destroys putrefaction or decay.

Dr. P. H. Van der Weyde—Scientists distinguish between different kinds of changes which may be grouped together under the general term fermentation. We have the alcoholic and the acetic fermentation, very different from each other, but requiring the same agents at different temperatures. Putrefaction is the last in this general series of fermentations. The alcoholic fermentation is the least destructive, but they are all destructions of organic elements. By the alcoholic fermentation the starch is first changed into grape sugar and then into alcohol. By the acetic fermentation the alcohol is changed into vinegar. Some agents which will prevent one kind of fermentation will promote another kind, because they require different conditions. The two theories spoken of in this paper appear to turn upon the question, which is the great question of the age, of spontaneous generation; for if we admit the existence of spontaneous generation we do not need those theories.

Mr. D'Heureuse—I do not wish to be misunderstood. The alcoholic process is a perfectly healthy action; and what is called the acetic fermentation is really an oxidation; but putrefaction is a process of decay.

II. VALUABLE AUSTRALIAN TIMBER.

Two kinds of wood indigenous to western Australia have recently attracted considerable attention, from the fact that they possess qualities not found in the common woods of our forests. The Jarrahjarrah timber is very hard, and capable of receiving a high polish.

It is never attacked by white ants, nor by the *teredo navalis*, which abound in tropical and semi-tropical seas. It is therefore of great value in hot climates for ship-building, pier and railway construction, as well as for the interior of buildings and for furniture. The immunity of this wood from the attack of insects, whether land or marine, has been proved by analysis to be due to the presence of tannic acid. The other variety is the Tooart wood. It has a very close grain, and is so extremely hard that it cannot be split, and will endure great heat without rending. On account of its non-liability to split, it has been suggested for use in gun-carriages.

Mr. J. K. Fisher—Might not other kinds of wood be made impervious to the ants by the use of tannic acid in some way?

The President—Various attempts have been made to protect common woods from the ants, but they have not been completely successful; and the wood prepared by nature is cheaper than anything else. I do not myself believe that tannic acid has the power of protecting wood.

Prof. J. Phin—The great difficulty is that the ants do not eat the wood; they merely burrow into it. They gnaw it and throw the dust out. Poisoning the wood, therefore, does not affect them.

Mr. Fisher—This is a matter of much importance in the fine arts. Many of the finest pictures, painted upon panels, have been entirely destroyed by worms. The experience of 350 years shows that pictures upon canvas are not as durable as those upon panels, provided we can get good panels. They are frequently made of cracked and knotty wood. What is wanted is wood impervious to worms, impervious to rotting, and not liable to crack or split. And as to the additional cost of half a dollar per square foot, half an inch thick, would not be an objection; chemists are not limited in their use of means in preparing the wood.

Mr. Robert Weir—Is not the millboard very durable?

Mr. Fisher—Yes, but it bends and gets out of shape.

Mr. Weir—Boards are also made of paper — of papier-maché.

Mr. Fisher—I think the best substance will probably be found to be prepared wood.

III. WATERPROOFS.

The "Lounger" of the *Illustrated Times* says: By the way, touching water-proofs, I think I can give travelers a valuable hint or two. For many years I have worn india-rubber waterproofs, but I will buy no more, for I have learned that good Scottish tweed can be made completely impervious to rain, and, moreover, I have learned how to make it so; and for the benefit of my readers, I will here give the recipe: In a bucket of soft water put half a pound of sugar of lead and half a pound of powdered alum; stir this at intervals until it becomes clear; then pour it off into another bucket, and put the garment therein, and let it be in for twenty-four hours, and then hang it up to dry without wringing it. Two of my party—a lady and gentleman—have worn garments thus treated in the wildest storm of wind and rain without getting wet. The rain hangs upon the cloth in globules. In short, they are really waterproof. The gentleman, a fortnight ago, walked nine miles in a storm of rain and wind such as you rarely see in the south, and when he slipped off his over-coat, his under-clothes were as dry as when he put them on. This is, I think, a secret worth knowing; for cloth, if it can be made to keep out wet, is in every way better than what we know as water-proofs.

Prof. Phin — I have seen a piece of common mosquito netting with the meshes 1-16th of an inch wide laid over a tumbler, and a teaspoonful of water poured upon it, and the water stood in a large globule and did not fall through. The material had been rendered repellant by some preparation, so that the water will not pass through unless under pressure. But the air passes through freely.

The President — The great objection to rubber waterproof is that it is air-proof also. I remember that when I was in college, I bought a pair of india-rubber boots with very long legs, to keep my feet dry when walking in deep snow, but, to my surprise, found that my feet were wet. I ascertained that it was because the perspiration could not escape. It is unhealthy to wear india-rubber clothes, for they retain the perspiration. But the prepared cloth allows the perspiration to pass off freely.

Dr. Van der Weyde said that in wearing clothing which retained the perspiration, we really poison ourselves; because the perspiration is a substance which nature is trying to expel, and which it is an injury to retain in the system.

IV. Wonderful Rapidity of Photographic Action.

The image of the full moon can be fixed in less than one-fourth of a second, and that of the sun instantaneously. According to the experiments of Mr. Waterhouse, a space of time no longer than one twenty-seventh-thousandth of a second is required to fix the solar image. Even this small fraction, however, inconceivably short as it appears, is a tolerable length of time compared with that in which photographs are taken by the electric flash. The duration of the illuminating sparks, according to the beautiful and trustworthy experiments of Mr. Wheatstone with his delicate chronoscope, does not exceed the millionth part of a second, and yet a clear and distinct photographic image is obtained by a single electric discharge. By this means may be shown the real form of objects to which a deceptive appearance is given by their rapid movement. If a wheel on whose side any figure is drawn in conspicuous lines be made to rotate with the greatest possible velocity, the figure will present to the eye only a series of concentric bands of different shades. Let it now be photographed while in motion by the electric flash, and the wheel will appear stationary with the figure well defined. A vein of water issuing from a small orifice, which appears to the eye as smooth as a stem of crystal, if seen or photographed by the light of the electric discharge, is shown to be composed of drops variously disposed, and of various forms, some being elongated, others flattened, and others almost spherical.

Mr. Fisher suggested that perhaps photography might aid in determining the speed of light.

V. THE GASOPHANER.

An invention that may develop into something of great value is that of an English chemist, designed to show the existence of malarious gases. A piece of fused boracic acid, the size of a walnut, is heated to redness in chlorine. The mass is then blown the same as common glass into a bulb, and the "gasophaner" is ready for use. When first made the bulb is perfectly clear, but in being brought into contact with carbonic acid gas it becomes clouded with a light blue film, giving an opal luster. By gentle reheating the film passes away. So great is the delicacy of the gasophaner that the breath of a child or a healthy person, breathed on the bulb, can be detected from that of a person exhaling more carbonic acid. When held over a solution of sulphur the bulb becomes pitted as with small-pox.

EMERY.

The President said — A new vein of emery has been discovered quite recently, specimens of which will be presented by Mr. Stewart, who owns the land on which it is located. Powdered emery is used in large quantities for scouring, smoothing and polishing hard substances. The mineral is chiefly brought from Naxos and points still further east. Its virtue consists in its hardness, and this arises from the large per centage of alumina (the sesquioxide of aluminum) found in it. Next to the diamond in hardness is sapphire, which is nearly pure alumina. Corundum contains about ninety per cent of alumina and ten per cent of magnetite, lime and silex, the largest portion of this being magnetite. Emery contains, in place of magnetite, sesquioxide of iron, the per centage of alumina varying from fifty to eighty, and that of sesquioxide of iron from twenty to fifty. The emery found at Chester, Massachusetts, has the largest proportion of iron. The specimens now shown are from Chester county, Pennsylvania, and seem to contain far less iron. All the minerals alluded to are classed under the general term corundum.

Mr. A. P. H. Stewart exhibited specimens of emery from this mine, developed and rendered valuable under the supervision and through the exertions of Captain John Elliot. They are finer than any before reached, and remarkably free from the oxide of iron. He also exhibited specimens of tourmaline, granite, soapstone, mica and asbestus, from the same region. This emery has been found especially valuable in working upon hardened steel or chilled iron. It has not yet been analyzed.

VEDDER'S SELF-ADJUSTING CAR-COUPLER.

Mr. W. E. Partridge exhibited a model of J. D. Vedder's self-adjusting car-coupler, and explained its construction. It requires no change in the framing of the car or truck, and can be applied to any of the cars now in use. There are two springs, seizing and holding the arrow-headed link in coupling the cars, and separated by a lever in uncoupling them. This lever may be so shaped as to be operated from any convenient position. When the car is turned at right angles with the link, the springs no longer hold; so that the car is free, if overturned, to roll down the bank, leaving the remaining cars on the track.

Mr. C. B. Boyle stated that he had applied twenty years ago for a patent for that exact thing.

Prof. Van der Weyde stated that the Miller patent now in use on the Erie railroad was similar to this, but that this was an improvement upon the Miller car-coupler.

Prof. J. A. Whitney considered the Miller plan the better of the two, there being in that but half the number of parts. The Miller coupling prevents the "telescoping" of the cars by avoiding the play of twelve to fourteen inches on each car allowed by the ordinary link. Whether the Vedder coupling will practically uncouple on the over-turning of a car, can only be ascertained by trial. It would seem to require so much lateral motion of the car before it could be brought at right-angles to the next car, that perhaps it would force it from the track before it could uncouple.

Mr. Partridge stated that the plan of preventing the play between the cars made it necessary in starting that all should be started simultaneously, which was a severe strain upon the engine. In this coupling, however, the drawing springs, while preventing any "lost motion," relieved the engine from the strain of starting the whole train at once.

Mr. Boyle said that his plan was objected to for the reason that it allowed the overturned car to separate; and it was thought that it should be held on the track by the remaining cars.

Mr. T. D. Stetson—There seems to be no doubt now that, practically, it is desirable to disconnect a car which gets off the track. It is now believed to tend to the safety of the disabled car; and, as to the others, there is no question but it adds to their safety. The Baltimore and Ohio railroad for a long time have used a wooden coupling, strapped with iron, so that it should twist and break when the car got out of line. There is much force in the objection that before the car can be turned over, it must necessarily be moved a considerable distance laterally.

Mr. Partridge—I think that that motion would cause this coupling to disconnect by opening the side springs and clearing the link from the jaws.

The following paper was then read by the author:

ELECTRO-MAGNETISM.

By Prof. John Phin—At the meeting of the British Association last September, a paper was read by Rev. H. Highton, which has attracted a great deal of attention both in Europe and in this country, particularly among persons fond of reading about scientific pursuits, and who imagine that the field of discovery is almost unlimited, but the foundation of whose knowledge has not been laid broad and deep. The paper of Mr. Highton was to the effect that the old ideas of correlation of forces are entirely erroneous, and, therefore, are not to be taken into account in any calculations upon the application of heat, electricity or any other force, for motive power. We shall get his views more clearly by reading the opening passage of his paper contributed to the January number of the Quarterly Journal of Science. He says:

"I think that I may say, first, that the theory at present accepted, and which it would be considered somewhat heretical to deny, is this, that a certain amount of chemical change corresponds and is interchangeable with a certain amount of heat and electric force; and that this heat again corresponds and is interchangeable with a certain amount of work or mechanical energy. This is, no doubt, a very pretty, plausible and apparently philosophical theory; but is it true; or how far is it true? This is the question I now propose to consider, with a special view to the further question of the economy of electro-dynamic engines."

If there is any one feature peculiar to modern science, it is that it is cumulative. Plato, Pythagoras or Socrates were men as capable as any of the present day; but our knowledge vastly exceeds theirs, because standing upon their shoulders we can see further than they did. It becomes important, therefore, if a single stone in the foundation of our great system of science is suspected of being unsound, that we should determine whether it is so or not. And I propose to-night to show you the errors which Mr. Highton has made, and that we have, therefore, no reason to abandon the laws from which we have come to the conclusion that in the present state of our knowledge electro-magnetic engines are not and cannot be made economical.

The experiment of Mr. Highton is this: With a certain battery, connected with a certain electro-magnet, he supports a certain weight. He then connects the same battery with four similar magnets, the wire dividing and each section passing around two magnets, and it supports double the weight. He concludes that that series can be multiplied to any extent, and thus that the power can be increased *ad infinitum*. Lest I should be thought to be caricaturing his argument, I will quote his exact words from the Chemical News of October 28. He says:

"In trying experiments on this subject the author found that the magnetic power evolved by a given battery could be increased without limit. This was the case both in theory and practice. * * * By simply increasing the length and section of the wire, the magnetic power may be increased without limit. * * * Enough has been said to set aside the *à priori* argument against electro-dynamic engines—namely, that as a pound of zinc can only produce a certain amount of heat, and a pound of carbon, which is much cheaper, can produce more heat, therefore electro-dynamic engines can never compete with steam engines. In fact, it is a question of prime cost of machinery and skill in construction, and not of cost of working."

Now, if you examine the conditions of Mr. Highton's experiments, you will see the cause of the apparent increase of power. An ox can drag four wheelbarrows as well as one. Hitch four baby-carts to a horse, and you will not see any signs of weakness. Mr. Highton used a very strong battery; and hence, when you put on the additional electro-magnets, with twice the length and twice the thickness of wire, he produced apparently a greater force. Yet he does not get the same force from each additional magnet. There is a limit to it.

The question arises, what are the conditions under which the greatest power will be evolved by any galvanic circuit? If a water-wheel turns with the velocity of the stream, it gives no power; if it stands still, it does no work. The law is, that it does the greatest work when it moves with one-half the velocity of the water. So the galvanic battery does the most work when the work outside is equal to the work inside, *i. e.*, the resistance of the wire must be equal to one-half the maximum power of the battery; or the resistance in the coil should be equal to the resistance in the liquid.

Of the success of the electro-magnetic engine, I have no doubt; but when we consider its economy as compared with steam, we must remember that in the steam-engine we burn carbon, a substance having a very low chemical equivalent, whereas, in the voltaic engine we burn zinc, a substance having a high chemical equivalent. It takes more than thirty-two pounds of zinc to do the work of six pounds of carbon. Moreover, the six pounds of carbon are raised to such a height that they fall twice as far — *i. e.*, each equivalent of carbon combines with two equivalents of oxygen, whereas, zinc combines with but one; so that the proportion is as eleven to one in favor of carbon. But, taking the market value into consideration, the difference is vastly greater, for zinc costs $320 a ton.

The President—The cost of the power is about twenty-five times that of steam power.

Dr. Van der Weyde—For oxidizing zinc we are obliged to use an acid which costs money. For oxidizing coal we use air, which costs nothing.

Mr. J. K. Fisher—The cost of the zinc will not amount to anything, for we can sell the zinc paint for more than the zinc costs.

Dr. Van der Weyde—Experiments which I tried, thoroughly, many years ago, the apparatus for which is still in this building, fortified the position taken to-night by Prof. Phin. I commenced in Holland, in 1838 or 1839, to make an electro-magnetic engine to turn my lathe with. It did the work successfully, but it consumed a tremendous amount of zinc. About two years ago, a gentleman by the name of

Prevost, asserted that the power of a battery could be increased by adding magnets. The fact is, that so long as the resistance in the coil is less than the resistance in the battery, you can increase the power until you make them equal. But many who make such machines do not know how to calculate the resistance. In the first place, it is in inverse ratio to the section of the wire. Then there is another principle. If you have two wires, and if the resistance in one is 100 times that in the other, the current will not all go in the easiest way, but one-hundredth part of it will go the other way; or rather, 100 times as much will go the easiest way as goes the other way.

Mr. T. D. Stetson—What will be the effect if the magnet does work?

Dr. Van der Weyde—It will affect it by interrupting the current. The magnetization and demagnetization of the iron will interfere with the primary current and diminish it. In other words, it will increase the resistance.

Dr. L. Bradley—What will be the effect of the armature?

Dr. Van der Weyde—When loaded with an armature the resistance will not be changed; but when they are not loaded, so that the magnetism is free to manifest itself, the resistance will be increased. Taking off the armature will increase the resistance.

The President—The gain in multiplying these magnets is like the gain by a lever. It is only a gain in the manner of using the power.

Adjourned.

May 25, 1872.

Prof. S. D. TILLMAN in the chair; Mr. ROBERT WEIR, Secretary.

The President, Prof. S. D. Tillman, read the following summary of scientific news:

I. NEW COAL MINES IN INDIA.

The London Mining Journal contains some interesting statistics with reference to the newly-discovered coal mines of Berar, in India. The total area of the coal-fields is more than 1,000 square miles, and the coal is easily accessible. Lately, a vein of coal was struck seventy-seven feet from the surface, and thirty feet of coal was pierced without the bottom of the seam being reached. The area of one field, called the Damuda, is estimated at 149 square miles, and the average thickness of the vein at forty feet. Valuable beds of iron ore have also been found in the Woon district, containing from fifty-three to sixty-eight per cent of iron.

The President remarked that probably the coal found was bituminous.

II. INTERESTING EXPERIMENTS ON COLOR.

Dr. Clerk Maxwell recently made some striking experiments on light and color at the Royal Institution, London. A mixture of blue and yellow pigments produced a green color. When discs of blue and yellow light were projected on a screen and made to over-lap, the combined lights produced not a green color, but pure white. In the same manner, by throwing red and green rays upon the screen, the area of the junction gave the impression of a brilliant yellow. Similar colors have been thus combined by American experiments, but with very different results from those obtained by Mr. Maxwell.

Mr. J. K. Fisher—I think Dr. Maxwell is very much mistaken. I do not believe he has a good perception of color. That blue and yellow rays will produce white, is contrary to all the theories and experiments of philosophy; for they produce green. Blue, yellow and red rays will produce white.

Dr. P. H. Van der Weyde—It is very curious; but, although it is utterly impossible in the chromoscope to make blue and yellow produce white, or to blend a red and green disc to produce yellow, yet it is true that blue and yellow light produces white. We must distinguish between the prismatic colors and the common pigments. If you throw upon a screen, by means of a prism, the seven colors, and intercept all but the green rays, you may look at that green disc through another prism, and you will see no color but green. But look through the prism at a disc painted green, and you will see blue and yellow. The blue and yellow mixed in the pigment produce a color corresponding to the mean undulation velocity. The number of undulations per second of the yellow light is about 500 millions of millions, of blue light about 700, making an average of about 600, which corresponds to green light. But the prismatic green rays all have 600 millions of millions of undulations per second, none moving faster and none more slowly; so that the prism cannot separate them.

In the same lecture, Dr. Maxwell speaks of a yellow spot in the eye. I have not much belief in that. There is a spot in the retina where the optic nerve passes through it; the fibers separating and feeling the image from the front like so many transparent fingers; but that spot is insensible.

Mr. Fisher repeated his belief that blue and yellow, whether pigments or rays, produce green, and that red and green produce a neutral tint; and inquired if the eye could distinguish between a pigment reflecting pure green rays and one reflecting blue and yellow rays.

Dr. Van der Weyde—No; but the prism can do it, and the spectroscope can do it still better.

III. New Method of Painting.

M. Violette, the inventor of a new method of painting, employs a so-called pulverizator (a spray-producing instrument), for applying liquid pigments and dyes to the surface of textile fabrics, paper, etc. The colored liquid is projected in an impalpable spray and made to fall to any desired depth on the objects to be painted or dyed.

IV. Preservation of Meats.

E. Pelouze gives, in the Moniteur Scientifique, the following description of his process: The meat or other animal substance, first cut into pieces of convenient size, is placed for some time in an atmosphere of carbonic oxide gas, under pressure. After this treatment, the material is dried in a current of dry, cold air, so as to remove all traces of moisture from the substance; it is then treated with an antiseptic solution—either a concentrated brine or a solution of saltpeter, or water with pure carbolic acid. Finally, it is packed in hermetically sealed vessels.

V. The Force of Detonating Gaseous Mixtures.

Dr. Berthelot has completed his investigations on the force of gunpowder and other explosive substances, by presenting in the Moniteur Scientifique a table of explosive mixtures, consisting of oxygen with various gases and vapors, also the amount of heat and pressure produced by one kilogramme of each mixture. According to this review, the maximum effect of each mixture varies only from one to two, and is about equal for the several hydrocarbons and the vapors of ether and benzine; but this effect surpasses that of all solid, as well as of all liquid, explosive compounds. With hydrogen and oxygen, for instance, it is five times greater than that of powder, and two and one-half times greater than that of nitro-glycerine. The gaseous mixtures experimented with are supposed to be under atmospheric pressure. The pressure theoretically exerted by them is between twenty and forty-nine atmospheres, each at fifteen pounds pressure to the square inch, and is very greatly different from the pressure exerted by the most of the solid and liquid explosive substances we are acquainted with; a result the very opposite to that which was supposed to be the case by most people until now. In order to obtain a pressure more nearly like that exerted by solid and liquid explosive substances, it would be required to compress the bulk of the explosive gaseous mixtures until their density was nearly that of the explosive solids and liquids. Leaving out of the question for the moment the difficulty of this operation, the result would be liquefaction of most of the hydrocarbonated gases while the oxygen remained in a gaseous state, and the destruction of the homogeneity of the explosive mixtures, and accordingly, also, the possibility of obtaining its instantaneous explosion by a spark.

Dr. Van der Weyde—In rating the effect of explosive mixtures, the velocity is often overlooked. Gunpowder is weak, because it burns so slowly. White gunpowder, made with chlorate of potash, burns six times faster; and for that reason does not answer the purpose of gunpowder. In making gunpowder for large guns, it is necessary to make it in large grains, to make the combustion slower; but in blasting we want sudden expansion. The fulminates do not produce more gas than gunpowder; but the enormous velocity of the production of the gases makes the difference. A mixture of hydrogen and oxygen will explode in the open air, but gunpowder in the open air only burns rapidly. For projectiles we want the combustion to be so regulated that the last grain of gunpowder shall be burned at the moment the ball leaves the musket.

Prof. John Phin—If you lay two trains, one of gunpowder, and another, crossing it, of fulminate of mercury, the gunpowder will burn to the point where the other crosses it, and no farther. The fulminate will scatter the gunpowder without igniting it, and the rest of the train of gunpowder will be left unconsumed. But if you confine the gunpowder so that the fulminating mercury shall give it a hard blow and explode it at the same time, it increases the force of the explosion.

Dr. Van der Weyde—That is the reason that gunpowder is more effective with percussion caps than with flint.

Prof. Phin—Fulminating murcury must be mixed with something else in order to fire gunpowder. Mix together a quantity of iron filings and of fine hard-grained powder, and throw them through an alcohol flame, and the iron filings will burn, and the gunpowder will not.

Dr. Van der Weyde—If you try to ignite gunpowder by means of an electric spark from a machine producing electricity of tension, it will not burn. But take a wet thread, and pass the current through it so as to make the spark move slowly, and it will ignite. A large Rumkorff coil will not ignite a match. The electricity flies around it. But dip the match in water, and it will ignite at once.

Prof. Phin—Place the substance between two wires, and you can ignite either the powder or the match.

VI. Exhalation of Plants.

The functions of the leaf are such that, during its exposure to sunlight, it gives off exhalations both of gas and vapor. It decomposes carbonic acid gas, absorbing the carbon and setting free the other component, oxygen gas; at the same time it concentrates the sap of the plant by carrying off its surplus water through the pores of the leaf in the form of vapor. During early vegetation, the quantity of water exhaled by the plant is very great. Botanists have carefully measured the extent of this exhalation in certain plants. Several experiments of Hales and others may here be noted. A sunflower, three and a half feet high, presenting a surface of thirty-nine square feet, and exposed to the air and light, was found to perspire at the rate of from twenty to thirty ounces avoirdupois during every twelve hours, or about seventeen times more than the amount perspired by an ordinary-sized man during the same time. An apple tree with twelve square feet of foliage was found to perspire nine ounces of water per day, and a vine of about the same surface from five to six ounces. Recent experiments by Dr. McNab with the laurel cherry prove that its leaves contain about sixty-three per cent of water. Sunlight was found to be more efficient than chloride of lime or sulphuric acid in extracting water from the leaf. In light of any kind the under-surface of the leaf was found to perspire more water than the upper surface. At night the process is arrested, and even in the shade only two per cent of the water in the leaf passed off per hour into a dry atmosphere, while in a saturated atmosphere exhalation ceased. It seems obvious that this function of the leaf must have great effect in modifying climate. Experiments in India and Africa in planting extensive forests in territory deficient in moisture have shown that within a few years the number of rainy days during the year have increased at least fourfold.

Dr. Van der Weyde — I think the attraction of trees for moisture is like the attraction of mountains for clouds. A group of trees has a tendency to cause the rain to fall there.

The President — May that not be because the atmosphere around the trees is saturated with moisture from the perspiration constantly going on?

Prof. Phin — The subject of the influence of forests upon rain is one of the most interesting now before the public. I think that there is an agent at work here, to which a great many effects are attributed without reason — electricity. I do not think it probable that the vapor given off in a particular locality is returned to that locality in the form of rain. A spire of grass is just as efficient in drawing off electricity as a needle point. In a forest of trees, with its numerous points discharging electricity from the clouds, we see a powerful influence at work, which, I think, has more to do with the result than evaporation. Further, the amount of vapor produced by a plant will be largely increased by its being placed in a dry atmosphere.

Prof. James A. Whitney — This is a question of practical importance, as well as of scientific interest. These experiments seem to me a repetition of experiments made many years ago. The proportion of water to the mineral matter has been shown to be 2,000 to 1; so that the amount of water passed off must be, to a certain extent, independent of the atmosphere around it. It has been stated by a German chemist that the amount of dilution of the mineral elements can never exceed in strength one grain to 1,000 of water. It hardly seems necessary to attribute to electricity the climatic results from the planting of forests. The water passing into the air will furnish it with moisture tending to the deposition of dew and the falling of rain. In my journey across the plains, last summer, it was a matter of consideration how those plains could be made arable, there being no mountains and no great mass of water supplying the necessary moisture. But I presume there are under those burning sands reservoirs of water which can be reached by artesian wells, as in California; and 700 artesian wells, scattered over those plains in the great desert, would make the land fertile. Then planting trees there, it is more than likely that we could create oases in the desert which would bring into that arid country the blessing of a more temperate climate. I do not hesitate to express the opinion that in the sinking of those wells will consist one of the greatest triumphs of engineering in the coming century; and in the results which will follow, one of the greatest triumphs of applied science.

Mr. Becker related the instance of wells in Germany surrounded by trees, which entirely dried up when the trees were cut down. On planting new trees there, on the hills, the water returned, and increased as the trees increased.

Dr. Van der Weyde—The number of rainy days in Egypt has been increased by the planting of trees. And the French have made artesian wells in the deserts of Algeria and created oases there. I do not think we need look to electricity for the cause of the rain. The coolness of the air, in forests, seems to me a much stronger source of the precipitation of water than any mysterious electrical tricks. When warm atmosphere fully charged with moisture comes in the neighborhood of the cool forests, there is, of course, a tendency to precipitation.

Prof. Phin—The difficulty with regard to the theory of coldness is simply this, that in winter plants are invariably warmer than the surrounding atmosphere, and that with the exception of hot days their temperature is always higher. When we have rain, the temperature of forests is always higher. On warm days, when the atmosphere is dry and carrying off the moisture, their temperature is lower; but then we have no rain. On cool days, when we have rain, their temperature is higher.

Dr. Van der Weyde—They are cooler on warm days in consequence of the evaporation; for evaporation is a cooling process. And when they are cooled, they are in a condition to condense the moisture from a current of warm and saturated air.

VII. Delicacy of the Spectrum Analytical Method.

Prof. Roscoe, in a recent lecture "On Spectrum Analysis and its Application to the Bessemer Process of Manufacturing Steel," presented the following table, showing that, in the spectrum analysis method, the delicacy of reaction is something almost beyond belief:

1. *Soda.*—1–3,000,000th of a milligramme or 1–180,000,000th of a grain of soda can be easily detected. Soda is always present in the air. All bodies exposed to the air show the yellow soda line. If a book be dusted near the flame, the soda reaction will be seen.

2. *Lithia.*—1–100,000th of a milligramme of lithia or 1–6,000,000th of a grain can be easily detected. Lithium was only known to occur in four minerals. It is now found, by spectrum analysis, to be one of the most widely distributed elements. It exists in almost all rocks, in sea and river water, in the ashes of most plants, in milk, in human blood, and muscular tissue.

3. *Strontia.*—6–100,000 of a milligramme or 1–1,000,000th of a

grain of strontia is easily detected, and has been shown to exist in very many limestones of various geological ages.

4. *Lime.*—6–100,000th of a milligramme or 1–1,000,000th of a grain of lime can be easily detected.

5. *Cæsium.*—This new alkaline metal was discovered by Bunsen, in the mineral waters of Baden, Durkheim. Its spectrum consists of two bright blue lines. Thirty tons of mineral water yield 100 grains of cæsium.

VIII. THE STRENGTH OF PORTLAND CEMENT.

Mr. John Grant, in a paper recently read before the Institution of Civil Engineers, London, described a series of experiments made by him for the purpose of testing the strength of Portland cement, also the different modes of using cement. A sewer constructed of concrete, consisting of one-seventh cement to six-sevenths of sand, and lined inside with cement, was regarded by him as the cheapest form of sewer, combining strength with soundness. Tables were also given of the strength of 589,271 bushels of Portland cement used during the last five years on various works south of the river Thames, showing an average tensile strain at the end of a week of 806.63 pounds, equal to 358.5 pounds per square inch, being an improvement on that reported five years ago of eighty-nine pounds per square inch. At the end of thirty days, 37,200 bushels of the same cement, ascertained by 1,180 tests, had an average strength of 455 pounds per square inch. Further experience had confirmed the earlier conclusions that the strength of Portland cement increased with its specific gravity, its more perfect pulverization, and its thorough admixture with the minimum quantity of water in forming mortar. Heavy cement, weighing 123 pounds per bushel, took about two years to attain its maximum strength when used pure; but by the admixture of sand or gravel, cement, mortar, or concrete was reduced in strength, and set less rapidly than pure cement. Roman cement, though from its quick setting property very valuable for many purposes, deteriorated after exposure to air before use, about twice as much as Portland cement, if measured by strength. In making cement concrete, it would, from this, seem desirable to spend no more time than was absolutely necessary to effect a thorough admixture of the cement with the sand and gravel.

COMPENSATING CAR-WHEEL.

Mr. W. E. Partridge exhibited and explained a model of W. F. Frayer's compensating railroad car-wheel. The wheel is constructed of two concentric wheels, united together at a point about equi-distant between the rim and the hub, by elastic packing, which takes the jar from the imperfections of the track before it reaches the axle. The outer part of the wheel is chilled iron, and the center is soft iron. The mechanism is very simple, and adapted to preserve the car from jar, and the axle from breaking.

The President — We had before us last year an elastic wheel, intended to accomplish the same end as this.

Mr. J. K. Fisher — Have there been any experiments to determine the force of traction required for this wheel?

Mr. Partridge — I do not know that there have been any experiments; but the theory is that it requires the same force as if the whole interior were of the same substance with the packing. The extra traction, I take it, is just equal to the friction in the spring.

The President — I do not think there is much loss there.

Mr. Fisher — The assumption is that the elasticity of the spring is perfect. I question that perfect elasticity; and I think we need the practical test.

Electricity as a Motive Power.

Dr. L. Bradle resumed the discussion of the subject of the use of electricity as a motive power.

He exhibited a model of a new electro-magnetic motor, made with two pairs of magnets. When the circuit is closed for one magnet of a pair, it is broken for the other. The dead center of one pair of magnets corresponds with the half stroke of the other. He had never been able to recognize the law stated by Professors Phin and Van der Weyde, that the resistance of the coil and the resistance of the battery should be equal. He considered the results by this motor as contradicting that law. He was satisfied that he had obtained altogether better results by putting a good deal more resistance in the magnet than there was in the battery. He was satisfied, also, that inserting an iron core in a spool did not increase the resistance; and he illustrated these several points by experiments. He also exhibited and explained his tangent galvanometer.

Dr. Van der Weyde—A great deal depends on the relation of the size of the wire to the strength of the battery. Again, much depends on the character of the coil. The first layer has more effect, being closer to the iron. Additional windings increase the power, but to a less extent; until finally we reach a point where the windings are so far from the iron that the increase of the magnetism does not compensate for the increase of resistance.

A Vote of Thanks.

This meeting being the last one before the usual summer recess, Prof. James A. Whitney moved a vote of thanks to the Chairman of the Polytechnic Association, for the ability, kindness and impartiality with which he had presided over the association during the past year, which was received with applause, and was seconded by Prof. Van der Weyde. Prof. Whitney, thereupon, asked the association to vote, and the resolution was unanimously adopted.

The Chairman, after expressing his warm acknowledgments for the compliments conveyed to him in the resolution just adopted, added that the great attractiveness of the Polytechnic must be ascribed to the action of the able scientists who have participated in its debates, and have furnished written dissertations on the practicability of proposed improvements, in which the public are supposed to be, for the time, interested, but more especially to the labors of those professors who have delivered lectures on scientific themes, and illustrated them with convincing experiments. The great range of topics introduced in the notes on new discoveries, and the novel devices presented here for examination, have furnished ample opportunity for eliciting valuable opinions from those whose judgments are founded on experience. On examining the annual reports of the operations of the Polytechnic, during the many years he had had the honor of presiding over its deliberations, he had often been profoundly impressed with the ability displayed in its debates, and had been struck with the fact that the light thus thrown on a subject had frequently been the means of harmonizing the apparently conflicting deductions of theory and of practice. He believed he was justified in saying that the always harmonious proceedings of this Society had been regularly increasing in interest and importance, from year to year, up to the present time; and for this gratifying result he must express his great obligations to those gentlemen well versed in science who have assisted the chair. Many of them had already attained high distinction in their respective professions; others had evidently made great progress in the high road to preferment, and nothing would give him greater satisfaction than to learn, hereafter, that the labors of each have won the crown of success.

In conclusion, the Chairman alluded to the fact that meetings of the Polytechnic, once in a month, were held on the same evening with those of the Institute, and therefore suggested that another evening of the week be selected for the meeting of the Polytechnic.

On motion, it was resolved that the committee in charge be requested to make this change.

On motion, the Association adjourned to meet in the fall, at the call of the Chairman.

October 12, 1871.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

The Polytechnic Association resumed its weekly meetings, after the summer vacation, and was called to order at half past seven P. M. by the Chairman, who delivered the following opening address:

Gentlemen of the Polytechnic Association.—The presence of so many of those who have long been identified with the prosperity of this Society, at this our first autumnal meeting, gives renewed assurance that our discussions of questions relating to applied science are deemed important, and that they are to be conducted with the same candor and acumen which have hitherto characterized our proceedings. Nearly seventeen years have elapsed since this branch of the American Institute commenced its sessions. At first its proceedings were wholly conversational, various improvements in the mechanic arts being the subjects which attracted most attention. In March 1859, while on the committee having charge of the organization, I proposed that greater latitude be given to discussion, and to accomplish that end I offered a resolution that its name be changed from "the Mechanic Club" to "the Polytechnic Association" which was adopted. From that time chemistry, as well as mechanics, furnished topics for discussion, and the dignity of our proceedings has been raised by the frequent introduction of able and exhaustive papers on questions relating to abstract as well as applied science.

While it is admitted that the present plan of free discussion on every new topic or invention which may be introduced has resulted advantageously, there are many who believe that the influence of the Polytechnic would be greatly increased if a portion of each evening could be set apart for a lecture or a paper by some prominent scientist. It is therefore proposed that the standing committee of the Institute, having charge of this organization, select from a large number of names, to be presented to them, lecturers for the coming season, and that a programme of this course of weekly lectures be printed on cards to be distributed among the members of the Polytechnic and others who might thus be induced to become regular attendants.

As the monthly meetings of the Institute are held on Thursday evening, it is proposed that the Polytechnic meet on some other evening, so that its weekly sessions may be held without interruptions. In making this change the standing committee would doubtless be guided by the wishes of the association.

During our recess I had the pleasure of attending the meeting of the American Association for the Advancement of Science, at Indianapolis, in August. The attendance was large. Nearly 100 papers were read. Some of the most important of these, when printed in full, will be presented for your examination. It will be gratifying to many here to learn that several members of this body bore prominent parts in the deliberations of the sections devoted to physics and chemistry. From the pleasant recollections of that association, whose highest aim is to ascertain the laws of the material universe, I turn with sadness to review the terrible consequences which have lately resulted from a disregard of some of those laws already well known.

On the 30th of July the "Westfield," a ferry boat plying between New York and Staten Island, was lying at her slip in this city, filled with passengers and ready to start, when her boiler exploded, causing the death of 100 human beings and the wounding of about as many more. The cause of this disaster, I hope, will be made the subject of your careful deliberation. No society has published more than this, on the causes of boiler explosions, or done more by discussions to prevent the occurrence of such disasters. Your warnings against the danger of using weak or defective boilers must be many times repeated before the public are fully aroused to the importance of greater safeguards in the use of steam.

Another subject to which this association has devoted much attention is the danger to be apprehended from the use of those hydrocarbons, the products of oil wells, which vaporize at a very low degree of heat. Rumor says the upsetting of a petroleum lamp, and the explosion of its contents among the combustible materials of a stable, was the commencement of the most disastrous conflagration of which we have any record, and which has resulted in the complete destruction of nearly all the business portion of the city of Chicago, involving her merchants in one common ruin, and carrying its calamitous effects to almost every part of the commercial world. An unusual combination of causes tended to increase the area of that fire until it was beyond human control, and then was seen, on the grandest and most terrific scale, the operation of one of the simplest and best known chemical laws in the rapid combination of the oxygen of common air with combustibles already heated to the point of ignition.

In this enlightened age we do not connect the disasters resulting from the operation of natural laws with the sins of those who have suffered by such disaster, yet every injury which arises from a disregard of the immutable laws appertaining to matter should be received as a Divine admonition; and in the sad case alluded to, the lesson taught us is, that combustible materials cannot be used with safety in the construction of compact rows of dwellings, shops and warehouses. If buildings are brought into close proximity, safety from general conflagration can only be insured by the use of materials in their construction which are absolutely fire-proof. The discussion of this important question will doubtless be renewed in this Society. In the meantime let us remember that, although a violation of physical laws often involves us in evils, the laws are the dictates of infinite wisdom, and that obedience to them has rapidly developed the material greatness of our race.

The Chairman then introduced Prof. James A. Whitney, who had recently visited California, and who read a paper entitled

A Day at the Comstock Lode.

By Prof. James A. Whitney.

The Comstock Lode, over which are built the permanent mining camps of Virginia City and Gold Hill, was discovered about twelve years ago. Since then, it has yielded more than $120,000,000 in silver bars, and the shafts sunk in it are among the deepest on the continent. Its out-crop is in one of the many mountain defiles in the barren portions of Nevada, and twenty-one miles south of Reno, on the Pacific railway, from which it is reached by stage. The coaches start from Reno at one o'clock in the morning, and reach Virginia City about five. Returning, they leave Virginia City at half after seven in the evening, and reach Reno in time to connect with the train bound west. This, a few weeks since, enabled me to turn aside from my direct route for twenty-four hours to visit the famous silver deposits, and the trip gave me as much of interest and information as one could well compress within the experience of a single day.

Several stages start from Reno nearly simultaneously, keeping about a quarter of a mile apart to avoid each other's dust. They are commonly crowded; three seats, with three passengers to a seat, and half a dozen more on top. Taking an inside place, I soon found the coach in motion at something more than six miles an hour. In a few minutes we rattled over a wooden bridge thrown across the Truckee, and for a little while the side lamps threw their light on fences along either side the road, sure indexes of tilled fields made green and fruitful by the irrigating waters of the little river. Soon, however, the fences disappeared, and we saw nothing but the clusters of sage brush, the powerful, half-aromatic, and not unpleasant odor of which filled the air. The sage brush is the only vegetation found in this region, except where, in a very few places, and these of small area, some oozing spring or small stream moistens the loose, dry soil. This curious plant, when young, presents a rather pretty appearance, growing in bunches about fifteen inches high, and from ten to eighteen across. It has a gray or silvery color; something like that of garden sage, which has undoubtedly led to its name of sage brush. Its taste is intensely bitter, and it probably contains a strong and peculiarly essential principle, the virtue of which is shown in the only known use of the plant, a specific for, I believe, the ague. When urged by hunger, however, cattle will eat it, and its bitter herbage has more than once saved emigrant trains that otherwise would have perished in the desert.

The stages have a down-hill road for about one-half the distance, and on reaching the "foot of the grade," as it is termed, they stop to change horses. The scene at this point was picturesque and peculiar to the country. Many teams were picketed before heaps of forage placed upon the ground, the craunching of the animals' jaws being distinctly heard even at some little distance in the still night air. The drivers and hostlers of the previous relay were lying wrapped in blankets and sleeping calmly under the starlit sky. We moved but slowly the remainder of the distance, so that the gray dawn found us still three or four miles from our destination. Here we saw, more plainly than in the night, the region through which we passed; often deep, naked gorges at one side of the road, while on the other the steep, sage-dotted slopes of the mountains rose hundreds of feet above. At last, after descending a short reach of down grade, we came into Virginia City, and alighted at the only hotel in the place. Finding that a room could not be obtained until one was vacated by the occupant of the night just ended, which was not likely to occur in less than an hour and a half, I started on a preliminary stroll about the village.

Virginia City is situate at the lower part of the eastern side of a high hill, or rather mountain, of rounded contour, and with a steep surface dotted with the sage plant. The slope is scarred with prospect holes or excavations made in search of ore. These are indicated by the heaps of earth thrown up at their mouths; most of them are only a few feet in depth, but some appear to extend inward from fifty to one hundred yards. Looking down upon the settlement, its farther limit is seen in an irregular line of large buildings erected over the shafts sunk in the lode. The streets run nearly parallel with the direction of the latter, but are at different elevations, forming, as it were, a rude system of terraces. The dwellings are small. All the structures are of wood, and this, coupled with the want of water in any considerable quantity, renders conflagration so frequent that insurance companies no longer take risks in the place. While clambering up the steep I beheld a scene that to me was possessed of a strange and peculiar beauty. The rising sun had been hidden behind the mountain to the east, so that I climbed in shadow, until, stepping a few few feet higher, it came suddenly into view as if it had shot up into the sky in an instant. The dry atmosphere of this arid region made the sun look broad and red, as we see it sometimes at its setting, and the sight of its marvelous splendor, as it flamed above the bare and desolate peaks, was worth tenfold the whole discomfort of the trip. Descending to the hotel I found refreshment, in breakfast and in two hours of sleep, and then set out on foot for Gold Hill.

Just as I started I had a view of one of the "wagon trains," on which much of the freight conveyed over the ordinary road is brought. Three wagons, very large and strong, were connected one behind another, and to the foremost were attached four mule teams, with a pair of horses ahead for leaders. These last had bells attached by wooden bows above their harness collars. The mules are taught to start simultaneously at the tinkling of the bells at the first movement of the horses, which causes the entire strength of the animals to be applied all at once to their work. The advantage of using several wagons arranged as just described, instead of placing the whole load upon one, is, that in starting the foremost wagon is first moved, then the second, and after that the third, so that, the entire draught power being applied to separately overcome the inertia of each wagon, much heavier loads can be started from a state of rest than could be done if the entire weight had to be started at one and the same moment, or if the same number of draught animals were divided up among the wagons and the latter run singly. These trains carry immense loads, as much as twenty tons being sometimes transported upon one of them.

Gold Hill, although separately named, is substantially continuous with Virginia City, and really forms part of the same settlement. About a mile south of Virginia the defile deepens into a bow-like gorge, much below the level of the place last mentioned, and in and around this are the buildings comprised in Gold Hill. There is, I believe, a difference in the character of the lode at the two points, the northern or Virginia City portion growing narrower as it descends, so that its transverse section is of wedge-like shape, while at its southern or Gold Hill end no diminution of its diameter is apparent at any depth. I have spoken of both localities as permanent mining camps, and they are nothing else. The narrow, upturned edge of the argentiferous rock was found extending a distance of two miles in a gorge between the mountains. Claims were staked off, each covering more or less of the length of the ledge, and each foot of this length was divided into twenty shares. Companies were organized, and each claim, the location of a mine, was pierced with a vertical shaft, over the mouth of which was raised a building to protect the machinery employed. At the same time board houses for the miners, traders and others were put up. In the course of events several churches and school-houses were provided, and in this way the two villages, as they now exist, were formed.

Arrived at Gold Hill, I made myself known to Capt. Thomas Y. Taylor, president of the company owning the Yellow Jacket silver mine, which had been described to me as affording one of the finest examples of the mining enterprise of the district. He promptly volunteered to show me the entire establishment, commencing with the building above the shaft, containing the machinery used in hoisting the ore, and also various other mechanical adjuncts of the works.

To sink the shaft is always the first thing done in opening a mine. Here, on the Comstock Lode, it is essential to wall it with heavy squared timbers, fourteen inches thick, in order to keep the sides from bulging inward under the enormous pressure of superincumbent rock. Nearest the top one thickness of such timber suffices, but a few hundred feet below the surface two courses are necessary, making the lining twenty-eight inches of solid timber. The available space or internal diameter is about six feet square. Here, in the Yellow Jacket, two cages, which would be called elevators anywhere else, run up and down within the shaft to lift the ore, and also to carry the miners to and from their work. The cages differ in construction from those used in the other mines in the neighborhood in being made with two floors or stories, one above the other, so that two ore cars instead of one can be raised at a time. By this means each hoist brings up 2,800 pounds of ore instead of 1,400 pounds, and the expense of this part of the work is diminished in a proportionate degree. Each cage is of wrought iron, of skeleton form, to secure lightness, and is attached to the end of a flat steel-wire rope, four inches wide and three-eighths of an inch thick. These ropes have each a breaking strength of fifty tons. They run upon sheaves nine feet in diameter, arranged immediately over the shaft, and with their bearings in the timbers of the roof, which is trussed to sustain the weight brought upon it in the hoisting operations. From its sheave the rope of each apparatus extends to a winding reel, to which its opposite end is attached, so that the reel, when turning in one direction, will wind the rope to elevate the cage, and, when rotated the opposite way, will release the rope to permit the cage to descend. The circular rims of the reels are fourteen feet in diameter, with radially projecting arms to prevent lateral displacement. The axle shaft of the reels connects by large spur wheels with a driving shaft, itself driven by the hoisting engines—two connected horizontal ones, with ordinary slide valves and link motion for reversing. These are employed for lifting; but in the descent of the cage, the engine power is disconnected from the driving shaft by the movement of a clutch—the speed of the cage in going down being regulated by a brake applied to the driving shaft and under the control of an attendant. The hoisting of the ore is, therefore, superintended by the engineer and the descent of the cages by a brakeman. The driving shaft has connected with it a system of gearing that gives axial motion to a vertical rod, that, in its turn, actuates an index finger placed in suitable relation with a dial. The parts are so adjusted that the index shows the exact position of the cage at any depth in the shaft, so that the engineer or his assistant may know at a glance the precise whereabouts of the cage, although it be out of sight and hundreds of feet below. The derrick is also furnished with an alarm, which rings when the cage rises to within 100 feet of the surface. The shaft has a signal rope extending from top to bottom, by which a passenger on the cages can signal the engineer to stop at any desired point. It will be seen that the shaft being made to secure access to the ore, and the hoisting apparatus to bring it out of the mine, it remains to come within immediate reach of the material, and to break it from its place. This is done by running horizontal galleries, tunnels or drifts radially, in different directions from the shaft. Each system of drifts is called a level, and the levels are 100 feet, more or less, apart, one below another. Whenever a drift strikes a large deposit of rich ore, the latter is removed until the drift is enlarged into an immense cavern. From the conformation of the lode, however, the vertical shaft and the ramifying drifts of the levels starting therefrom cannot fulfill all the requisites essential in the workings. The ledge of silver-bearing rock lies in an inclined position, having a dip or slope of forty-five degrees toward the east, a hard syenite below and a softer material above it. When the shaft reached the depth of 1,150 feet it struck the syenite. Instead of piercing this refractory and worthless rock by continuing the shaft vertically, and then running drifts horizontally, to get back to the ore, the manifestly better course was taken of running an inclined tunnel following the angle of the ledge and communicating with the bottom of the shaft. This sloping tunnel, like the horizontal ones in the levels, has a railway track, but the car, instead of being run by hand, is worked up and down by a wire rope, extending up the shaft to the surface, and then, like those that operate the cages, over a sheave to a reel which is operated by a separate engine. The driving shaft which communicates motion from the engine to this last indicated reel has also an indicator for showing the position of the car at any portion of the incline, there being further provided the whole length of the latter a wire that works a signal at the surface, so that the car can be stopped, if necessary, at any point. A general idea of the subterranean workings in the mines may therefore be had by imagining a timber-lined shaft or well extending down 1,150 feet into the earth, with horizontal tunnel radiating from it at different depths, ramifying in various directions through the rock, and sometimes expanding into huge caverns where the ore has been found of unusual richness and in large quantities. From the foot of the shaft extends a tunnel of about the same diameter as the shaft itself, and sloping down at an angle of forty-five degrees for a distance of 200 feet or thereabout. As the mines are all located on the same lode, they are, of course, divided only by imaginary lines, their drifts connecting so that parties may pass directly from one mine into another, the ledge being honeycombed by the tunnels. The caverns caused by the excavations, as just mentioned, must not be considered clear spaces hollowed out within the rock. It is true the ore is all removed, but in its place heavy timbers, closer and stronger than any railway trestle work, are framed in to prevent the fall of rock, which, were this precaution neglected, might at any moment involve whole gangs of miners in destruction. As the excavations are carried deeper, the want of fresh air is more and more serious, and to supply the deficiency, iron pipes, zinced or galvanized, are extended to the lowest recesses, and air-blasts are driven through them from a rotary blower at the surface, operated by a separate engine. Still another engine is devoted to working the pumps by which the little water in the mine is lifted. This water, I may remark, is somewhat impregnated with sulphuric acid, derived by oxydation from the sulphuret of the silver-bearing rock, and producing considerable mischief by corroding the metal air and water conduits.

After making notes of the details just set forth, I followed the example of my conductor, in exchanging ordinary garments for a blue flannel shirt and overalls, and then stepped with him upon one of the cages. Down we went into the darkness, only dimly illuminated by the red gleam of the lantern we carried. At stages a flash of light showed us where a level opened into the shaft, with the men trolling iron ore-cars to and from the farthest corners of the subterranean passage ways and chambers. Soon we reached the lowest level, 1,130 feet below the surface and twenty feet above the extreme perpendicular depth of the shaft. Here we paused to look down, but not to descend, the incline. We then entered a drift, where the miners were busily at work loading the cars with the broken ore dislodged by a previous blast, and running them to their outlet at the shaft. The heat here was terrific; 110 degrees, said the captain, and I needed no thermometer to confirm my belief in the assertion. The miners work naked to the waist, an old pair of pantaloons, quite frequently deficient in the matter of legs, being the only article of raiment common among them while toiling in the steaming atmosphere. These miners, who, in physique and demeanor, compare favorably with an equal number of laboring men anywhere, are mostly Cornishmen. They are paid four dollars in gold per day, and this high rate of wages being known abroad brings to the Nevada mines the best and most adventurous of the class. There are from 1,500 to 2,000 miners, I was told, employed underground in the ledge. Arrived at the foot of the shaft and at the entrance of the lower level extending therefrom, the first thing noticed was the tracks laid upon the floor or bottom of each drift, and the construction of the ore-cars running upon them. The tracks have a gauge of about twenty inches. The rails are not mere iron straps or bars, laid upon wooden sills, as I have seen them in other mines, but miniature rails of the most approved pattern used for above-ground railroads, from which they differ only in size—being very light. The cars are made with flanged wheels to fit the rails, and their axles are journaled in the angle-iron side pieces, which, connected by wrought iron plates, constitute the running gear or framing of the truck upon which the box or body of the car is placed. The latter is so connected to the truck, or wheeled lower portion of the car, that it can be readily tilted back to discharge the load, the rearmost end of the body being hinged at top and held in place by a catch at bottom. This enables the end to swing outward, and allow the "dumping" of the load when the car is brought to its destination at the surface. Great improvements have, of late years, been made in these cars, their weight having been reduced about forty pounds by the judicious use of wrought iron in their construction. This, of course, reduces the weight lifted at each hoist to the extent of eighty pounds. It is proposed to secure this advantage in a still greater degree by using steel in lieu of iron.

After this examination of the means employed in the subterrene, and transporting the material, we continued on our way in a northerly direction, and reached, 400 feet from the shaft, a cross-cut from the east, which communicates with the tunnels of the old north mine, as it is called. The shaft of the latter, a thousand feet north of the one now used, has been given up, its only present purpose being to assist the ventilation of the workings. As we pass the cross-cut, the cool fresh air coming in gives, for a moment, a sense of grateful relief. After going on about a hundred feet farther we retraced our steps, and going in southerly passed quite out of the Yellow Jacket into and through the Kentucky, ninety-three feet, and then into a "slope" in the Crown Point. This slope is a horizontal bed from which ore, of a very rich quality, is taken. The deposit has an average width of sixty feet, a length of two hundred and thirty, and an ascertained depth of at least two hundred. How much deeper it may be is unknown. Its discovery, some months ago, raised the stock from three dollars per share to three hundred, as I was informed; and no wonder, for in a period of ninety days it enabled the owners to divide among them forty dollars to the share. Here I saw a fine example of the manner in which, in all these mines, the excavations are filled in as the quartz is taken out, the fourteen-inch timbers intersecting each other in squares six feet across. The quantity of lumber, which is all pine or fir, required for such purposes may be estimated from that used in the Yellow Jacket alone—240,000 feet per month. From the Crown Point we entered the Belcher, the next adjoining mine on the south. Here we saw what had by this time become somewhat familiar, the operation of drilling preparatory to blasting, loading and running the cars, etc. By some mutual understanding, the ore from the lower drifts of this mine is taken to and hoisted from the Yellow Jacket shaft, that of the Belcher being, as yet, but 700 feet deep. Here the drift has been run into rock, paying about forty dollars to the ton. It cost about twenty dollars a ton to mine and mill; on that, one-half the yield, even of this comparatively poor rock, is profit. A new "breast," opening out from the side of the drift, three or four feet above the floor of the latter, was under way, and, to see all that was to be seen, I climbed up into it, but saw only the same routine of toil witnessed in other parts of the lode. For a long time the ore of the Belcher was so lean that the mine was believed to be worthless, another illustration of the vicissitudes which such enterprises frequently undergo. Returning to the Crown Point, we sat down to rest where one of the drift bisects the incline of the last named mine. The incline, as previously explained, is simply an inclined continuation of the shaft following down the dip of the lode, but in the present instance, for some reason or other, the angle is thirty-six degrees instead of forty-five degrees. In other respects it corresponds with the Yellow Jacket incline, except that a round hemp rope, instead of a flat steel one, is used for operating the car that runs up and down. It had, moreover, a rude lifting pump for drawing water from the bottom, and placed at the same angle from the horizontal. Its reciprocating piston-rod moved on pulleys arranged underneath to support it, and was operated by some motive power that I did not see. Its dull sound, as the piston moved slowly to and fro, mingling with the intermittent gush of the water, was dismal enough in the dim caverns. From here, nearly by the way we came, we went back to the foot of the Yellow Jacket shaft, through which on the cage we rode to the surface at the rate of 900 feet in a minute. But at this point let us trace the course of ore from its bed, until it awaits transport by rail to the mills at Carson, sixteen miles distant, where there is water enough for the purpose.

The rock blasted from, or rather in, the drifts, radiating from the vertical shaft is placed at once in the small cars that run upon the narrow tracks; these cars, when laden, being pushed by two men to the shaft and upon one of the cages, one car on the lower and another on the upper floor, which is performed by raising or lowering the cage, as the case requires, to bring its floors successively in range with the cars. These are then hoisted to the surface, where they are moved by manual power upon one or the other of two narrow tracks, according to which of the two cages is used for hoisting, these tracks leading out upon a trestle, extending horizontally from the steep hill-side upon which the building is situated. It is from 250 to 300 feet long, and its outer end about fifty feet from the ground below. Its top is floored with planks, upon which are laid the two tracks, corresponding in rails and gauge to those in the drifts, but there is an opening in the floor at the outer end of each track, and immediately below there is a large wooden receiver, capable of holding 350 tons of ore. As the cars are run out to the end of the trestle they are empted through the openings, their contents falling into the receiver below. This has its bottom placed at an angle of 45° with chutes at the lowermost part, through which the rock may be conducted direct into freight cars on the railroad track beneath, which connects the mines with Carson. The rock excavated from the foot of the incline and the drifts, extending from the latter, is brought up to the foot of the shaft in the car which, by a wire-rope, runs up and down on the sloping track. This is so contrived that as soon as it reaches the top of this track it is automatically empted into a receiver provided for the purpose, and which, like the large receiver above ground, has a sloping bottom upon which the broken ore descends by its own weight to lateral outlet chutes. From these chutes, when opened, the material falls into the cars used in the upper levels, which are then placed on the cages and brought to the discharge openings in the trestle, in the same manner as those from the other or higher drifts.

Before proceeding to examine a stamp-mill and amalgamating works in the immediate neighborhood, which, though small, were stated to be the same in their methods of operation as the larger establishments, in which almost the whole of the ore from the lode is worked up, I took occasion to note some adjuncts, worthy of attention, of the boilers which supply steam to the engines; and one or two other items about the works.

The steam generators are of the tubular kind and six in number, set in pairs, and so connected that one or more can be used according as greater or less power is required. Their forward or furnace ends are arranged in line, and in front of them runs a short length of railway track. At one end of this is an elevator, having a vertical movement of about sixty feet. The wood used for fuel is all brought by rail from Carson, sixteen miles away, and the track which brings it to the works runs upon the slope at the height just indicated above the floor of the building. The wood from the freight train, therefore, is placed in a rude kind of car or box, say six feet long, four wide and three deep, and mounted on small cast-iron wheels, this car being on the elevator. When the car is filled, it is let down to the floor and run out along the track in front of the boilers, the furnaces of which, from the immediate contiguity of the fall, are thus very conveniently fed. Formerly the wood was simply thrown down into the building from the freight cars, and the amount of kindling material produced thereby is spoken of as something amazing. At some little distance from the boilers is an apparatus comprising a wooden tank, two feet wide, two deep and twenty long, with a drum at each end about twenty-four inches in diameter. This is used in an operation to which the wire ropes are subjected once a month, for the double purpose of preventing corrosion and of keeping them in a supple and flexile condition. The rope, when under treatment, is wound upon one drum, with one end-portion extending through the trough and attached to the other drum. The latter being rotated, draws the rope longitudinally through the trough, the rope unwinding from the first drum as fast as wound upon the second. The trough is half or two-thirds filled with hot tar, with which has been incorporated about five per cent, by volume, of tallow. While the rope is passing through the mixture, an operator scrubs it thoroughly with a wire-brush, thus forcing the material well among the strands or metal fibers. Of course, this provides an air-and-water-proof coating, the lubricating character of which, furthermore, enables the strands to move more easily when bent upon each other, thereby very much reducing the wear and abrasion incident to use. Near by, also, is the blacksmith shop, devoted to the making and repair of the iron work required about the establishment, and employing six men in the daytime and two at night. Being above ground, it differed little from any ordinary smithy, and I mentally remarked the contrast, in point of picturesqueness, between it and the blacksmith shop I saw a year or two since in the New Almader quicksilver mine, in California. That was two hundred and fifty feet below the surface, and was approached through five times that length of subterranean ways. The fires of two forges lit with a dull glow the gray rock, veined with crimson cinnabar streaks, and the sparks from two anvils showered around the brawny smiths, until they seemed veritable sons of Vulcan. In this as in that of the Yellow Jacket, and indeed of almost all well conducted mines, the smiths work in alternate parties, the fire on the forges being seldom extinguished from one month's end to another.

The stamp-mill, to which I have already referred, is about three minutes' walk from the Yellow Jacket, with which, however, I believe it has no business connection. The ore, broken to about the average size of paving stones, but of angular and irregular form, lay in a heap as it had come from the mine. Two Chinamen, with long-handled hammers, were breaking it to an egg size; this being about the only kind of labor to which, in the manipulation of the ore, the almond-eyed foreigners are found adapted, as the underground work is too severe for them. The broken rock is thrown into the mill, which, in this case, had ten stamps. The stamps are simply iron pestles fitted on the lower ends of vertically-moving shafts, which have collars upon them, under which move cams provided on a transverse shaft. The rotation of the last causes the cams to lift the stamps a certain distance, and then, the cams slipping past the collars, let the stamps descend upon the material placed in a strong rectangular receptacle, or, so to speak, a mortar arranged underneath. A stream of water enters the mortar at one side, and flows out at the other through a sieve. This sieve retains the coarsely-broken rock in position under the stamps, but allows the finer particles to be carried out continually by the water into a shallow tank. Here the floured ore sinks to the bottom as a muddy sediment, which is transferred, mingled with a quantity of water, to the amalgamator. This is an iron mill, the lower plate or grinding surface of which is stationary, while the upper one revolves, inclined blades or guides being so arranged within the surrounding case that, as the semi-fluid mass is thrown outward from between the edges of the two plates, it is swirled back over the uppermost, and passes down through an opening in its center to be subjected to a repetition of the operation. After about five hours of this treatment, the mass is ready for the quicksilver, which is added in the proportion of 200 pounds to five tons of ore. The grinding is continued for a couple of hours longer, by which time it is assumed that the amalgamation, otherwise the combination of the silver with the quicksilver, is well-nigh complete. The contents of the grinders are then transferred to what are called "settlers," circular tanks with revolving mullers inside similar to the grinding devices of the preceding apparatus. The muller keeps the mass in constant agitation, during which the amalgam, together with the uncombined mercury, sinks to the bottom, whence both are drawn off by a siphon, and then placed in a long and narrow wash-leather sack. By applying pressure to this sack the free mercury is strained out, and the remaining amalgam, having about the consistence of putty, but with less coherence and an unctuous feel, is transferred to the retorting apparatus. This is a horizontal iron cylinder set in brick-work, with a furnace underneath. A pipe from the rearmost end of the cylinder extends downward to an oblong trough of water, and then horizontally through the same, and finally out at the end. The heat of the furnace volatilizes the quicksilver, which sublimes over into the pipe, is condensed as it passes through the portion immersed in the water, and flows out into any suitable vessel placed to receive it. The precious metal, meanwhile, is left behind, in a state of greater or less purity, in the cylindrical body of the retort, from which it is taken and sent to the mint at Carson for assay and coining.

The twilight was drawing near when my examination was completed, and, shaking hands with the courteous captain, I took the omnibus that runs at uncertain intervals between Gold Hill and Virginia. Here I was unwittingly given an idea of what is, perhaps, the prevailing phase of society in the locality, by the conversation between two young girls, one apparently about fourteen, and who would have been called beautiful even in an eastern city, and the other not more than two years her senior. Both were tastefully dressed, and modest, though with an air of unconstraint, as if subject to slight control. Their talk turned upon an evening party of the week before that had ended in a fray, and at which the brother of one of them had been wounded by a pistol shot. The story was told and commented upon with a strangely realistic simplicity and *naivete* that plainly pictured the wild attributes of life in these border regions, including, in scope, all that is symbolized by the glee of the dance or the hot words of wrath, the soft voices of women or the crack of revolvers. But I found here among these people, miners, workmen, teamsters, a rough politeness, a rude good nature, a blunt kindliness of manner, that makes the memory of them very far from an unpleasant one. Of these characteristics I found a good example in a boisterous son of Erin, who, on the return, shared with me the back seat of the stage, and who, although he took three square drinks of raw whisky during the half hour before the coach started, voluntarily subjected himself to some little self-denial and inconvenience to make the tedious night journey more comfortable to the stranger from the east. Reaching Reno a little past midnight, an hour later found me with closed eyelids in the berth of a sleeping car, and when I awoke the sun had been shining, for two hours at least, upon the pine covered heights and depths of the Sierra, through which we were passing. At noon, at Sacramento, I took the boat, and through the long afternoon watched the banks of the narrow, yellow river, lined with bushes that shut off the view of the golden stubble fields beyond, and finally merged into the edges of the Tule lands. These are low-lying, level tracts of great extent, and covered with a vegetation that, at a distance, looks like tall and waving corn, but is, in reality, only a kind of flag; something the same as that which grows on moist ground in New England, but twice as high and far more thrifty. Were these flag-covered fens diked and drained, as they will be some day, they would make fields among the finest in California, for their soil is unrivaled in fertility, and they would know no lack of water such as has, the past summer, made the famed valley of the San Joaquin like a bed of ashes. Slowly the Tules receded from the sight, as the low pressure engine, carrying but twenty pounds of steam, steadily drove the boat out upon the broad-reaching waters of the bay. Here, as I remember, just as the sun went down, a stern-wheel steamer, of odd shape and swift motion, passed us, throwing a distorted and fantastic shadow upon the low, wide waves. A few minutes after ten o'clock we came to the wharf at San Francisco, and I had reached the western limit of my tour.

Dr. Feuchtwanger—Our friend has given us a very glowing and graphic account of the silver mining in Nevada. I have been delighted with it, because it recalls to my memory what I witnessed in the same region eight years ago. But he has omitted to mention the fact that the matrix of the silver ore is a white limestone, which looks like snow.

The thanks of the association were tendered to Prof. Whitney for his interesting paper.

The Secretary read the following paper:

TILGHMAN'S SAND-BLAST FOR CUTTING GLASS OR STONE.

By ROBERT WEIR, C. E.

A new invention by B. C. Tilghman, Esq., of Philadelphia, known as "Tilghman's sand-blast," for cutting stone, glass or any hard substances, of such a nature, is now being exhibited at the American Institute fair, and from its simplicity and quick action this process will be sought after and applied to many purposes in engineering and the arts, which may not at first occur to our minds.

It may well be said there is nothing new under the sun, when we see the marvelous results of Tilghman's process; for here has a man made use of one of nature's most common and constant actions in the way of lifting or driving the sand with the winds or waters, and wearing or cutting away the hardest substances. In this process the action of ages is merely concentrated by artificial means—and the wonder is, why has nature remained so long without imitators—in an action of elements against which constructors and engineers are forever fighting.

Mr. Tilghman first applied a jet of sand driven by high pressure steam to cut stone, but later experiments have proved that the work can be done with an air blast of lighter pressure, and excellent results have been obtained from a current of air caused by a fan blower.

The machine now exhibiting at the fair consists of a hopper or elevated box, which is supplied with sand and a flexible blast-pipe, for the air or steam. The sand which is supplied to the receiving hopper dry, is conveyed from thence through a flexible tube terminating into a smaller tube of metal, which passes through a larger chamber or tube through which the supply of air or steam is admitted. This part of the machine may be called the ejector, and is made of metal. The sand falling through the flexible tube into the smaller metal tube is carried about four inches past the entrance of the air-blast; here the air-blast tube is contracted and carried several inches further down, so that the sand falling through the inner tube is met by the blast of air or steam, and mingling with it, is driven forward from the nozzle, striking with great force against the surface to be cut.

The flexible sand and blast tubes allow motion and direction to be given to the nozzle, and thus the surface to be cut need not be limited. In the machine above described, an air-blast is used with a pressure of from seventy to seventy-five pounds per square inch, though this extreme pressure is not necessary for ordinary use, or to illustrate the perfect action of the invention.

A machine has been made to supply a blast of sand and air from a simple fan-wheel. A quart of sand can be thrown into this machine, and the surface to be frosted or cut is placed on a sliding table under the broad nozzle of the blast; the whole is then closed up and the fan revolved. The sand is drawn into the air current in the center of the fan and forced up and around through the flat channel or nozzle against the surface to be cut; at the same time the table slowly moves across the blast, keeping the material about an inch from it. A few seconds of exposure will completely destroy the smooth surface of a sheet of glass and give it a beautiful frosted appearance; or if a design has been previously made upon the glass with paint, paper or thin gum cloth, all the interstices where the surface of the glass would be exposed will be cut, while the covered portion will be left untouched. The sand in the machine is used over and over again as fast as it has done its work, falling from the plate into the fan, and is kept constantly circulating. The pressure of this blast is not much more than two or three ounces to the square inch. A pattern or design, or stencil, as it may be called, is made of india rubber cloth, or of paper, or the design may be painted on the surface to be cut; the sand striking these materials, which are elastic, rebounds, while it cuts into the hard surface of the stone or glass. In many cases which were tried with the use of high-pressure steam or air, a cast-iron register front was used as a pattern; a plate of glass three-eighths of an inch thick and about fourteen inches square was cut through in fourteen minutes.

Woods of all kinds can also be cut or embossed, and for making large letters or type for printing, this process will be expeditious; the harder the wood the more perfectly does the material cut. It may readily be applied to the cutting out of coal; its effect on such a mineral would be like a jet of steam or hot water on ice, only to cut coal with the sand-blast would be far more economical than to fuse ice with steam. For cleaning or frosting silver this process will save much time and expense. For cleaning castings, and preparing metals for tinning or soldering, it is marvelously efficient. In its effect on glass almost anything can be accomplished, from the cutting of a fine engraving to the coarsest open scroll work; even steel cannot withstand its subtle action. In stone-cutting and ornamentation the process is invaluable; for, figuring or lettering in relief, the stone-cutter must exercise the greatest care and patience, while this machine will accomplish in half an hour what it now takes a man a week or ten days to do. Prof. Coleman Sellers has written a very interesting article on this process, which was published some months ago in the Journal of the Franklin Institute. He mentions many curious facts in regard to the action of the sand-blast on a variety of surface. To illustrate the extremes of its action, he states that, with a current of air of light velocity, very delicate materials, such as the green leaves of the fern, will resist the impinging of the sand long enough to allow of their outlines to be beautifully engraved on glass, and that the exposure can be so graduated that the thin parts of the leaves may be cut through, while the veins and branches of the leaves resist, so that a fine shaded engraving of the leaf is made; while with a high velocity of steam, quartz sand will cut any substance harder than itself. With a jet of 300 lbs. pressure, a hole was cut through a piece of corundum, which is next to the diamond in hardness, one and a half inches in diameter and one and a half inches thick, in twenty-five minutes. Where templates or patterns of metal are used, the blows of the impinging sand soon cause the metal to curl up as though under the blows of a planing hammer, even hardened steel being affected in this way. Fine lace will leave its design upon the surface of glass most perfectly, and the lace patterns cut in paper make excellent work.

In examining the action of the sand-blast upon the glass with a microscope, it is found to have a more uniform surface than is left by the rubbing or grinding process to accomplish the same end. At the point cut by the sand in the blast a reddish light is seen, caused probably by the crushing or cutting action of the sharp particles. It may be suggested that the dust from the cut materials will be very injurious to the workmen employed about the machines; but this can be easily obviated by using the sand and dust as in the smaller machines, or where a high-pressure blast is used, as is now in operation at the fair, a fan blower can draw the spent material from the surface of the work and keep the stream constantly returning to the hopper.

Mr. Weir exhibited specimens of work done by this process at the fair of the American Institute.

Mr. J. K. Fisher inquired whether the process could be applied for drilling stone.

Mr. Weir stated that it could be used for splitting stone, by cutting a groove into which wedges could be driven.

Mr. Disturnell inquired whether it could be used for dividing masses of copper.

Mr. Weir—No, sir; it would cut a diamond sooner than copper. Copper is so soft that it is a good material for a template.

Dr. Feuchtwanger, conceding the fineness of the photograph etched by this process, said that he could do it equally well in a quarter of a minute by hydrofluoric acid.

Mr. Weir—It took but six or eight seconds to do this, with a pressure of only about two ounces to the inch.

Mr. Fisher—Can glass be depolished for windows by this process, economically?

Mr. Weir—It is a very simple thing to do, but I do not know how much it would cost.

Mr. Disturnell—I was in hopes this could be used for disintegrating copper, or dividing the masses, which is now done by a very expensive process. If human skill can invent any process for disintegrating those masses, it will be invaluable.

Mr. Weir—The sand-blast will not do it. It is resisted by india rubber, paper, or anything soft or elastic.

Dr. Feuchtwanger—It must be the sharp sand that is used.

Mr. Weir—It is river sand; and the sand is used over and over again. A quart of sand will last as long as the machine.

Mr. Fisher suggested its use in cutting marble or stone, cutting out the interior in useful forms. In tunneling, these forms cut out might pay part of the expense.

Mr. Weir—They are only experimenting with the process now. I see no reason why they should not be able to tunnel with it, if they can arrange the machine so as to draw off the sand when it has done its work. There is no difficulty about the cutting, for it will cut glass or trap rock quicker than steam will cut ice.

The President—This seems to be one of the most important inventions lately brought before us. It acts upon the principle of giving the sand a high velocity. There is no wasting or sharpening of drills in this process. Another remarkable fact is that the very particles of waste matter taken off in cutting glass, are mixed with the sand and utilized in cutting other glass.

MINES ON THE SHORES OF LAKE SUPERIOR.

Mr. J. Disturnell read a paper on the mines of Lake Superior. He mentioned the abundance of veins carrying native copper on the south shore of the lake, from Ontonagon district on the west to Keweenaw Point and Portage Lake on the east. The iron ore deposits near Marquette, which are now very extensively worked, he said had produced 1,000,000 tons of ore this year. The extensive deposits of iron ore, lately discovered on the Menomonee river, and another field in Ashland county, Wisconsin, some twenty miles south of Lake Superior, were also very highly spoken of, the speaker claiming that the iron made from these ores surpassed the best Swedish iron in tenacity.

The last discovery of great importance, that of the silver vein on Silver Islet, near Thunder Cape, was then mentioned. The vein in July last had been sunk upon to a depth of only fifty feet, yet $1,000,000 of treasure had been taken out of it. Other veins on Jerris Island, in Tunder Bay, were also highly spoken of. The whole shore line, from the Pigeon river to St. Ignace Island, was declared to abound in copper, lead, iron and precious stones.

This land can be purchased from the Canadian government for a dollar an acre in gold.

Suspension Bridge.

Mr. Dudley Blanchard exhibited a model of a suspension bridge, intended to illustrate the strain upon the several parts, and explained its theory. He had tested the strain at different points by introducing a system of levers to measure it.

Adjourned.

October 19, 1871.

Prof. S. D. Tillman in the chair; Robert Weir, Secretary.

Chromium and its Compounds in the Arts and Medicines.

By Dr. Lewis Feuchtwanger.

[Illustrated by many natural and artificial productions.]

This metallic element is of a very remarkable nature, although its compounds do not occur very widely distributed over this globe. Chromic iron is the only native ore from which all the compounds are produced that form important vehicles in the arts, and as pigments of very bright colors. The metal is one of the most infusible substances—much more so than platinum. It combines with oxygen, forming only four different oxides, the fourth oxidation being an acid, and when combined with three atoms of oxygen is isomorphous with the magnetic oxide of iron.

Chromic iron is found only in serpentine rocks, forming veins and imbedded masses, or in grains mixed with sand. It is quite abundant in Siberia, Styria, the Shetland Islands, Cuba—the United States furnishing by far the largest number of localities. The writer examined large deposits in California, Maryland, Pennsylvania, Vermont and North Carolina. Its component parts are 60 per cent oxide of chromium, 20 per cent protoxide of iron, 12 per cent of alumina, and 7 per cent of magnesia.

Another native mineral, called Crocoisite, occurs in Siberia, resembles the artificial orange chrome-yellow of the shops, and is, in fact, a chromate of lead, $Pb\ Cr\ O_4$. There is another, but rare mineral, called Vauquelinite, which is a chromate of lead and copper, found in Brazil, which Dr. Torrey found fifty years ago in the lead mines at Sing Sing, N. Y.

The principal uses to which the chromic compounds have been put, are:—

1. The yellow or neutral chromate of potassa; it is the base for all other salts, being prepared by a simple process from the chromic iron.

2. The bichromate of potassa, or red chromate, is the present material used for all practical purposes, and is prepared from the yellow or neutral chromate of potassa.

3. The chromic acid, obtained in ruby-red needle crystals from the bichromate.

4. The chromic oxide, or green oxide of chrome, is a sesquioxide of chrome, is a permanent green pigment, obtained in presence of organic matter; it is much used in glass making for green, and in printing for the bank note paper of the United States currency.

5. For bleaching of palm oil, both the bichromate and the chromic acid are employed.

6. In the preparation of the aniline purple called mauve, by a combination of the bichromate and pure aniline.

7. It has latterly been introduced as a powerful exciting liquid in batteries, possessing many advantages.

8. In photography the bichromate of gelatine has lately been put to use, from the peculiar property of being soluble in the dark; but when exposed to the light it becomes insoluble.

9. In calico printing bichromate of potassa is a powerful auxiliary, for it renders some vegetable colors faster; also the lead pigments enter on fibrous textures more deeply.

10. Chromic acid, from its excess of oxygen, forms a powerful bleaching agent.

11. The various shades of yellow and orange chromates of lead form the most brilliant pigments for painting.

12. Chromium steel, made from a small admixture of five per cent chromic iron to cast-iron, bears a tensile strain of 140,000 pounds to the square inch. It is extensively used at the St. Louis bridge and Louisville bridge for girders, which have to stand both pressure and expansion.

13. In medicine the bichromate acts externally as a caustic, and is used for removing warts, also in curing affections of the mucous membrane.

Vauquelin, in 1797, first obtained the pure chromium metal by exposing green oxide of chromium in a charcoal crucible, kept in a blast furnace for some time; the pure metal is found at the bottom of the crucible in grains of a gray-white color (between steel and tin), very brittle, not magnetic, but conducting electricity. It is scarcely attacked by cold nitric acid or aqua regia, but readily by hydro-fluoric acid, evolving hydrogen gas. Its specific gravity is 6.8, and its combining weight 52.2.

The conversion of the chromic iron into the yellow or neutral chromate of potassa, and thence into the chromic acid and the green chromic oxide, may be shortly stated. The chromic iron is finely pulverized and calcined, and then mixed with powdered slacked lime intimately, both of which are now stirred in a hot concentrated solution of sulphate of potassa, so as to form a paste, which is then stamped into wooden cylindrical moulds, and exposed to a powerful oxidizing flame. The greater part of the chromic oxide is converted into chromic acid; the whole mass is then broken up and thrown into boiling water, and left to crystallize. The yellow crystals are formed in oblique four-sided pyramids; are of such intense color that one part of it dissolved in 40,000 parts of water will retain a yellow tint. It has an alkaline reaction, is permanent in the air, of bitter taste, and very soluble in boiling water, but insoluble in alcohol.

The bichromate of potassa is obtained by adding sulphuric acid to the above solution of the yellow chromate while hot, and on cooling intense orange-red crystals are soon formed, which are rectangular prisms; they are not altered by exposure to the air; are soluble in ten parts of water, but insoluble in alcohol.

In order to obtain the sesqui or green oxide of chrome, we have only to precipitate the bichromate solution by ammonia. This green oxide is principally used as a pigment for porcelain or glass, to produce an emerald-green color. A simpler method of producing a fine sesquioxide is by igniting twenty parts of bichromate of potassa with four parts of sulphur for half an hour. By mixing the yellow chromate of lead and Prussian blue together, a beautiful green pigment is obtained.

The neutral salts of chrome form yellow precipitates, while the basic salts produce orange precipitates. It is wonderful to see how many pigments are obtained from chromium; for instance, a brown oxide is obtained by digesting the green oxide with chromic acid; another yellow precipitate is had from a combination with zinc salt, and a yellowish-brown pigment from sulphate of copper and the chromates.

Peach-purple crystals are obtained from the sesquichloride of chrome. Chrome-alum obtained from the combination of sulphates of chromium and ammonia, in the form of deep purple crystals, is very extensively used by calico printers.

Dr. P. H. Van der Weyde—A more interesting subject than chromium could not have been selected; for there is no more wonderful substance in the whole field of chemistry. It has been found that chromium steel is one of the stoutest kinds of steel existing. The superintendent of the great bridge, building at St. Louis, has made experiments upon the strength of different kinds of steel; and he found that heavy bars of steel did not come up to the standard. For instance, taking a bar of steel of one square inch section, which would bear a tensile strain of 100,000 pounds, it was found that a bar of steel, of six or eight square inches section, would not bear a strain in proportion. Their bridge is to be of the same character as that of Louisville, upon the same system of girders which have to stand both pressure and expansion. It is found that chromium steel will not only bear 140,000 pounds for a bar of a square inch section, but that a bar of eight square inches section will bear eight times that strain. It has been decided, therefore, to build the St. Louis bridge of chromium steel. I have become acquainted recently with parties making silicic steel. It was to be expected that silica might take the place of carbon in steel; but that chromium could take the place of carbon was unexpected. Sulphur or phosphorus in iron injures it, making it cold-short; but chromium, carbon and silicon improve it.

The oxide of chromium is the substance with which our greenbacks are printed. It is not so bright as green produced with prussian blue, but it cannot be changed chemically.

Dr. Feuchtwanger—That is the reason I made ink of it. It makes a good black ink, with a greenish tinge.

Dr. Van der Weyde—The bichromate of gelatine has the peculiar property of being soluble in the dark, but when exposed to the light it becomes insoluble. Coating a plate with it, and putting it under a negative, wherever the sun strikes it, it makes it insoluble, the solubility being in proportion to the amount of light. After it has been exposed two or three minutes, it is carefully washed with warm water, and that which is still soluble is washed away, leaving the picture in relief upon the plate. In this way the Albertype is made, and any number of copies can be printed.

The bichromate of potash was introduced for use in batteries by Messrs. Chester in this city, under the name of the Electropoion fluid. When it is used in a battery, there are no fumes at all, because the product is chrome alum, an alum in which chrome-oxide replaces alumina.

Chrome yellow is often adultered with chalk. The test of its purity is to determine how much blue may be mixed with it, and form a green. If there is much white in it, it will not make a good green. It will take a good deal of white without showing it in the yellow color; but mixing blue with it detects it at once.

Mr. Reuben Bull—The chromate of potash acts like prussiate in hardening. The prussiate of potash leaves a scale upon the metal; the chromate leaves it cleaner; but the cyanide of potassium leaves it very clean.

Dr. Van der Weyde—When you use the cyanide you make a carbon steel; but when you use the chromate of potash you make a chrome steel.

Mr. J. K. Fisher—The safe-makers are using chrome steel. Marvin introduced chrome steel for that purpose. The strength of the chrome steel has been estimated at 140,000 pounds. It will be recollected that last season we had here a sample of the Sherman steel, stated to sustain 263,000 pounds to the square inch of section. The Bessemer steel comes up to about 130,000 pounds, but it is not uniform. I would like to know whether the chrome steel is uniform, and whether it is an expensive steel.

Dr. Feuchtwanger—It is not more expensive than any other steel.

Prof. James A. Whitney—According to Osborn's recent work, chromium steel is inferior for tool making to the best made crucible steel of ordinary manufacture. But these kinds of steel are of little consequence compared with low steel. The quantity of high steel used in this country is small compared to the low steels that either now find, or must hereafter find, application for rails, axles, steam-boilers, etc., as a substitute for wrought iron. I may mention, incidentally, that two or three years ago I saw steel cylinders, of steel about one-sixteenth of an inch in thickness, which had been tested with a pressure of 600 lbs. to the square inch; and they were bulged out in the center into a barrel shape, while cast steel cylinders of the same size and thickness showed no change from the severe test.

Dr. Feuchtwanger—The chrome steel is not so good as the tungsten steel; but it can be made cheaply. Chromic ore can be bought for $4 a ton.

Dr. L. Bradley suggested the use of chromic acid instead of bichromate of potash for batteries, as probably cheaper; but, learning that the former costs forty cents and the latter seventy-five cents, concluded that there was no material difference in cost, taking into consideration the work done by each

Dr. Van der Weyde stated that he had ascertained by experiments that bichromate of potash and sulphuric acid would bleach linseed oil and deodorize it splendidly; but unfortunately, the moment the painter mixed it with white lead, it turned yellow, forming the chromate of lead. (Laughter.)

NEW COFFEE-POT.

Mr. O. Tinkham exhibited and explained a new coffee-pot, consisting of three parts: 1. The ordinary coffee-pot; 2. A small cup, placed above it, with a flannel filter at the bottom in which the ground coffee is to be put; 3. A vessel with small holes in the bottom, to be placed above the cup, and filled with water. The water from the upper vessel descends slowly upon and percolates through the coffee, receiving its aroma, and is received in the lower vessel. He remarked that some philosopher had said that a man who buys his coffee in packages, and expects to find it pure, "don't know beans." (Laughter.) With this apparatus, the coffee may be ground as fine as meal, and yet will be clear. So far as the taste is concerned, he regarded coffee boiled as coffee spoiled.

Dr. Van der Weyde recommended making coffee by percolation with cold water, and warming it afterwards. If we take the coffee, after its aroma has been taken out by percolation, and attempt to form a drink from it, it will be unfit to drink.

Mr. Fisher stated that Liebig's plan was to take the grounds and make coffee from them, and to mix it with coffee made by percolation; thus combining the strength of the former with the flavor of the latter.

Dr. Van der Weyde stated that in Paris they have discovered that coffee beans can be made out of clay, which, mixed with the genuine coffee, takes up its perfume; and it is difficult to distinguish this from the real coffee, especially after burning.

Prof. Whitney stated that when coffee beans are roasted, the peculiar essential principle, caffeine, is produced from the constituents of the berry. This is doubtless more readily soluble in cold water than the resinous matter and tannin. If we apply the leaching process, we simply extract the first; but if we apply heat we dissolve also the resinous, the coloring and astringent matter, and, of course, the coffee is muddy. I found it impossible to get a good cup of coffee between San Francisco and Chicago, and if this principle could be applied to a small portable coffee pot, to be used with an alcohol lamp, it would be a blessing to travelers.

The President remarked that condensed milk is better in flavor and, he believed, healthier than cream, when mixed with coffee.

Dr. Van der Weyde considered it a mistake to make coffee in a tin coffee-pot, and recommended the porcelain lined coffee-pot.

Mr. Fisher added that it was a mistake to make the coffee-pot with a nozzle, which could not be kept clean.

The President read the following items of scientific news:

I. A Steam Hygrometer.

This instrument, invented by Leiscester Allen, is designed for the purpose of measuring the amount of moisture in steam generated in ordinary boilers; the terms "wet steam" and "dry steam" being used to distinguish steam holding particles of water from that which has been completely volatilized. The construction of this instrument is based upon the fact that the amounts of heat in a pound of water at 212° Fahrenheit and a pound of steam at the same temperature are well known. To determine the amount of heat carried out of a boiler, an apparatus has been devised, which consists of a scale-beam with a platform and a thickly felted water-chamber at one end, and a counterpoise at the other, having a sliding weight indicating pounds and half-pounds. The walls of the water-chamber are made of thin tinned sheet copper, there being two shells, between which felting, 1½ inches thick, is placed. A felted cover is also provided, through which is inserted a standard thermometer having a large bulb, and easily read in fifths or degrees. A finely perforated coiled copper pipe rests upon the inner floor and passes out at the lower part of the side wall of the chamber. This is the steam induction pipe. The lower part of the chamber has the shape of an inverted tunnel, to which is attached an escape-pipe. Both pipes are provided with cocks. A small funnel in the cover, also provided with a cock, completes the apparatus. To use this instrument, five pounds of water are placed in the chamber and raised to 80° Fahrenheit, by allowing steam to pass through the coil. The surplus water is drawn off, leaving five pounds of water at 80°, containing 400 units of heat. The sliding weight is then placed at the 5½ pounds notch, and the steam to be tested is allowed to flow in until the scale-beam is balanced. The influx of steam is then stopped, and the thermometer is read. With these data the amount of water in the steam is calculated.

II. To Detect Sulphur in Coal Gas.

Ulex has published a simple process of detecting the presence of sulphur in ordinary illuminating gas. The flame from the gas is used in a Bunsen burner to heat a clean platina dish containing water. After evaporating about a pint of water, the outside of the vessel will be found to be partly coated with an oily fluid, which can be distinctly shown, by ordinary qualitative tests, to be sulphuric acid. The same author states that the white incrustation which sometimes makes its appearance on the inside of the lamp chimneys consists of sulphate of ammonia.

III. A Great Electro-magnet.

The Stevens Institute of Technology has an electro-magnet, made in Ansonia, Conn., which weighs about 1,600 pounds, and has a lifting force estimated at between thirty and fifty tons. About 400 pounds of copper wire, one-fifth of an inch thick, is wound on eight spools, each nine and one-half inches high by eleven and one-half inches external diameter. The cores are hollow, and six inches in diameter by three feet three inches in length. This magnet is about five times as powerful as that used by Faraday in his famous researches.

IV. Test for the Presence of Ozone.

M. Lamy has recently published in a Paris journal the results of his experiments in obtaining reagents for ozone. He says that paper moistened with the oxide of thallium, when freshly prepared, is far more sensitive to ozone than that prepared with the iodide of potassium and starch. When a rapid and trustworthy test of the presence of ozone in the atmosphere is desired, the oxide of thallium is recommended; but it should be understood that the sensitiveness of this reagent depends on the strength of the solution and the extent to which the oxide has absorbed carbonic acid.

V. Colors Changed by Heat.

5. Prof. E. G. Houston and Mr. Elihu Thompson, of the Central High School of Philadelphia, have recently made a series of experiments to ascertain the law by which the color of various salts and oxides are changed by the action of obscure heat rays. The substances under examination were placed, in the state of dry powder, on strips of sheet-copper, which were heated by means of an ordinary Bunsen burner. Colored bodies which did not return to their original tint on being cooled were excluded from the experiment. It was found that in all cases in which the color of the body is changed by the application of heat, and the original color regained on cooling, the nature of the body being in no wise altered, the character of the

change is as follows: The addition of heat causes the color to pass from one of a greater to one of a less number or vibrations; the abstraction of heat from one of less to one of greater number. Violets are changed by heat into indigo-violets, or indigoes; indigoes into blues; blues into bluish-greens, or greens; greens into yellowish-greens, or yellows; yellows into yellow-oranges, or oranges; oranges into orange-reds, or reds; and finally, reds into brownish-reds, or blacks. Upon the application of cold the inverse order is observed. In many instances substances were noticed that ran down the scale two or more colors; for example, the green iodide of mercury passes from a yellowish-green through the yellow and orange to the red. The experiments prove that the waves producing heat, being slower than those producing light, have a retarding effect on the latter, and change the rate of oscillation; it being previously well settled that the waves producing the extreme violet have nearly doubled the velocity of those producing dark red.

Dr. Van der Weyde said that as the heat spectrum is at one end of the light spectrum, extending beyond the red rays, it was natural to expect that on heating a substance its color would go toward the warmer end of the spectrum, and that on its cooling its color would go back.

Mr. Fisher—Ever since English art began, red and the neighboring colors have been considered warm, while blue has been considered a cold color.

Dr. Van der Weyde—My impression is that in fact blue feels cold, and red feels warm.

Mr. R. Weir—In painting a winter scene, the artist uses different tints from those used on a summer scene. He indicates the warmth or the cold by the tints employed.

Adjourned

October 26, 1871.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

Dr. P. H. Van der Weyde delivered the following lecture:

On the so-called Psychic Force.

The so-called psychic force has lately been brought to the notice of the scientific world by Mr. W. Crookes, editor of the London Quarterly Journal of Science, a man favorably known among scientists as the discoverer of important chemical facts. Last July he gave an account of experiments made by him, in conjunction with Mr. Home, the "Spiritual medium," who surprised the Court of Napoleon and a great many others by his feats. The account of those experiments has been reprinted by the Scientific American, and they have thus been brought to the notice of the people of this country.

The first of these experiments consisted in making an accordeon sound when held in one hand. It is said that the accordeon floated in the air when Home withdrew his hand; but this Prof. Crookes did not himself see, but gives on the authority of his assistant who saw it. There was a copper wire coiled around the legs of a table, many times, connected with the poles of a galvanic battery. Mr. Home held the accordeon beneath the table, and then the accordeon played, swinging one way and the other.

The other experiment consisted in resting one end of a mahogany bar upon a table, and the other upon a spring balance, which then indicated a strain of three pounds; but when Mr. Home placed his finger upon the end which rested on the table, the balance indicated a weight of six pounds.

These two experiments were all; and from these Prof. Crookes came to the conclusion that there must be some mysterious force, not investigated by scientists, to account for it.

It has long been asserted that there was such a force. One of the earlier investigators who maintained it was Mesmer, who claimed that he could not only move objects, but cure diseases by it, without contact. Mesmer believed in his theory. He was honest about it, and considered himself one of the greatest discoverers in modern science. The delusion was fortified by the supposed cures he performed. He employed a battery which was in imitation of a Leyden battery, only the jars contained iron filings, had iron filings about them, and were filled up with sand or water, and had the same substances around them. The battery had points to be directed toward those parts of the patients where they felt pain, and Mesmer, dressed like an astrologist of the olden time, with a magic baton in his hand, manipulated them, and succeeded in making it fashionable in Paris, particularly for rich people, to come to him, and they supposed they were benefited by it. At the time he was in his full glory, he wrote a petition to the King of France asking for compensation. He said such a discovery as he had made could not be paid for in money; and the only thing he would accept was a chateau with plenty of land around it. Failing to obtain this reward from the French government, he went to England, associating himself with M. d'Eslon, who was also a believer.

Mesmer always kept aloof from scientific investigation. He kept away from the French Academy. But M. d'Eslon pursued a different course. When Mr. Crookes says that scientific men have neglected this matter, it shows he is not aware of what has been done. The Academy of Sciences appointed a committee of five to investigate the matter, the committee embracing Lavoisier, Franklin, and Bailly. They first undertook to ascertain whether such a force existed. They examined the apparatus, and discovered nothing. Then they placed patients around it, and they found that when they were connected with it, without being magnetized, they felt it; but if they were magnetized, without knowing it, they felt nothing. They came to the conclusion, therefore, that the whole paraphernalia was only a means of acting upon the imagination of the patients.

The first practical experience I had with mesmerism was in Holland, about 1833, nearly forty years ago. Persons were put into the so-called clairvoyant state by hand-motions. I was much inclined to believe in it, and was very anxious to come to a knowledge of the truth. I would now like to believe that it is true; but I cannot. I found, after several sessions, that it depended altogether upon imagination. It was generally hysteric females who were most easily influenced. At one time I was inclined to believe it, and even supposed that I felt the influence myself; but I came to the conclusion that imagination, in the first place, and then exaggeration, sufficiently explained the most wonderful accounts. I found nothing indicating a supernatural or a new force.

In this country, the phenomenon assumed a new phase, which was called the "spiritual knockings." So many deceptions have been practiced in this as to throw strong doubts upon the whole, even among believers. But in the present state of the controversy, spiritualism is excluded; for those who agree with Mr. Crookes unite in saying that spiritualism is a delusion. But they say that there is a force residing in the human body, besides the muscular force, which manifests itself in these phenomena; and they say it is very probable that there is such a force, because we know that persons under excitement perform acts for which their ordinary strength is insufficient.

We perceive at once the great difference between Mesmerism and Psychic force. Mesmerism acted only upon human bodies, or objects which could be acted upon by the imagination. But Home causes inanimate objects to move.

Now, has science taught us anything which either proves or disproves the existence of such a force? The experiments resemble so much the tricks of legerdemain, as to create the suspicion that they belong to the same class. As to playing on the accordeon, the jugglers will play on an accordeon without having any accordeon. We have had exhibitions in the Academy of Music surpassing anything done by spiritualists. They will imitate the voice of birds, and cause the sound to ascend until it appears to come from the top of the house. But they do not pretend that it is anything more than ventriloquism. And as to the experiment with the spring balance, it is so simple that it is scarcely worth speaking of. It is surprising that Mr. Crookes should have considered as a new force a result so easily explained by well-known principles of physical science of which jugglers make constant use.

It is impossible to give an explanation of tricks without seeing them. An account of the performance is not enough. The person relates what he noticed; but there may be other things which, were they noticed, would explain the whole thing. For instance, when the Davenports came here, I was at first at a loss to account for their experiments. I was selected as one of the committee to go upon the platform, and tie them, and see if everything was rightly done. It had been my good fortune to see a great many jugglers' tricks, for my parents thought it a good way to teach quickness of perception, and I saw all kinds of jugglers, and when I was a boy I was a juggler myself, and performed thousands of tricks. When I came upon the platform, I saw that the Davenports were to be tied with a new manilla rope, which cannot be tightly tied. I called for an old-fashioned hemp rope, and tied one of them so well that he was an hour in getting out. The other one was tied with the manilla rope, and soon got loose. They threw a speaking-trumpet out through a hole in the closet in which they were tied; but after they were gone, I found, by trying the experiment myself, that I could lift the trumpet with my teeth and stick it through the hole. Of course, when the doors were opened, their hands were found still tied. Now, to show you the amount of perception of the public generally, I will say that, suspecting how it was done, I thought I would give the public the key to it, and so I took up the trumpet in my teeth, thinking they would perceive what I meant; but instead of that, some of them came to me after the exhibition was over, and said the most wonderful thing of the whole was to see that trumpet stuck fast to my nose!

(Great laughter.) When you have such people to see, is it any wonder that they are taken in?

When the Davenports are once loose they tie themselves. They tie the two ends of the rope to their feet, and pass a loop around their wrists, behind them, so that pushing forward their feet, their hands are instantly free, and they can do what they please. So all their tricks, wonderful as they are when unexplained, are simple enough themselves; and so I have found it everywhere.

In 1859, the Mechanics' Institute held meetings similar to our own. The question of spiritualism came up for discussion. I was opposed to it; but when it was decided to have it, I proposed that we should have the spirits there, and see for ourselves. The first night I was on the committee, when several communications were received from the spirit world. When I took my place at the table, I was favorably received, the medium thinking, from a remark I had made, that I was a believer. I wrote down two questions in German, thinking I would take my chances. The first was whether spiritualism was true, and the answer was "no." The second was whether spiritualism was a humbug, and the answer was "yes." And I was willing to accept it at its own valuation.

It is very difficult to determine where a sound comes from, when we do not know what produces it. It is therefore very easy to deceive people about the raps. At first the sounds appeared to come from the wooden partition behind the medium; but I had my stethoscope with me, and by privately applying it to those boards I found that the sound did not come from there. I tried it on the table; and still there was no indication of the sound. But when I tried it upon the board on which "the medium" had her feet, I found that there was where the sound came from. I requested that she should move forward to the edge of the platform; and then I found that the sound had shifted from the third board to the front board, on which her feet were now resting.

It is said sometimes that we should not go to public circles, but to private circles, where deception is out of the question. I have been in private families; and sometimes the raps delayed so long that I thought I would produce them myself. I found they would swallow anything. No matter how absurd the answer was, they would so interpret it as to make it wonderfully wise. Now, what has science taught about the existence of a force outside the body? Modern physiology has taught us a great deal, and the doctrine of the conservation of forces, and of the chemical and mechanical equivalents of heat, is a new branch which has sprung up within the last twenty years. The first question is: What is force? Is force supernatural —something residing in the human body, or is it something material? Here is the key. It is a delusion to suppose that force is immaterial. The moment we adopt that idea, we may suppose that it may be communicated without contact. But modern biology, the science of life, teaches us that what we call life and force are nothing but the motion of matter. Force is matter in motion; and where there is no matter there is no force. Heat also is motion; and in the steam-engine the heat of the steam is converted into the motion of the piston.

What does that expansion of the steam consist of? It is a new theory that the molecules of gases are in rectillinear motion, impinging upon the walls of the vessel, producing by their impact what we call the pressure of the gases. In a solid, the motion is a vibration; in a liquid, it is a revolution of the molecules; but in a gas, they are in rectilinear motion in all directions. This idea is strongly fortified by the known fact of the diffusion of gases, which takes place with astonishing rapidity, even when the lightest is above the heaviest. If we raise the temperature, the velocity becomes greater, and of course the pressure becomes greater; and as the force is as the square of the velocity, this explains why the pressure increases so rapidly with small increase of temperature. In moving the piston, the molecular motion is changed to motion of the mass; and in friction, the motion of the mass is retransformed into molecular motion.

So with the animal. Give an ox no food, and he cannot work. The living animal is a most complicated machine. To produce motion, the muscles must be contracted. That contraction must be caused by the action of the nerve; and that action of the nerve must be caused by the will, the seat of which is in the brain. Experiments have proved that every action is at the expense of matter. As you can have no motion of a machine, so you can have no motion of an animal, without the expenditure of material. Every time I move my arm, there is matter destroyed, or rather changed. Matter must be supplied continually to the blood, to supply its place; and as the waste is greater than the supply, when we are in action, it is necessary to sleep for one-third of our lives, to give time for supplying the waste; just as the engineer lets his engine stand still while he is getting up steam. The nerve, in acting upon the muscle, and causing it to contract, is consumed. The brain, where the will resides which acts upon the nerve, is consumed. Without the consumption of brain we cannot think. Every thought which passes through the mind destroys parts of the gray matter of the brain.

Phrenology may be regarded as demonstrated so far as this, that the brain has different functions, which act by preference in different localities. The brain contains a great deal of phosphorus, which is mostly eliminated in mental labor by the kidneys; and it has been found that those who on one day in seven severely tax their brains, have an excess of phosphorus on those days in the products of the kidneys. And those who use their brains a great deal require food which contains the constituents of the brain. It has therefore been asserted that it is the function of the brain to produce or secrete thoughts and affections, just as the liver produces or secretes bile.

My conviction, then, is, that the so-called psychic force does not exist; that the phenomena observed by Mr. Crookes do not differ from the jugglers' tricks which we have often seen. If asked to explain them, I should say, as Arago said to Napoleon about Home's performances, "It is impossible for me to explain what I have not myself seen."

The President—Can you state what was done by the late Dr. Robert Hare, of Philadelphia, fifteen or twenty years ago?

Dr. Van der Weyde—I knew Dr. Hare, and I had great respect for him as a most profound investigator. His discoveries in electricity were very important. But after he had become a believer in spiritualism, I called upon him, and found that his mind had become weak. He had an apparatus made which could be moved by a touch of the hand, and which answered questions; and at the Scientific Convention at Albany he desired to exhibit that apparatus; but he was refused on the same grounds that I had objected to considering the subject at the Mechanics' Institute; for Prof. Peirce said that, if it was true, it was a religious matter, and beyond their department, and if it was untrue, it was a deception and not worthy of consideration. The probability is against the existence of such a force, for force is but the motion of matter, although it takes a variety of forms—heat, light, etc., convertible into one another; and life itself is but the motion of matter.

Mr. Young—What is memory from childhood to old age?

Dr. Van der Weyde—Dr. Draper has shown that memory is a material thing, depending upon the ganglions of the brain. Memory is destroyed by an injury to those ganglions. People who have much knowledge recorded in the mind, have more convolutions in the brain than others.

Mr. Young—Mr. Varley, the celebrated English engineer's account of the phenomena, destroys everything you have said to-night.

The President stated that Mr. Crookes is still experimenting, and is determined to continue until he can come to a positive conclusion with regard to the cause of the phenomena. Coleman Sellers, of Philadelphia, has replied to Mr. Crookes, and he stated that, judging from the reported weight of the mahogany bar, it must have been hollow ; but Mr. Crookes replied that Mr. Sellers is mistaken as to the kind of mahogany used.

Dr. Van der Weyde stated that this experiment was only tried once, but suggested that it could easily be performed by electro-magnetism, the pressure of the finger making a connection, through wires concealed in the mahogany bar, with the spring balance, in which an electro-magnet may be concealed. This experiment was no more wonderful than the magic clock, the hand of which Heller causes to move; yet the latter is easily explained. The clock has two glass faces, and the hand is suspended disconnected from the rim, while the whole is hung from the ceiling by two cords. But the rim of the clock is an electro-magnet, the wires passing through the two cords; and by using a strong battery the hand will revolve in one direction or the other, according to the direction of the current, or stand still when the current ceases. The magicians are familiar with all such devices.

Prof. John Phin—There are two questions to consider : one is the question of deceiving our neighbors, and the other is the question of deceiving ourselves. It is easy for a man to move a table, knowing that he is doing it, so as to deceive others; but there are persons who will move the table not knowing it. To determine this, Prof. Faraday constructed a table with a double top, and attached an index, so that any force applied by the hands moved the index. He found that whenever the index was in sight of the individual, so that he could know what he was doing, there was no motion. But when the index was concealed, after a time the muscles began to act involuntarily, and perfectly honest persons were ready to say that they had exerted no force when really they had exerted it.

The tricks which can be performed by electro-magnetism are almost endless. A juggler suspended a glass dish cover, with a little hammer attached, to strike as a bell, by a single very fine wire or thread from the ceiling, and the bell sounded as he wished. Of course it was thought there was no electricity about that, because he would need two wires. The fact was that he *had* two wires, insulated and covered with another fine wire.

Now, granting that there is a psychic force, it is confessedly very delicate. It requires the nicest apparatus to detect it. It seems to me that this experiment with a lever is *prima facie* evidence of a trick, for it proves too much altogether.

Mr. Young—I am unwilling to have a matter I have examined so long, dismissed in such a cavalier style. The gentleman speaks of a motion of a table with hands upon it. There are thousands who have seen tables move without any hands, and intelligently answer questions. I have myself seen it repeatedly.

The President—The question before us is concerning psychic force, and not spiritualism. Mr. Crookes and Mr. Huggins do not take sides with the spiritualists.

Dr. Hallock—I would like to state a few facts. The speaker proceeded to describe the power of spirits in raising heavy bodies; he had seen a table, with several heavy persons on it, lifted entirely from the floor.

Mr. T. D. Stetson — Have you with your two eyes seen it clear of the floor? How high was it?

Dr. Hallock — Bless your soul, yes! I have seen it clear up *there* (pointing upward). I have seen a man, with twenty gentlemen sitting around, in a parlor seventy feet deep, lifted over and over again, right before our eyes, and finally floated right through the room and laid down upon the table!

The President — How long is it since you saw the feats described?

Dr. Hallock — I think it is ten years. As much as that. I offer that as a proof of psychic force.

The President — It proves too much. The energy thus displayed was too tremendous for psychic force.

Mr. Blanchard — When a scientific man discovers a new fact, he tries the experiment over and over again, until he finds under what circumstances the same result will always ensue. Then he can bring it before his friends, and show it; and the same result ensues, no matter whether they are credulous or incredulous. Now, we are called upon to believe strange things, such as we have never seen the like of, on the statement that others have seen them. We know there is in human nature a disposition to exaggerate, and that many will make a story right straight out; and this is so prevalent in human nature that I don't believe a word of the gentleman's story. (Laughter.) If spirits will perform their experiments here, we shall all be convinced.

The President — In our free discussions we are sometimes drawn too far away from the original question. We do not want those experiments before the Polytechnic. We are considering the psychic force; and as soon as we can learn from Mr. Crookes how to use it, we will repeat his experiments here.

Adjourned.

November 9, 1871.

Prof. S. D. TILLMAN, in the chair; Mr. ROBERT WEIR, Secretary.

ON THE EXPLOSION OF THE STEAMER WESTFIELD.

By NORMAN WIARD, Esq.

It was my intention to submit to you this evening some very elaborate apparatus which I have prepared in illustration of the causes of the explosion of steam boilers; but, as there are some inventions to be exhibited this evening which will occupy your time, I have concluded to defer that until another meeting. The steamer Westfield exploded on the 30th of last July. The effect of the explosion on human life is not a matter for us to discuss, but only the scientific question of the cause of the explosion. At the official investigation into the cause of the explosion, there were about twenty experts called as witnesses, men of reputation and experience, but no two of them agreed as to the cause of the accident. The newspapers discussed the question with a similar result. Every one seemed to have a theory of his own, and no conclusion was reached. Shortly after the explosion, I received a letter from Mr. Erastus Smith, who had charge of the steamers Bristol and Providence, calling my attention to the fact that the newspapers were manufacturing an injurious public opinion, and asking me to set the public right. I did not feel able then, in the heat of public indignation, to undertake this. I propose now to give some explanation of the different theories advanced, and will on the next evening give a more full explanation of what I believe to be the true cause of the explosion.

One theory was that the boiler was subjected to over-pressure; another that there was unequal expansion of the metal; one that there was too much water in the boiler; another that there was too little; one that the steam was superheated; another that the steam was decomposed; one that the boiler was weakened by the drift pin; another that it was weakened by the caulking tool; another that the water was superheated; another that the boiler burst on account of pulsations; another that it was weakened by the water-test; another that the explosion resulted from some mysterious action of oil in the boiler; another that the safety-valve was not in order; one that it was bad iron; another that it was bad workmanship; another that it was badly designed; another that it was badly stayed; one that there was a generation of electricity; another that the boiler was oxidized, and thereby so weakened as to be incapable of standing the pressure applied to it.

Mr. W. proceeded to make a drawing of the boiler, and to explain how it was exploded. It separated at the bottom, and two seams being weak, one course of the shell was rolled over like paper, separating at the line of rivets on both sides, and one end of the boiler was projected into the eyes of the ship, and the other end was moved two feet and brought up against some timbers. All this operation must have occurred in an incredibly short space of time; because, if the rupture had been gradual, the reaction, when the sheet was half removed, would have thrown the boiler over the side of the ship; but, instead of that, both ends were projected in a line parallel with the keel.

The first theory I shall refer to is that of over-pressure. A cylindrical boiler, subjected to elastic pressure, will be ruptured longitudinally with half the pressure that will cause it to rupture transversely. Another rule is, that any piece of metal subjected to tensile strain will be extended permanently by about half the force that will break it. If, then, we cannot find in a boiler any part of equal strength with the part that gave way, permanently extended, we may be sure that the boiler did not burst by over-pressure. There is no part of the boiler of the Westfield that exhibits the slightest evidence of permanent extension, otherwise than at the point of rupture; and I conclude that over-pressure of the steam was not the cause of the rupture.

If a boiler were burst by over-pressure, the permanent extension of parts which did not give way would be so great that it would be impossible to repair it. When the boiler of the steamer St. John exploded, some years ago, I know that the boiler was repaired, and that when steam was put in there was no leak anywhere; so that there was no strain on that boiler sufficient to cause permanent extension of the iron. And I venture to say that no engineer ever saw in an exploded boiler any indication of over-pressure. The indications would be that the steam-gauge would suddenly advance, the engine would move more rapidly, the condenser would become hot. There is no reliable evidence that any such indications have ever been observed.

I have endeavored to burst a boiler by over-pressure, and in one case I subjected the boiler to a pressure of 650 pounds to the square inch. Before it gave way it was so stretched that it was two inches larger in circumference at the center than at the ends; and it did not give way until the leaks were so great that we could not get more pressure upon it. There was evidence in every part of that boiler of the extraordinary pressure that had been applied.

As to the weakening by the water-test of forty-eight pounds, so that afterward a less pressure will cause a rupture, it is only necessary to suggest that after the water-test the boiler is subjected to a pressure of forty-seven pounds, forty-six, and so on, pound by pound down to the ordinary pressure at which it was to be worked.

The theory was advanced, that in applying the water-test the boiler was strained by the momentum of the water flowing into it. We must remember that, although the water itself is incompressible, the iron is so elastic that ten or twelve gallons may be put into a boiler after it is full, the iron stretching to receive it, and afterwards returning to its original size. The elasticity of the iron makes up for the want of elasticity in the water.

As to the theory of too little water exposing the upper tubes to the steam, we must remember, first, that the perpendicular tubes were always exposed to the steam; and, next, that even a temperature of 500° or 600° would not materially injure the iron. Furthermore, we find in practice that boilers of this form are just as apt to explode with the proper amount of water in them as without it.

Superheated steam cannot have caused the explosion. It is supposed that the surplus heat of the steam might be communicated to the water, generating an increased quantity of steam and causing an increased pressure. That is now known by engineers to be impossible. There being a given number of units of heat in the steam and water contained in a boiler, it makes no difference whether the water is cold and the steam is at 1,000°, or whether the two are mixed; the pressure is the same. I have tried repeated experiments to determine this; and I have superheated the steam up to 1000°, heating the iron red hot, while the water was about 300°; and upon mixing them, I have found only the increase of pressure which could be directly traced to the heat in the boiler iron.

There is a theory of the decomposition of steam, that the oxygen leaves the steam and unites with the iron, at a high temperature, forming an explosive gas. It would be impossible that the gas should explode without a new supply of oxygen, or without being raised to the temperature of incandescence; and even then the gas would be so much expanded by the heat that the force of the explosion could not be great.

I next come to the driving in of the drift pin, and I assert that it is impossible to break a sheet with the drift pin, from one rivet hole to another. It is easy to account for their being found broken after the boiler is exploded. Frequent heating and cooling of the iron may cause it to bend back and forth and finally to break at the rivet holes.

As to the injudicious use of the caulking tool, the weakening due to punching out the rivet holes is equal to .57 of the entire strength of the iron, so that unless the caulking tool goes half way through the sheet that could not cause the fracture.

Pulsations would cause the sheet to bend at the seam, and would be injurious. A boiler, when the pressure is removed, may settle into an oval form from its weight, and, upon putting on steam, the pressure restores its circular form. These changes would cause the iron to bend at the seams and weaken it.

Oil has no effect in a boiler, that I know of, except to prevent or to cause foaming, and to prevent the oxidization of the sheets.

The safety valve indicated a pressure of twenty-seven pounds, for the engineer says it was "just simmering." I never saw any reason to apprehend that a safety valve failed to open at the proper pressure. Mr. Richardson invented a safety valve which would not only open with certainty at a certain pressure, but which remained open until the pressure was reduced several pounds. But although that safety valve is now almost universally used upon locomotives, there are about as many explosions as before.

I examined the quality of the iron of the Westfield boiler very carefully. It has been found, of many tests applied during the war, that the best and most reliable test for iron is the sharpness of its fibers when the iron is broken. If it will scratch the finger, the iron is strong. I found, on applying that test, that the fiber of the Westfield boiler iron was remarkably sharp. It seemed like a handful of needles. The iron was, therefore, really of a very good quality. There seemed to be an attempt by the maker of the boiler to make it very superior.

The manner in which this boiler was stayed has been complained of. As it was constructed, the boiler was six times as strong to resist longitudinal fracture as to resist transverse fracture. Then there were tubes running longitudinally, and for the shell to break transversely it would be necessary to break all these tubes at the same instant that the shell gave way; but these tubes did not break at all. The stays were drawn out, although they had strength enough to support two or three times the pressure upon the head; and, besides these tubes, there was the strength of the shell itself.

I have no doubt whatever that the rupture of the boiler was caused by the contraction of the bottom of this shell, while these lower flues were expanded, causing a transverse rupture first, which caused the hissing sound heard by the fireman immediately before the accident; the bottom of the shell was opened at one end of the longitudinal rupture, and the sheet carried edgewise so as to tear it from one line of seams to the next; then the pressure of the steam threw open these sheets, thus loosened and separated, and threw the two ends of the boiler to the places where they were found. I shall endeavor, on another evening, to demonstrate the correctness of this conclusion.

The President—That there is no weight in the argument that the pressure in the boiler is increased vastly by the decomposition of the steam, may be seen from the fact that when decomposed two volumes of steam become two volumes of hydrogen and one of oxygen gas; so that it will only occupy, at the most, one-half more space.

Dr. Van der Weyde—I do not think that meets the theory, which is that an explosive mixture is formed. That is fallacious, however, for it is well proved that steam, in contact with red hot iron, can only be decomposed by its oxygen uniting with the iron, leaving the hydrogen alone, which is not explosive.

The President—And if the iron takes up the oxygen, the hydrogen will occupy only the same space previously occupied by the steam.

Dr. Van der Weyde expressed the opinion that the over-pressure of the steam, the boiler being unprovided with stays along the central portion, caused it to burst; and stated that the pressure on each head, the boiler being ten feet in diameter, was more than a quarter of a million pounds. The true remedy is to make smaller boilers. Traveling on the Ohio last summer, and finding his room over the boiler, he went to see what the pressure was, and found it 140 pounds; but even that was safer than a pressure of twenty-seven pounds on the Westfield boiler, because instead of one large boiler they had several small ones. If the diameter of the boiler is two feet instead of ten feet, the pressure upon the head is only one twenty-fifth; and one twenty-fifth of 160 pounds is much less than twenty-seven pounds.

At the suggestion of Prof. Phin, the discussion upon the subject was deferred until Mr. Wiard should have explained his own theory.

Mr. W. E. Partridge made an inquiry in relation to portions of the head not supported by the stays.

Mr. Wiard replied, and mentioned an instance in which the steamer Narragansett had had its boiler broken in two by unequal expansion before there was any pressure of steam upon it, and then had made the trip before it was repaired. He stated, also, that the boiler of one of the Staten Island boats is now running with a rupture eight feet long.

Steam Canal-boat.

Mr. D. L. Kennedy exhibited a model of a canal boat, with a propeller in front, taking in the water and passing it through two pipes, and ejecting it at the stern.

The President stated that the plan of passing the water through the vessel was not new. In fact it was first proposed by the philosopher Franklin.

Dr. Van der Weyde—It was found that the friction of the water in the pipes was so great as to counterbalance the apparent advantages of the plan.

Mr. Kennedy said it had not before been done in the same manner.

Brush Machine.

Mr. E. C. Woodbury, the inventor, explained the principle of the machine exhibited by him at the fair, and exhibited portions of the apparatus and specimens of the work. No practical machines for pushing or pulling the bristles into a brush-stock and making them stay there, had been given to manufacturers till this of the Woodbury Brothers was perfected. This country manufactures about 45,000,000 brushes annually. New York city has twenty-six brush factories, and the total product of the metropolis is $2,000,000 worth annually. These are made by hand-drawing — that is, bundles of bristles or tampico are by hand lashed about with a wire doubled down and the end pulled through the holes of the brush-stocks. The wire is then fastened to another on the back of the brush, and, after all the holes are filled, a false back of veneer is screwed or glued over the wires.

The Woodbury machine abolishes all this hand labor, and effects the insertion of the material wholly by steam-driven machinery. A quantity of the bristles is laid upon a comb-shaped feeder, and a steel point parts from the edge of the bristles, as spread upon the apron, just enough for one bunch. A plunger comes down upon this bunch and bends it double, the two halves fitting into slots in the follower in size suited to the work in hand. Then a wire carrier, advancing, pushes about two inches of wire through the bunch at the bend and cuts off the part thus advanced. The plunger now pushes the doubled bunch with wire down into a nut with spiral threads or rifles on the inside, at the same time giving it a twist. The effect of this motion is to wrap the wire as a spiral or screw thread around the bunch, and the twisting or gimlet motion continues so as to screw the bunch, wire and all, into the hole of the brush-stock below, giving it the firmness and solidity of a screw. Then releasing its hold and giving one revolution backward, to take the twist out of the bunch, the plunger flies up and is ready for another bunch, which it prepares and inserts by exactly the same motions. Now, the remarkable thing about all such nice and accurately made machines is, that if they do their work and do it well at a slow rate, they will do the work just as well when the machine is driven at high speed. All this series—parting the bristles, gathering them into a firm package, doubling them over, pushing the wire through the loop, twisting the wire around the bunch, screwing the bunch thus armed with the wire into the hole of the brush-stock, and, last of all, relaxing the twist so as to leave the projecting bristles smooth and ready for the trimming shears—manipulations that the most expert workman could not go through in less than half a minute, the Woodbury machine performs at the rate of seventy bunches a minute. The common scrubbing-brush is composed of about sixty bunches; the machine makes such a brush in one minute, and performs the work thoroughly. As the holes do not pass through the wood, no back is required. The machine produces a greatly increased amount of work continuously, and without tiring, equaling the performance of ten of the most expert and rapid hand-drawers in speed, and doing better and what appears to be more lasting work.

Mr. Wiard said the remarkable part of the invention consisted in making the wire which confines the bristles, the tap to cut its own screw-thread into the wood, the ends of the wire, after it is in place, serving as pawls to prevent its return by reversed motion. He compared the cost of the work done by the machine with that of hand work, and considered the inventor of the machine a public benefactor. (Applause.)

Adjourned.

November 16, 1871.

Prof. S. D. Tillman, in the chair; Robert Weir, Esq., Secretary.

The Chairman gave notice that the meetings of the Polytechnic Association would hereafter be held on Friday evening.

The Chairman read the following notes of scientific progress:

I. Indium.

Bunsen has found the specific heat of indium to be 0.057. Applying the law of Dulong and Petit to the result, the atomic weight of indium is ascertained to be 56.7, which is a little more than double the atomic weight heretofore assigned to that metal.

II. New Mode of Illumination.

Dr. Harcourt purposes to mix coal gas with a certain proportion of air, and to allow the mixture to impinge upon platinum sponge. A more brilliant light, it is claimed, is thus produced without increased expense.

Mr. Fisher inquired whether platinum sponge, exposed to a continued flame, would be durable.

Dr. Van der Weyde — I should be afraid the sponge platinum would not last. The sulphur in common gas acts injuriously upon platinum. Merely mixing air with coal gas reduces its luminosity. Ten per cent only of common air will reduce the luminosity of gas to one-half. But we can restore the luminosity by heating a substance like platinum in the flame.

The President — It will be remembered that some time ago I presented to this association a theory of luminosity. Scientific books say that the carbon produces light because it is intensely heated. That is no explanation. The theory I presented was this: Light is produced by vibrations of the ether which fills all space. In ordinary gas we have carbon and hydrogen united. In its combustion, the hydrogen unites with oxygen and forms water. Hydrogen being a gas, its combustion produces no light; but carbon, when isolated, cannot be brought into a gaseous or liquid state. It is always a solid. Now, what will be the effect of the union of oxygen with common gas? The carbon must leave the hydro-carbon, in which it is in a gaseous state, before it unites with the oxygen, and in doing that it passes from the gaseous to the solid state. It then unites with the oxygen, and forms carbonic acid gas; and in doing that it passes back from the solid to the gaseous state. This passing of particles of carbon from the gaseous to the solid state, and back to the gaseous state, a great many million times per second, sets the ether in vibration and produces light.

Dr. P. H. Van der Weyde — I indorse that fully; although I had not the pleasure of hearing it when stated here before. I would like to ask why it is that light is not produced when we mix the gas with air, as we do in the Bunsen burner, where the heat is greater.

The President—For the reason that the mixture checks the change, and the lower rate of vibration produces heat but no light.

Mr. J. K. Fisher — In burning hydrogen, magnesia or any powder dropped into the flame makes it luminous. How do you explain that upon your theory? Is carbon an exception?

The President — The calcium light is produced by burning hydrogen by a jet of oxygen, and placing a piece of lime at the point of combustion. The intense heat sets the particles of lime into a higher state of vibration, in like manner as overtones are produced by musical sounds. That light would not be produced in any ordinary flame. The particles of a powder in a flame being luminous, is a result very different from that which produces the light we have here to-night.

Dr. Van der Weyde — I think the theory of the President agrees perfectly with the facts. We must remember that heat is a vibration. If the vibration becomes rapid enough to be perceptible to the eye, we call it light; below that, we call it heat. In order to be luminous, the vibrations must be 400,000,000,000 in a second; and it goes up to about 700,000,000,000. Below 400,000,000,000, it is invisible, but is felt as heat. Above a little more than 700,000,000,000, it is invisible, but is made manifest in photography. These rapid alternations between the gaseous and the solid state — for, although each particle goes through the process but once, there are millions of millions of particles constantly changing — increase the velocity of the heat vibrations, and make them luminous.

A Member — In using the Bunsen burner, stop the holes through which the air has access, and you produce the ordinary bright blaze, and it will smoke a paper held over it, showing the presence of solid carbon. Allow the air to mix with the gas, and when it is thoroughly hot, there is no solid carbon at all, and no light. How is that explained by the vibration theory?

Dr. Van der Weyde — The greater the heat, the more of the less rapid vibrations there will be.

Dr. D. D. Parmelee — We produce the electric light from solid carbon between the poles of the battery. It may be a question whether going through the solid form does not detract from the luminosity.

The President — It is more probable that there is a transmission of fine particles of carbon from one pencil of carbon to the other at the rate which produces not only luminous vibrations, but also those longer waves, moving at a less rapid rate, which produce heat.

Dr. Van der Weyde — In the galvanic battery electricity is transformed into heat. The neutralization of two opposite electricities always develops heat or light, when there is a medium which resists the current. The heat is greater in proportion as the resistance is greater. Fine platinum wire will become heated, and will become luminous when the current is strong enough. Placing carbon there, we get the vibrations. I think all the data confirm the theory of the President.

III. Fluorescent Solutions.

Henry Morton, President of Stevens Institute, Hoboken, has made a series of experiments from which he draws the curious conclusion that all familiar fluorescent solutions, such as the tincture of turmeric, of argaric, of chlorophyl, and the solution of nitrate of uranium, emit light of the same color by fluorescence, namely, a blue identical with that developed by acid salts of quinine. This blue, however, as is well known in the case of quinine, is not of a single tint or refrangibility, but yields a continuous spectrum, in which the more refrangible rays predominate. Thus it seems that the molecules of fluorescent bodies in solution are not capable of restricting their vibrations to limited ranges, though the same substances in the solid state may act quite differently.

Dr. Van der Weyde — We give the name of phosphorescence to luminosity which a body gives of itself. Fluorescence is that which a body attains by being acted upon by a strong light. This light, however, is always of more refrangible rays than that by which it is produced. This action has been compared to the harmonic tones produced by a string when another string is sounding.

The President — The subject of fluorescence has been very fully investigated by Prof. Stokes of England.

IV. Time Occupied in Perception and Expression.

Mr. T. C. Mendenhall, of Columbus, Ohio, has given, in The American Journal of Science and Arts, an account of experiments made by him to determine the time required to communicate impressions to the sensorium, and to receive a response to such impressions. His plan of proceeding does not differ essentially from that first used by American astronomers in determining what is technically called the personal equation. Time is measured by means of an ordinary register, similar to the astronomical chronograph, in which a strip of paper is moved with great regularity at the rate of about one inch and a half per second, the seconds being registered upon this slip by means of a seconds' pendulum in the electric method. The person on whom the experiment is made is seated at a table, having his hand on a key, by pressing which with his finger the circuit is completed, and the time of this action is registered upon the moving band of paper. An apparatus is attached, by means of which the circuit is completed for an instant, at the moment that there appears at a circular opening—about three-quarters of an inch in diameter—a card, red or white, which completely fills the opening. The subject is instructed to watch this opening, and to close the circuit by pressing for a moment the key immediately on seeing the card. The actual appearance of the card and his closing the circuit in response are registered upon the band of paper by two dots, separated by an interval approximating perhaps to one-fifth of an inch. By carefully measuring this interval and comparing it with the registered second, an expression is obtained for the time occupied by the somewhat complex operation of his perceiving the object and acting in response to that perception. Many devices were used for varying the conditions of the experiment with each subject. With different persons as many as 2,000 individual trials were made, and the errors of experiment eliminated, as far as possible, by the method of averages. Below is a table of the reduced results in one case, in which each number is the mean of the results of from forty to eighty trials:

CASE OF A. G. F.	Time in Seconds.
Response to appearance of a white card	0.292
Response to appearance of electric spark	.203
Response to a sound	.138
Response to a touch on the forehead	.107
Response to a touch on the hand	.117
Response when deciding between white and red	.443
Response when deciding between circle and triangle	.494
Response when deciding between tones C and E	.335
Response when deciding between tones C and C above	.428

The most remarkable fact shown by Mr. Mendenhall's experiments is that perception is quicker through the ear than through the eye.

Dr. J. W. Richards—The sense of hearing seems to be more rapid than the sense of sight. And if the body producing the sound was not very near the ear, the time occupied by the sound in reaching the ear must be taken into account.

Dr. P. H. Van der Weyde—The sound would move two feet in 1-550th of a second; so that that would not make much difference.

Mr. Partridge—Probably the persons were directed to look at the opening. In order to see a motion we should not look directly towards the body which is to move, but near it. The persistence of the impression is greatest in that portion on which falls the image of the object which we are looking directly at. The persistence of the impression on the retina adds to the time required to perceive the change.

Dr. J. V. C. Smith—It may be well to explain a little of the anatomy of these organs, that it may be understood more clearly why the mind receives impressions more quickly through the ear than through the eye. Light traverses space at the rate of nearly 200,000 miles per second; but yet an impression remains a considerable time upon the retina before the mind is cognizant of it. Sound moves only about 1,100 feet in a second; yet the acoustic apparatus is such that the mind is reached more quickly through the ear than through the eye. The ear is so constructed that any disturbance in the air is conducted in whirls and concentrated upon a drum-head. On the opposite side of the drum-head there is a little bone attached to the drum, and between that and the interior part of the ear are four small bones: one looking like a hammer, another like an anvil, and one, called the stapes, resembling a stirrup; and these bones constitute a compound lever increasing the motion produced by the vibration of the drum-head, and carrying it to the sac in which the acoustic nerve is placed.

We see one object with two eyes, because the two images fall on exactly corresponding parts of the two retinas. If we press upon the eye, so that the images do not fall on corresponding parts, we see two images. It is probably a matter of education to learn to see one object with both eyes. I am satisfied that infants in the cradle do not see very distinctly. The fluid of the aqueous humor is so turbid that it is like looking through ground glass. And the same is the case with young birds, puppies and all young animals. By-and-by this is absorbed, and a purer fluid takes its place, and they see more distinctly. This fluid is secreted with great rapidity. A man in Amsterdam, 200 years ago, had great success in curing the blind. A cataract is simply an opacity in the crystalline lens. By pricking the eye, he allowed the fluid to escape, and its place was soon supplied with a more transparent fluid. This man, not being a doctor, was called upon to operate upon a dog, and thrown into prison with the promise that when the dog could see again he should be released. The next morning the lens had filled up with new fluid, and the dog could see.

Dr. J. W. Richards remarked that people often become blind in one eye, or deaf in one ear, without knowing it.

Dr. L. Bradley—I apprehend that persons suffering from strabismus, or cross-eyes, always see double.

Dr. J. V. C. Smith—Cross-eyed people see with both eyes, but much more strongly with one of them. In the case of the chameleon, the two eyes are entirely independent of each other, and they seem to distinctly apprehend two objects at the same time. I do not know whether the mind can think of two things at once, but the chameleon seems to have that power.

Dr. Van der Weyde—I think most birds see with one eye in one direction, and with the other eye in the other direction. In pressing upon the eye, at first we see double; but if we continue the pressure we cease to see double, and then removing the pressure again we see double. People who have strabismus do not see double, for they see with one eye. Strabismus can be cured, especially in children, without any operation at all, by merely strengthening the weaker eye, and accustoming it to look. Notice which eye is used, and cover that eye, forcing the child to look with the other. On uncovering the eye, for a time it will be found that the eyes will move together. By a frequent repetition of this covering of the stronger eye, strabismus can be completely cured.

Dr. L. Bradley—It is not always the case in strabismus that one eye is defective. Sometimes the person can look equally well with the two eyes, and looks first with one, and then with the other.

Dr. J. J. Edwards—Ordinarily we look with both eyes; or we could not have stereoscopic views.

Mr. J. K. Fisher—Artists learn to look at objects as a whole, and not merely at the separate parts.

The President—In playing a new piece of music, in eight parts, the performer must read every note separately, and must do this in a small fraction of a second.

Dr. P. H. Van der Weyde—It is not necessary to read every note. There are rules of harmony and melody; and by giving a glance at it, the musician can divine the rest.

Dr. J. J. Edwards—He must see every note with his mind, which comes to the same thing.

Dr. P. H. Van der Weyde—He only needs to look in most cases at the upper and lower note, and that will know all that is between. A good musician will not make mistakes in that way.

The President—Suppose there are accidentals.

Dr. P. H. Van der Weyde—He knows when there should be accidentals, and if they are omitted he plays them, knowing that the omission is a mistake. The number of chords is limited; and it is that which makes it possible to play operatic scores so easily.

The President—How the mind perceives so much at once we do not yet know. But it reminds me of the process of telegraphing the handwriting, or a picture, by passing a pointer over the sheet containing the writing, the circuit being completed every time it crosses the writing.

Dr. J. W. Richards—I have heard nothing said to-night upon the mode of expression after perception. Good readers see half a line or more before they read it, committing it to memory as they proceed. The difficulty seems to me as great in the expression of the perception as in the perception itself.

Dr. Van der Weyde—A good illustration of that is in playing music at sight. The musician must read a good deal in advance,—in difficult music, twenty or thirty notes to the second; it would be impossible to execute it, if every note had to be looked at. But the musician has practiced all possible combinations, and when he sees a certain combination he executes it. We don't look at every letter when we read a newspaper.

Dr. L. Bradley—I know a case where a person gradually moving the eye down a printed page, without moving it from left to right, can see and comprehend and remember the contents of the page.

Dr. D. D. Parmelee—Probably one man in every five reads his newspaper in just that way. It is the only way now that a man can keep posted up.

Dr. J. J. Edwards—You must analyze as well as generalize. A letter expresses an idea, and if you do not read every letter as you go, you cannot get the sense.

When we look at a complicated vista, the eye at once takes that in; but to understand it, you must go through every detail; if you break a link in the chain, it is gone. The rapidity of the action does not destroy it. So with double vision. It is there; and the rapidity of putting the two things together does not destroy the duality.

Mr. W. E. Partridge—In superimposing the image seen with a telescope upon a number of lines seen by the naked eye, to ascertain its magnifying power, there is distinct vision, and you are doing something with each eye at the same time.

Dr. Van der Weyde—It requires some training to do that. When we see the words "American Institute," we do not look at every letter. If we did, and there was an error, we should always see it. The proof-reader looks at every letter, but I do not read like a proof-reader.

The President—We do a great deal by association; we look at a word and see a certain part of it, and know what the word is. There are two ways of learning a thing by heart. One is to learn the idea, and the other by exercising the organ of locality, remembering the first word on a page, for instance, and from that recalling the rest of the page. The best way is to learn by actual association with the idea itself.

Dr. J. V. C. Smith cited the case of Laura Bridgeman, who was deaf, dumb and blind, and yet had been tolerably well educated through the ends of her fingers. When Charles Dickens was in South Boston, visiting the institution, she was saying something to her instructress, who, on being asked what it was, said she was asking if horses loved butter. The case of Julia Brace, also deaf, dumb and blind, educated at Hartford, was also a remarkable case of education under great difficulty. Julia Brace could put a small cambric needle on her tongue, and the end of a thread, and instantly thread the needle with her tongue.

Dr. J. J. Edwards—When we know how the blind fish see, we shall learn something about it. We are only at the beginning. We shall learn by and by that the blind do see, and the deaf do hear.

Dr. J. W. Richards stated that the appreciation of Laura Bridgeman of the conditions of society, was illustrated by the fact that during the Irish famine she went to work and earned money and bought a barrel of flour and sent it to the Irish.

The President—It is worthy of notice that everything that can enter the mind can be described by a dot and a line—by the Morse telegraph.

Dr. J. V. C. Smith—All this time we have been talking about the organs, and have not talked about the mind. There is a presiding archon that receives the intelligence; and we suppose it is lodged in the brain. We know that we are duplicated throughout; two eyes, two hands, two halves of the nose, and so we have two brains. But we have a great many brains. There is the great solar plexus, for instance, behind the stomach. But we have a class of beings with no brain at all, which act with as much discretion as a man. The spider has no brain at all; and I have watched them as they worked. I have discovered that they are right-handed, working better with the right hand than with the left. It was certainly acting with reference to the attainment of an end, when they have tried the different cords of their web to see which was slack, and then mended that which was broken.

The President—It may be questioned whether the action of the spider is not the result of the education of a great many spiders as predecessors; whether instinct is not really the education of all their progenitors.

Dr. J. W. Richards—The brain is only one large ganglion or congeries of ganglia, similar to the little ganglia that are scattered all over the body. It is not necessary that the functions of the brain should be confined to one organ in all animals.

The President—The skull itself is only an expansion of the upper joint of the back-bone.

Dr. P. H. Van der Weyde—A spider has brains. Agassiz ascribes brains even to the oyster. A spider has eyes, and therefore an optic nerve. Where does the optic nerve go to, if not to the brain?

V. Plants Killed by Frost.

Professor Gœppert, of Breslau, has satisfactorily shown that in certain cases plants die in freezing and not in thawing. The white flowers of some orchids change in color upon a chemical reaction which takes place on the death of the parts. When crushed, or when the vitality of the cells is in any way destroyed, they turn blue immediately. Cold may produce a similar result. These flowers turn blue at once on freezing, showing that life has departed.

Dr. D. D. Parmelee inquired what was the cause of the action of the sensitive plant.

Dr. P. H. Van der Weyde—On the back of the leaf is an organ of brown color, which contracts when it is shaken, causing the leaf to close. If that is cut off, the plant is no longer sensitive.

Dr. J. J. Edwards—It is not one plant alone that is sensitive. Every plant follows out its own nature as much as the sensitive plant, and there is as much motion in one as in another. That of the sensitive plant is more apparent, but they are all equally wonderful when we observe them.

VI. On the Descent of Glaciers.

Henry Moseley, Canon of Bristol, continues in the Philosophical Magazine for August, the discussion on the cause of the descent of glaciers. He opposes the generally received theory, the object of his various memoirs being to show: 1. The mechanical impossibility of the descent of glaciers by their weight alone: 2. The actual cause of their descent to be their dilatation and contraction by alterations of temperature, in addition to their weight.

Adjourned to Friday next, at half-past 7 o'clock, p. m.

November 24, 1871.

Prof. S. D. Tillman, in the chair; Mr. Robert Weir, Secretary.

Dr. Firman Coar read the following paper:

Sewerage Systems at present in use.

Mr. President and Gentlemen.—It is perhaps proper that I should make some apology for appearing before you, an entire stranger as I am. Although born and raised in the old Keystone State, my profession called me to Europe about seventeen years ago, where, with the exception of a few months that I spent here last year, I have been residing ever since. The calls of a profession alone do not, in Europe, suffice to satisfy the desire of many active professional men, and you will find such persons devoting their leisure hours to some particular hobby, which in Germany they call a "hobby horse." These hobbies range from the grandest theories in science, down to that of drinking twenty-five mugs of beer in one evening.

Falling in with the custom, I also mounted my hobby, and that is the subject of sewers, and feeling that I did not like to relinquish it entirely upon my return to my native country, and having occasion to lay the subject before your worthy professor here, he was so kind as to ask me to present it in the form of a lecture before the Polytechnic Society. This, gentlemen, is my excuse.

I therefore propose this evening to call your attention for a short time to the history and working of sewers; to point out some of the misuses to which they have been and still are applied, and I will review briefly some of the means that have been adopted to abate or to mitigate the evil consequence of these wrong uses.

We have no reliable or authentic account of sewers being constructed before those commenced in Rome, by Tarquinius Priexus, 600 years before Christ. These sewers were constructed for the purpose of conveying the fecal matter into the Tiber. Of these sewers (or *Cloaca Maxima*, as they were called), Professor Liebig says, "they swallowed up in a few hundred years all that could make the Roman peasantry prosperous, and when the fields of the Campagna were no longer able to produce the necessaries of life for the Roman people, then the riches of Sicily, Sardinia and the fertile coasts of Africa, irretrievably lost in these cloacæ."

There is, no doubt but one of the results has also been to assist "materially in causing" that rise in the bed of the Tiber which is so well known to have taken place. The consequence of this rise has been to render a great part of the country around Rome swampy, and so unhealthy that it is impossible, during some seasons, for strangers, particularly, to remain a night in the vicinity of these swamps without contracting some fatal malarious disease. At a later date Alexandria, Carthage, Constantinople, Marseilles, Florence, London and many other cities, adopted a system of sewers similar to the *Cloaca Maxima* of Rome. It does not appear, however, that until of late years water was used in sufficient, if to any extent, as a vehicle for carrying off this fecal matter. The only practical demonstration we have of water being used effectually, in early times, for carrying away manure, is that of Hercules turning the river Peneus through the stables of Augias.

The oldest sewers in Germany are, perhaps, some of those still in use in Cologne, which were built in the time of the Roman occupation of Germany. Many sewers, or cloaca, as they were called, that were built in early times in Cologne, have become completely filled up with fecal and other matter, and the consequence has been that these, in connection with the cess-pools of later date, have impregnated the earth in that city to such a depth, that the well water (upon which the city, until now, wholly depends), is of such a nauseous character that it is almost unfit for drinking or culinary purposes. One remarkable fact may also be mentioned, that during the prevalence of the cholera in Cologne, the disease has, in all cases, manifested itself to a far greater extent in the vicinity of these old sewers, and in some cases has been confined entirely to their locality.

There is no doubt but that in the last twenty-five years industrial enterprises of all kinds have made most rapid progress in Germany; but previous to this period all communities followed the beaten track of their ancestors, and the great improvements that sprang up in America and England, during the second quarter of this century, were looked upon as inapplicable to the Teutonic requirements, and he who presumed to advocate the introduction of such improvements was looked upon either as an enthusiast or a disturber of society. The consequence has been that the introduction of both gas and water in the German towns and cities has progressed very slow. Even at the present day there are cities in Germany containing over 100,000 inhabitants that have no regular water supply further than that afforded by the wells of the city. One result of this want of water has been the absence of a proper vehicle to carry away the solid matter that must inevitably enter the sewers, as much of this solid matter is composed of organic substance, which, from its sluggish motions through the sewers, becomes decomposed before its exit from them; the result is a constant evolution of disagreeable and noxious gas within the sewers, which must and does escape through every aperture connecting with the atmosphere.

Even New York, with her abundance of water, is familiar with this *sewer gas*, for there is scarcely a sink or a water-closet or an inlet to a sewer where this gas does not make itself manifest to our olfactory organs. Judge, then, of the extent to which these disagreeable odors prevail in some of the European cities which are not provided with water for carrying away the filth that enters their sewers.

The bad state to which the water in the wells of the continental cities was being reduced, and the want of a supply of water from external sources, have led to a great many trials and expedients to mitigate the evil effects produced by the accumulation of fecal matter. In some places the earth had become perfectly saturated with corrupt and putrefied organic matter, and the exhalation from it was producing disease and pestilence, and it became manifest to the most obstinate that some means must be adopted to prevent a further pollution of the earth and water. In some cities it was decided that all cesspools should be so constructed that the fluid matter could not pass through their walls. Had it been possible to accomplish this end, we might, with some reason, have expected that the water in the vicinity would have gradually improved. It was found, however, that the best walls, even when double cemented, were not impervious to the chemical action of the mass that they were intended to confine; that the cement would soften, and fissures be formed in the walls, through which eventually the fluids would partially escape. It is evident, however, that no matter what care may be taken in storing this corrupt mass of organic matter, decomposition invariably takes place in it attended by a disengagement of most vile and pernicious gases, and that it is *impossible* to prevent these gases from mingling with the atmosphere. It is therefore doubtful, in my opinion, if a perfectly tight reservoir for containing the fecal matter would have any decided advantage over the ordinary cess-pool, where the fluid parts are allowed to soak gradually away in the earth.

Within the last few years, the disposition of the authorities of many of the large cities has been to follow the example that was being so extensively carried out in the cities of England, viz.: To construct large and deep sewers, into which all filth, garbage and excrement should be consigned, and which should, by mechanical or other means, be supplied with such an abundance of water as would float this mass so far without their limits that the pestilential vapors arising from it should in no way contaminate the atmosphere of the city from which it was discharged. This appeared to be (so far as the immediate advantages of the cities themselves were concerned) a most practical mode of solving the difficulty they had experienced—in liberating themselves from the daily accumulations of objectionable and unhealthy deposits. Enterprising contractors and engineers took hold of the idea with assiduity, and representing, in their most favorable light, the great result that had been obtained in England, some German cities were induced to adopt a similar system.

In the mean time, however, observing scientific men, both of England and the Continent, had been studying closely the workings of the English system, and the result of their investigations has been to render it exceedingly doubtful whether that system is correct, or if it is based upon principles that are fundamentally wrong. As a solution of this problem is of the greatest importance to our young and growing country, I shall endeavor to call your attention particularly to it. You will understand that in speaking of this system, I imply, also, the uses to which it is put, viz.: As being the channels by and through which a large amount of the waste matter, street dirt, house slops, fecal and refuse organic matter are to be conveyed to such a distance that the effluvia arising from a decomposition of any of them may have no injurious or disagreeable influences in the locality from whence they were removed; that a part of this system is the carrying away of the waste and rain water, and, in some cases, a draining of the underground, and also that this water, in connection with that especially provided for the purpose, is to act as a vehicle for carrying the first mentioned substances.

Two important theories were put forward in regard to the organic matter that was to be allowed to enter the sewers. One was that this matter would be carried to such a distance before any decomposition could take place, that no danger was to be anticipated in the vicinity from whence it was taken. The other theory was, that should any decomposition take place in the nitrogeneous compounds of the mass, the oxygen of the water would cause such a rapid oxydation, that instead of a deleterious gas escaping in the atmosphere, a harmless salt would be formed, which would be carried away with the effluent water.

As a greater part of the advantages sought for, by means of sewers, depends upon one or the other of these results being accomplished, it is desirable to know what experience has shown us, and in treating upon this matter I shall refer to the critical investigations of undoubted authorities.

Undoubtedly the most perfect system of sewers that can be found anywhere are in some of the cities of England; and in no country has there been so good an opportunity of observing their workings. In London, over £30,000,000 were expended upon the sewers in twenty years, from 1846 to 1866.

Previous to the construction of the present large sewer in that city, the sewers in use opened into the Thames, and their contents flowed into the river, at various points along the city, similar to the manner in which the sewers of New York discharge themselves; and the consequence was, that the Thames, along its whole course through that city, had become a surging cess-pool. In order to do away with this nuisance, a large sewer was built parallel with the river, and the other sewers so arranged that their contents should flow into this great sewer. This main sewer was extended about twelve miles below the city, where its contents had to be pumped up to the surface of the earth. It was proposed, in some manner, to utilize this sewage, but this was found afterward to be impracticable, and it was allowed subsequently to flow off into the Thames. It was, however, soon found that the tide carried this stuff back again to the city, and then came the famous "Thames Pollution Act," which prohibited the discharge of sewage into the Thames. Since then the solid parts of a portion of the sewage are allowed to subside in large reservoirs, constructed for that purpose; and another portion is allowed to flow over a large surface of land, where it undergoes a partial filtration, before it enters the river.

Under ordinary circumstances, where water-closets are generally in use, we may safely state that at least four-fifths of the substance that must necessarily enter the sewers, and which is subject to decomposition, is composed of the fecal matter; the remaining fifth is made principally of the slops of the kitchen, the waste matter of breweries, the offal of slaughter-houses, the fluid from stables, and the organic matter that becomes mixed with the street dirt.

We will now endeavor to arrive, as near as possible, at the chemical ingredients of this sewage as it enters the sewers, and before any fermentation or decomposition may be supposed to have taken place. In doing so, I shall quote considerably from the highly interesting report of the royal commissioners appointed in 1868 to inquire into the best means of preventing the pollution of the rivers. This report was published in 1870, and contains an amount of useful information that should recommend it to the careful perusal of all who may be desirous of investigating the workings of the sewage system. In cities where water-closets are introduced, they estimate about 100,000 pounds of sewage to each person per annum, of which the fecal matter of one person forms but a small part. As a matter of course, the constituents of this fecal matter differ very much according to the customary diet. In a country where much meat is eaten the nitrogenous and phosphorous compounds will be found to predominate to a greater extent than is the case where a vegetable diet prevails. The consequence has been that authors differ very materially in regard to the component parts of this mass.

The commissioners above referred to have accepted the statement of Röder and Eickhorn, based upon the researches of Wolff and Lehmann, which is, taking the average of men, women, and children, about 850 pounds per annum, containing nearly eight pounds of organic nitrogen. Thudichum made an estimate in 1863, the result of which was that he found the amount of ammonia to be 15.9 pounds. Liebig's estimate is about 600 pounds of fecal matter, containing nearly seventeen pounds of nitrogen. Dr. Kyl, of Cologne, has lately investigated this matter very closely, and although I have not yet seen his statement published, I will give it as communicated to me. He found that he could place the average daily product at two pounds; and, from a series of analyses, that he could place the amount of nitrogen at 1.5 per cent. This would make an annual product of 730 pounds, containing 10.95 pounds of nitrogen. As this appears to be a medium estimate, compared with other authors, I think we may accept it as a basis.

We have, then, in this 100,000 pounds of sewage 10.95 pounds of organic nitrogen contained in the human excrements. Allowing this 10.95 pounds to represent four-fifths of the organic nitrogen contained in the sewage, the whole amount would be 13.14 pounds to every 100,000 pounds of sewage. If no change should take place in this sewage, it would be found to contain the above amount of organic nitrogen, when examined at the place where it is discharged from the sewer. This is found not to be the case, since the result of fifty-two analyses of the sewage of the principal cities of England, which are called "water-closet towns," shows an average of 22.05 pounds of organic nitrogen in the 100,000 pounds of sewage. The same analysis shows also the presence of 6.703 pounds of ammonia, making a total of 77.25 pounds combined nitrogen in the 100,000 pounds of sewage, a fraction over one-half of what it should contain, nearly 6.5 pounds having escaped in some way during its course through the sewers. It is important that we should know what form these organic elements have taken, and fortunately we have already sufficient reliable evidence to enable us to arrive at a tolerably rational conclusion. In order to show that very little of these elements undergo oxydation from their combination with the oxygen of the water of the sewage, I will refer again to the tabular statements of the commissioners referred to. In their examinations of the waters of the Irwell, the Mersey and the Darwin, into each of which an immense amount of sewage was discharged, they found that in a flow of eleven miles the average reduction of the organic nitrogen of their contents was 8.5 per cent, and the reduction of organic carbon 10.5 per cent. They do not, however, take into consideration that during that flow of eleven miles a large amount of these organic elements were undergoing other combinations, in which they were, to a material extent, disengaged and allowed to mingle with the atmosphere. In order to test the subject fairly, they mixed five per cent of London sewage with ninety-five per cent of water, and after determining the amount of organic carbon, organic nitrogen and dissolved oxygen contained in the fluid, it was placed in a series of well-stopped bottles. These bottles were opened in succession, one every twenty-four hours, and by determining the amount of dissolved oxygen still remaining in the fluid, it was possible to estimate the amount of oxydation that had taken place. The result of this experiment shows that in twenty-four hours 6.5 per cent of the organic matter was oxydized, and in

168 hours 43.3 per cent had undergone oxydation; and they estimate that sewage flowing in a river, where it would be deluged with twenty times its volume of water, would, by flowing at the rate of one mile per hour, be conveyed at least 168 miles before two-thirds of the organic matter in it would be reduced by oxydation. Another very conclusive proof that this oxydation goes on exceedingly slow, particularly in the nitrogeneous portions of the sewage, is that almost the entire nitrogen that is found in the sewage is in combination with organic matter, scarcely a trace of nitrates or nitrites being discernable, and it is only where the sewage undergoes a proper filtration that oxydation takes place energetically. The examination of the effluent water of the sewage of a large number of cities in England, where irrigation or filtration was in use, shows this to be the case. I think we may, therefore, safely conclude that the theory of oxydation of the sewage, in its flow through the sewers, has very little to rest upon. It is possible, however, that a part of the nitrogen may unite with some of the material of the walls of the sewers, and with the earth surrounding them, and that insoluble compounds may be formed in this way; but as this process would have its limit we need hardly consider it. It is evident, then, that neither of the theories put forward are correct, and we must, therefore, conclude that a physical change takes place, to a great extent, in the organic matter that enters the sewers before it is again discharged from them. The precise nature of this change has not yet been sufficiently investigated to enable us to determine its character with any absolute certainty; but observations lead us to conclude that it is more of a physiological than of a chemical nature; although we find the workings of both principles involved in it. For instance, the rapid development of carbonate of ammonia that takes place, may be partly the result of the chemical affinity of the nitrogen of the urea and the carbonic acid of the sewage; but this transformation is attended with the development of myriads of living organisms, chiefly vibria and bacteria, which rapidly set up putrefaction, attended with an escape of vile and putrescent gases. In the report to the magistracy of Berlin, upon the subject of purifying and draining that city, Professor Virchow and Dr. Hausmann have given a most interesting statement of their miscroscopical observations upon not only the sewage itself, but also the air of the sewers; the results of which I will convey to you in as few words as possible. The sewage was taken from the sewer in Koniggratzer street, and was found to be of

a dirty green color, and of a most disagreeable smell, and depositing considerable sediment, consisting principally of sand and humified organic residue. A great variety of animal and vegetable organisms were not found.

In all cases they discovered:

1. Infusoria in abundance, among which prodominated amoeba diffluens, monas lens, cersomo-monas, paramerium aurelia, stylonyshia mytilus, and on the surface vorticellen.

2. Algae containing chlorophyl of a green color were seldom found in the fresh sewage, although occasional threads of spirogyra and ulothrix were seen. Oscillarien were plentiful and in active motion.

3. None of the well-known species of fungus were found in the fresh sewage, although threads of leptothrix and torula cerebisiæ were always to be seen.

4. The batrachian order of animals, and they were found to be exceedingly numerous in the sewage. Bacterien were in abundance, and particularly the miero and mona bacterien of Hoffmann, which were in active motion. Monas bacterien of Hoffmann, single cell organisms, were found in great activity. Spirillen, lineal formed bodies, having a lively serpentine motion, were also found.

Besides the above, there was found on the surface of the sewage numbers of very small cells, singly and in groups.

An examination of the air of the sewers was done by allowing the air near the surface of the fluid to pass for two hours through a filter of gun-cotton. A part of this was afterwards dissolved in ether and examined under the microscope, when traces of fungus and monas bacterien were found, the last of which was very numerous.

A part of this gun-cotton that had been used as a filter was placed in fresh bailed urine and sealed up tightly.

In another portion of the same urine ordinary gun-cotton was placed, and both vessels were allowed to stand fourteen days, when both tests were found to contain bacterien in active motion.

Although the surface of the fluid in which the ordinary gun cotton was placed remained comparatively clear, the surface of that in which the gun-cotton, used as a filter, was placed was covered with a thick coating of mucor racemosus.

These examinations throw some light upon the organic changes that take place in the sewage, and although at present the results obtained are very unsatisfactory, still I believe that such investigations are in the right direction, and if persevered in will lead to important information.

I will now call your attention, for a few moments, to some practical observations that have been made. We have heard of many instances where persons who have been engaged removing obstructions from the sewers being suffocated, but I will only refer to the one reported in the Medical Times of London, which took place on February 8th, 1861, where four workmen were killed. These workmen entered one of the branches of the Fleet-street sewer, for the purpose of removing the slime and sand that had collected in the bottom of it. It was soon found that something was wrong with them, and it was afterwards discovered that they had been suffocated by the poisonous gas of the sewer.

Thorwirth, who has given this subject great attention, and has traversed the interior of the sewers for miles, says that through their whole course millions of bubbles filled with noxious gas are continually rising to the surface of the sewage, the contents of which mingle with the contiguous atmosphere. The same author says that a house will employ an expensive water supply to remove the small amount of filth belonging to itself, in exchange for which it places itself in a position to receive the poisonous gas from all the cloaca of an entire city district.

Behrend informs us that sewers in Berlin, that are plentifully supplied with water, emit an intolerable stench.

Dr. Thormahlen writes, in regard to the Hamburg sewers, which are well constructed and plentifully supplied with water, that in warm weather a most offensive gas escapes from the sewer inlets, and that by high tides this gas is driven through the house pipes into the dwellings.

I am enabled to state, from my own observations, that in the city of Cassel the escape of gas from the sewers is very great, and that this escape actually takes place, to the greatest extent, in the higher parts of the city. It is also an established fact, that typhus fevers are much more prevalent in these more elevated parts of that city.

Mr. Child informs us that when the cholera prevailed in Oxford, in 1850, sixteen cases occurred in the higher parts of the city, which were to be attributed to the fact that the houses in which they occurred were connected with the sewers by means of water-closets and drainage pipes.

Harkermann states that when the cholera raged in the prisons of

Brest, it was confined to those apartments which were connected with the sewers by means of water-closets.

In the official report of the Metropolitan Board of Public Works, London, for 1865–66, we find it stated that it is necessary for all the sewers to have openings into the air, to allow free ventilation, otherwise the sewer gas will pass through the house pipes into the dwellings, and without such ventilation it would be impossible for workmen to enter the sewers to clean them and make repairs.

In the report of the Metropolitan Sanitary Commission, Dr. Phillips says that he examined the direction of the currents of air in the sewers with the flame of a candle, and without exception found that the flame was drawn into the openings of the house pipes.

It is not necessary for me to cite any more cases, for the fact of the existence of such gas is well known, and it is a common saying among plumbers that a water-closet will stink before it has been used.

It has been proposed to destroy the injurious influence of this gas by consuming it, but until now no such plan has been put into operation. Chief Engineer Bazelgette says in his report, that in order to deprive the London sewer gas of its injurious properties by combustion, it would be necessary to have about 230 furnaces with high chimneys, at a cost of £460,000, with an annual cost for coal of £225,000.

In the face of these important facts I am unable to discover how, as long as the sewers are made the receptacles of the fecal matter, they will enable us to obtain the first and second of the three great desideratums that a good sanitary system requires for all cities, viz.: pure air, pure earth, pure water.

It is the opinion now of a great many well informed persons that the only practical way of preventing the sewers from becoming a permanent nuisance, is to absolutely prohibit the discharge of all fecal matter into them, and the enactments in England in this respect are of such a character that it will soon be almost impossible for the sewers to be used as the channels for carrying away this substance. Various ways have been proposed to transport this stuff out of the city, but I will only call your attention to those that propose to utilize it.

The first that I will mention is what is called the "cask system." This has been in operation for over ten years in the city of Gratz, in Austria. The city contains nearly 100,000 inhabitants, and the system may be said to be in general use there. The system consists of single casks provided with proper funnels for conveying the deposits into the casks. Each house is provided with a fresh cask every three or four days, and at the same time with a certain amount of disinfecting material. The filled casks are carted out of the city, where their contents are partly disposed of to the farmers, and partly manufactured into poudrette. With the assistance of a very small contribution from those who use the system, the company working it have carried it on successfully for more than ten years. The inconveniences of this system would no doubt render it objectionable to our American ideas; nevertheless it has one important feature to recommend it, and that is a giving back to the soil its natural elements of productiveness.

The mole, or earth-closet, is already so well known here that it is unnecessary for me to comment upon it. My opinion is, that for small towns and villages it could be made to answer most satisfactorily.

"The Gaux system" is a kind of combination of the "cask system" and earth-closet. It consists of a cask in which a conical core is placed and the earth filled in around this core, after which the core is removed and the cask with its earth contents is placed under the privy seat where it remains until the whole mass becomes a sort of muck. It is said that, for an ordinary family, one of these casks will suffice for two or three weeks. When the casks are removed their contents are formed into blocks and allowed to dry, when the substance is in a marketable form. I learn that the Gaux system is already patented in this country, and efforts are being made to introduce it here. There is no doubt that each of the above systems has much to recommend it, but the great objection now, and that will remain to them, is the manner in which they must be worked. Few persons in this country will tolerate the continued entrance into their houses of a class of persons that must necessarily be employed in working either of the systems referred to; besides, the disagreeableness of having those vessels carried in and out at inconvenient times will be an objection that I think will hardly be surmounted.

The Pneumatic Sewage System.

I will now refer to another system somewhat more complicated than either of those above mentioned—but at the same time one that is attracting considerable attention in Europe at the present time. In the last annual of the Agriculturist I had occasion to bring this system into notice; but as I did not enter into its details at that time, I shall endeavor to give you as clear an understanding of its principles and workings as it is possible for me to do.

This system is called "The Liernu Pneumatic Sewage System," invented by Captain Charles S. Liernu, a Holland engineer. The inventor proposes to remove the fecal matter expeditiously and effectually, regularly every day from all buildings that it may be brought in connection with—and to do this without any disturbance to the parties using the system, and even without their knowledge. As this is done by using air as a motive power, it has been called the "pneumatic system." The plan is to divide the city into complexes and subcomplexes. A subcomplex would consist of about 200 houses or their equivalent. A complex would comprise all the subcomplexes within a radius of 2,500 feet. A subcomplex would have one air-tight cast-iron reservoir, in common, for the reception of the fecal matter, as shown on the black-board. The connection between this reservoir and the different houses is by means of 5-inch cast-iron pipes, consisting of a main street pipe, with a branch to the closet of each house. These pipes are provided with traps, valves and cocks, by which a circulation of air through them may be prevented, and which are necessary for a successful emptying of the pipes. The last of these (the cocks) are placed in the main pipe near the reservoir, and may be worked by means of a crank from the surface of the street. These are shown on the black-board. A self-acting valve is connected with each branch pipe at its junction with the main pipe. The branch pipes as well as the mains are provided with traps at different intervals. The reservoir has one pipe opening into it for the purpose of exhausting the air. It has also one entering it and extending nearly to the bottom of it for the purpose of carrying all the contents of the reservoir.

The fecal matter, after entering a fall pipe and filling the trap at the bottom of it, will be carried by the force of gravity on to the next trap, and so on until it forces open the valve at the connection with the main pipe, when it will enter that. If all the pipes should become filled (which would rarely be the case), their contents would flow into the reservoir. In order to empty these pipes thoroughly it is necessary to exhaust the air from the reservoir with which they are connected. This is done by means of a powerful steam-engine driving an air pump in connection with the large central reservoir, with which, as I have said, all the reservoirs within a radius of 2,500 are connected.

Before opening the corks in the pipe communicating between the main reservoir and the sub-reservoir, it is necessary to close those in the main pipes communicating with the houses.

If a communication is then made and we have a rarefaction of the air in the main reservoir, it is plain that a corresponding rarefaction will take place in the sub-reservoir. Then, after cutting off the connection with the main reservoir, a cock in one of the main pipes is opened, and it is evident that the atmosphere pressing upon the contents of the branches of this main pipe must force these contents in the direction of the reservoir. Should they not be forced entirely to the reservoir, the valves in connection with each branch pipe would prevent any return, and a second exhaustion of the reservoir would enable them to be driven still farther. By a proper manipulation of the cocks the contents of all the pipes of a sub-complex may be conveyed in less than five minutes in the main reservoir. I am not aware that Mr. Liernur has yet proposed any plan by which the fecal matter should be conveyed in pipes from these main reservoirs to without the city limits. But I do not apprehend that engineers would find much difficulty in devising such means, provided they were furnished with the necessary stimulant. The reason, perhaps, is, that most of the European cities have, apparently, obtained their growth, and may almost be said to be "fenced in," not being surrounded with the suburb reservoirs for miles around, so that immediately outside them farming and gardening commences; and the practice, so far, has been where this system is in operation to fill the stuff into barrels at a decanting station within the city, and the farmers and gardeners carted these casks away themselves, paying at the same time about twenty-five cents per hundred weight for their contents. It does not require a very extended knowledge to understand the general principle upon which this system works. But, as a matter of course, when it comes to a practical application of it, there are many details that time will not allow me to enter into the discussion of.

For instance, the construction of the air-pumps is such that, with a two horse-power engine, we may, in half a minute, reduce the air in a reservoir, containing 100 cubic feet, to such an extent, that water would be raised twenty-seven feet in a pipe communicating with it. The construction of the valves on the branch pipes are also an ingenious contrivance.

This system, if in proper working, would certainly accomplish two important objects, viz.: It would prevent any possibility of the earth being further impregnated with corrupt and decomposed fecal matter. Secondly, it would prevent this matter from being discharged into our rivers and harbors, the practice of which has already in many cases become such a serious nuisance, and which, if persevered in, must become a source of absolute danger.

I believe, also, that this stuff being confined in air-tight pipes, and shut off from the action of the atmosphere, would be subject to very little change by fermentation, during the twenty-four hours that any part of it would remain in the pipes, and, consequently, there would be little or no escape of noxious gases from it. I believe that it would be difficult to accustom ourselves to either of those systems that would require the removal from our houses, at stated periods, vessels containing such disagreeable contents. The pneumatic system, however, provides a way that is free from any objections on the score of modesty or decency. This system has been in successful operation in the city of Prague, Bohemia, for about two and one-half years. In Brunn, Moravia, some forty reservoirs have been in operation a little over a year. In the city of Hanau, near Frankfort, it has been in operation about a year; and when I left Germany, last August, works were being completed for Heidelberg, Manheim and several other places in Germany; beside, works were in a far advanced stage for its introduction in a large part of the city of Amsterdam, Holland.

By either of those four systems we accomplish one very important object, but one that I fear is not yet sufficiently appreciated. It is this: we are enabled by them to restore to the earth a large amount of the important elements of productiveness, that have been taken from it by the food which we consume.

It is discouraging to find gentlemen, who are extensively engaged in agriculture, and even those occupying high official positions in our agricultural societies, giving way to the ignorance and prejudices that have grown up against the use of fecal matter as manure.

Let us compare its component parts with those of two of the most popular organic manures:

Guano contains uric acid, phosphoric acid, oxalic acid, carbonate of ammonia and a small portion of earthy salts; the nitrogen of the uric acid and carbonate of ammonia being the principal elements upon which the value of the guano is based.

The fluid parts of horse manure contains urea, hippuric acid, soda and common salt, or chloride of sodium. We have here the same important element, nitrogen, contained in the urea and hippuric acid, which constitutes almost the entire value of this fluid.

In the fluid parts of the human excretion we have in 1,000 parts about fifty parts that are composed to a great extent of organic nitrogen, a, the urea; b, lactate of ammonia; c, uric acid; d, phosphate of ammonia; about seven parts of sulphate of soda and potash, and about four parts phosphates in different forms, the remainder of the 1,000 parts being principally water.

These last figures are taken from Berzelius' Analysis, and they show that the nitrogenous compounds contained in the urine are about five per cent. Taking nitrogen as a basis upon which the value of organic manures are estimated, we can place them thus: Guano contains, nitrogen, 10 per cent; fecal matter, nitrogen, 1.5 per cent; the fluid of horse manure, nitrogen, .3 per cent.

For my part, after examining the component parts of these different manures, I am unable to discern any ground whatever for the entire regestion of one of them as a producing element. To be sure, I would object seriously to the manner in which it is offered to the consumer; but as hundreds of the necessaries of life pass through their objectionable stage before they are brought upon the market, there is no reason why this important item may not be so dealt with as to render it easy for the consumer to dispose of.

I cannot close this subject without asking one serious question. If we refuse to avail ourselves of this important source of nitrogen, upon what are we to depend when the guano fields become entirely exhausted? Mineral manures seem to be turning up in abundance, but they will not help us, unless we provide the earth with sufficient nitrogenous compounds upon which the vitality and growth of plants depend.

Boussingault, who is so often quoted by Prof. Liebig, tells us that in the fecal matter produced by one man in a year there is sufficient nitrogen to support the growth and mature the development of 800 pounds of wheat. Our agriculturists and national economists may continue for some time still to disregard the importance of carefully preserving and utilizing this valuable and vital element of plants, but, be assured, the time will come when, if they wish to see our country continue to be the garden that must supply the deficiency of the rest of the world, they must abandon the present extravagant policy which they have already too long indulged in.

In conclusion, gentlemen, I would thank you for the opportunity of bringing this matter before your honorable society, and also for the patience with which you have listened to my remarks.

Mr. T. D. Stetson inquired what was the arrangement in the house.

Dr. F. Coar stated that the funnels are constructed very deep, with an air passage outside, connected with a chimney, for ventilation. At

Prague it was used in the barracks. At Amsterdam the work is far advanced for trying it on an extensive scale.

The President said that in a city like New York, with plenty of water, the ordinary system seemed preferable, as we have not yet any necessity for saving the sewage. But in many places where the supply of water is small, the plan presented advantages worthy of consideration.

Mr. J. K. Fisher did not consider the system in New York as satisfactory. The gas rising into the houses from the sewers was sometimes very offensive and noxious.

Dr. J. V. C. Smith considered the proposed system too complicated for general use, although it would undoubtedly work well for barracks, or in similar positions. He stated the customs at Cairo, where a tub was placed in the back room of the dwelling, and emptied every day, and on Mount Lebanon, among the Druses, where deep wells are employed which require no attention. In no place in the world was a better system than in New York or Boston; and there was no necessity for any modification of it.

Mr. T. D. Stetson said it would not be necessary to go from New York city to find a place where the system is not satisfactory. Even here there is something to complain of, as the traps at the street crossings, which are sometimes four inches deep, while in the houses the traps are only two inches deep, so that the first escape of the foul air, when forced back by high tides or heavy rains, is into the houses instead of the open air. If we go to Newark, we find a beautiful growing city, with a good supply of water. Go up to Belleville, and we find them pumping up this water from the Passaic river to send to Newark and Jersey City. Go a few miles further up, and we find the active and growing city of Paterson, and we see rows of machine shops, whose out-houses overhang the river. We remonstrate, and suggest that the people of Newark and Jersey City have to drink this water. But, says the Patersonian, if you place them anywhere else, it all washes into the river; and what can we do? There are plenty of such instances, and as the country is filled up they will become more and more numerous. We may be happily situated in New York, but should take a cosmopolitan view of the question, and consider the interests of humanity generally. The earth-closet is valuable in many respects. It is wonderful how completely a deposit of half an inch of fine earth—not sand or gravel—will absorb all the gases from fecal matter. The earth can be used four or five times, being dried, before it becomes really offensive; and in the case of a gentleman living in Providence, an Irishman, who knew nothing about the apparatus, being employed to pass the earth through a screen, that it might be used over again, did so without discovering what it was, showing how thoroughly it was deodorized. Earth-closets make the best system, not for this city, but wherever water-closets cannot be advantageously used.

The President stated that there was a prospect of carrying out the system of supplying pure water to Jersey City, described in his paper of last winter. We need to devise some system suited to the whole country. The cities upon the seaboard are an exception, but the arrangements generally throughout the country are of the rudest kind. It is of great moment, therefore, that the pneumatic system is to be tried on a large scale at Amsterdam, among an advanced and reading people, who will give it a fair trial.

W. E. Partridge said that, in four cases out of five, probably, the rising of gas into the houses in this city is the fault of the plumbers, and not of the system or of the sewers; and he explained how it occurred. It being inconvenient in many cases to connect the waste-pipe from the sink and from the bath-tub with the main pipe above the trap, they are connected below; so that the only use of the trap is to send the current of foul air through the bath-tub and the wash-basin instead of through the water-closet. And lest this should be closed, there is provided another opening, through the overflow pipe of both wash-basin and bath-tub, which always affords direct communication from the sewer to the interior of our dwellings.

Adjourned.

December 1, 1871.

Professor S. D. Tillman in the chair; Robert Weir, Secretary.

The Chairman read the following notes on recent scientific investigations and discoveries:

I. Another Planet Discovered.

On the 14th of September last, Dr. Luther, of Bilk, discovered a new planet. It was equal in brilliancy to a star of the eleventh magnitude. The number of asteroids now known is 117.

The President stated that American astronomers have discovered more asteroids than have been discovered in Europe within the last ten years.

II. Colza Oil.

Messrs. Wurtz and Willm have ascertained that colza oil, after being subjected to a current of steam heated to about 250° Fah., loses its peculiar acrid taste and smell. Any trace of fatty acid which remains after this treatment can only arise from the adulteration of the oil, and may be removed by washing with a weak solution of carbonate of soda. The oil is then fit for table use, as a substitute for olive oil.

III. Variation in the Solar Spectrum.

Zöllner, in a recent lecture, said new evidence has been found that the motion of a shining body alters its spectrum lines. Dr. Vogel had recently shown, by means of an improved spectroscope, that the lines derived from one side of the sun were different from those of the opposite side; that is, as the sun rotates, the parts approaching give a different spectrum from the parts receding.

IV. Influence of Brass and Copper against Cholera.

Dr. Burg, in reviewing the statistics of deaths from cholera, finds that out of about 32,000 artisans in copper, brass and bronze, employed in Paris and other cities during the last outbreak of cholera, only sixteen deaths resulted from that disease. Another interesting fact bearing on this question is that the city Mio-Tinto, surrounded as it is by copper mines, has never been visited by this epidemic.

V. Chemical Reactions.

Berthelot, from investigations of changes of pressure and volume produced by chemical combination, deduces the following proposition, viz.: That the heat invariably produced in a chemical reaction, supposing it to be applied exclusively and without loss to warm the products, is such that an augmentation of pressure always takes place at a constant volume; or, what is the same thing, augmentation of volume at a constant pressure.

VI. Animal Phosphorescence.

M. Panceri has recently given to the Congress of Naturalists and Physicists at Turin an account of his investigations of animal phosphorescence. He concludes that this phenomena is due to the slow combination of oxygen with the adipose tissue, since it immediately disappears on placing the phosphorescent matter in any medium free from oxygen. Phosphorescence commences soon after the death of the animal, and when decomposition sets in it ceases.

VII. Sponge Paper.

This article, recently patented in France, is fabricated by adding to ordinary paper pulp, evenly and finely divided sponge; and by means of the ordinary paper-making machinery the mixture is worked into sheets of different thickness. As this paper absorbs a great deal of moisture and holds it for a long time, it is capable of important technical applications. In dressing wounds, it has been used with considerable advantage.

Dr. L. Feuchtwanger stated that some years ago asbestus paper was made in Baltimore for printing, which was used also for its incombustible and absorbent qualities.

VIII. To Calculate the Heating Power of Petroleum.

H. St. Clair Deville of France gives the following rule for estimating the calorific effects of a given sample of oil, which, although it makes the theoretic amount a little larger than that found in practice, is near enough to ascertain the relative values of oils as fuel. First, the amount of carbon, hydrogen and oxygen contained in the sample is found by analysis. Second, subtract from the hydrogen one-eighth of the oxygen, then multiply the difference by 344.62, and add to the product the quantity of carbon multiplied by 80.8, and this sum will be the number of heat units in one kilogram.

IX. Spectra of the Nitrogen Group of Elements.

M. Ditte has examined the spectra of nitrogen, phosphorus, arsenic and antimony, produced by passing the electric spark through their several chlorides, taking care to eliminate the bands known to result from chlorine. The most interesting phenomenon noted by him was that the spectra increase progressively from nitrogen to the antimony; they begin at points near the orange red, but the more refrangible rays extend themselves more and more toward the violet in proportion as the properties of the elements under examination approximate to the metallic character.

X. Contagious Epidemics.

M. Chauveau has laid before the French Academy of Sciences the results of his researches on contagious epidemics. He had previously shown that the contagion caused by virulent humors depends not on dissolved substances, but on solid corpuscles which they hold in suspension; in fact, inoculation with dissolved substances remains without result, and that with corpuscles produces characteristic results. By similar experiments, M. Chauveau proves that the miasms diffused in the air are not disengaged gases, but solid corpuscles. The fluid obtained by condensing the vapor arising from the evaporation of a virulent liquid may be used in inoculation without danger, while the primitive liquid retains all its contagious properties. The same results were obtained in experimenting with the virus of small-pox, the rot, the epizootic typhus, etc.

XI. Nitrate of Silver and Charcoal.

Prof. Chandler, editor of the American Chemist, states in that journal that when solid nitrate of silver is placed upon glowing charcoal deflagration takes place, the result being that silver is left behind in the metallic state. The curious phenomenon attending the reaction is that the nitrate, being fused by the heat of chemical action, sinks down in the pores of the coal, and as each particle of the latter is replaced by the reduced silver, the structure of the original wood is retained. In this way he has succeeded in producing masses of silver weighing an ounce or more, which show most beautifully the rings of annual growth in the wood. The author advises that a crystal of the nitrate be placed on the end of a stick of charcoal, and the blowpipe flame directed upon the coal beside it to start the reaction. As soon as the deflagration sets in, crystal after crystal may be added.

XII. Solidifying and Melting Points of Fats.

Dr. Wimmel, in Poggendorff Ann., directs attention to the fact that many fats may be made to solidify at two different temperatures. Those fats which yield glycerine by saponification especially show this peculiarity, the temperature at which solidification occurs being lower than that at which melting takes place. When these fats, after melting, are allowed to cool, their temperature gradually falls to a certain point, where, for a time, it remains stationary, and then exhibits a certain rise as it becomes solid. The definite degree of heat at which this takes place Dr. Wimmel proposes to call the natural point of solidification, as this point is less changeable than the melting point — a characteristic the direct opposite of that attending the change of water into ice. The fact that ice is formed at different temperatures, has led to the adoption of the melting point of ice as a fixed point from which to measure degrees of heat.

XIII. Proposed Improvement in Telescopes.

The late Rev. W. V. Harcourt of England made a protracted series of experiments, commencing as early as 1862, for the purpose of reducing or eliminating the secondary spectra found in the best achromatic object glasses. It can be shown, theoretically, that any three different kinds of glass may be made to form a combination achromatic to secondary as well as primary spectra, but the actual construction of such a triplet is beset with difficulties. Mr. Harcourt found that by combining a concave lens made of glass containing terborate of lead with positive lenses of ordinary glass, or else a positive lens containing titanium with negatives of crown and flint, or a positive of crown and negative of low flint, triple combinations free from secondary spectra might be formed, and that by substituting a borate of lead for the flint glass, and a titanic glass for crown, still further advantages might be gained. After encountering many difficulties, discs of terborate of lead and of titanic glass, homogeneous throughout, have at last been obtained, with which it is intended to construct an object glass which shall be entirely free from secondary color. Such an achievement will be a great advance in the optical art.

XIV. Action of Magnetism on Gas.

De La Rive and Sarasin have recently laid before a scientific society of Geneva, Switzerland, an important communication, in which they arrive at the following conclusions: 1. The action of magnetism, when only exercised upon a part of an electric jet, projected through a rarefied gas, causes an increase of density. 2. The same action on an electric jet placed equatorially between the poles of an electro-magnet produces in a rarefied gas an increase of resistance, which is greater in proportion to the conductivity of the gas. 3. The same action creates a decrease of resistance when the jet is directed in the line of the axis between the magnetic poles. 4. When the magnetic action consists in the impression of a continued movement or rotation of the electric jet, this action has no influence upon the resistance, if the rotation is in a plane perpendicular to the axis of the cylinder of magnetized iron which determines the rotation; whereas the resistance decreases considerably if the rotation takes place so that the electric jet describes a cylinder of revolution about the axis. 5. These several effects cannot be attributed to a variation of density produced by the action of magnetism on the gas, but probably they are explained by the perturbations that such action causes in the molecular arrangement and disposition of the particles of the rarefied gas necessary for the propagation of electricity.

Dr. A. Ott then read the following paper:

HYDRAULIC CEMENTS—THEIR ADAPTABILITY FOR USEFUL AND ORNAMENTAL PURPOSES.

PART 1.

There are few branches of industry which to-day present more practical interest than that pertaining to the application of hydraulic cements. They are not only of the greatest importance for all constructions under water, but they are also capable of replacing the natural stone for superstructions in most, not to say in all, instances. Unless the use of mortar be abstained from altogether, and large and carefully prepared building stone used instead, it would be impossible to erect a building under water without having recourse to hydraulic cement. The enormous expense and the difficulties of the latter method would undoubtedly reduce the number of such constructions to a minimum. "Where, for instance, we now see imposing lighthouses boldly defying the threatening pressure of the waves, the mariner might be exposed to all the dangers of the coast without a warning signal or a guiding beacon. Where splendid ports, with massive docks and bulwarks, most effectually protect trade and commerce against the indomitable action of a powerful element, we should probably find no trace of the lively intercourse and international commerce which animate our principal seaports, had not chemistry given us means to replace, by art, what nature has either refused or granted only at a few exceptional places.

"For the security of commerce, for coast defense and protection, for the intercourse on our water roads in the interior, and for a thousand other purposes, hydraulic cements are of the highest importance. 'Concerning their use for buildings above water,' says Michaëlis, 'it may safely be asserted that they have made a remarkable impression on our modern architecture, and have replaced the old stiff and clumsy masses by elegance and boldness of conception. One need but compare the columns, arches and lofty balconies of European capitals with those of former periods, to see how much more ease and freedom characterize our modern style. It seems as if the architect knew how to influence his design by his genius; yes, as if he had succeeded in freeing himself, as if by magic, from the fetters of gravitation to which all matter is inevitably subjected.'"

Hydraulic mortars are all mortars which, in contradistinction to common or lime mortar, resist the action of water. These mortars were already known by the Romans, and applied by them on a very extensive scale. We will only call attention to the harbor dams of Puteoli, the aqueducts of Claudius in Rome, near Segovia in Spain, of Metz, in the Eifel (between Cologne and Treves), and to the Tiburtinian gate, which, to this day, have resisted the vicissitudes of time. However, when it is considered that hydraulic mortars occur in the volcanic districts of South Italy, the merit of this knowledge is considerably lessened; a mere accidental observation of the same, it being perhaps mixed with sand instead of lime, may have led to its application.

Vitruvius, in the fourth chapter, second volume, of his work, De Architectura, says: "There exists a kind of dust which produces strange things; it is found near Baja and the Vesuvius. When mixed with lime, it forms a mortar, which not only imparts great strength to buildings, but also to water-works."

The natural cement in question is a volcanic earth, mostly of an ash color but sometimes yellowish and brown, which is still found in the environs of Naples. At a less remote period of time, when the Romans invaded the valleys of the Lower Rhine, they easily recognized the volcanic nature of the Brohl valley. Here, among the long extinct Rhenish volcanoes, they found another natural cement, the trass, in such considerable quantities that the quarries which they opened are still in existence. The use of hydraulic cement in ancient times could therefore have only been a limited one, as it was found only at the places mentioned. Its artificial preparation was not understood. However, the Romans had made very fine observations on the properties of this natural product. They cast, for instance, immense blocks of stone from it, which they applied as ballast for the erection of docks. Upon this topic, Vitruvius expresses himself, in the third chapter, fifth volume, of the above named work, as follows:

"If there is a place not suited by nature to protect vessels against storms, it seems that it is the most proper to throw up walls and dams on one side, provided there be no river in the way, and a good anchoring ground on the other side. But, if piers are to be erected in the water, I proceed in getting earth from the dominion that extends from Cumæ to the promontory of Minerva, which I mix with lime in the proportion of two to one. Boxes are then submerged in the selected spot, and are united by strong piles and clamps in order to keep them in their original position. Next, the boxes are filled with a mixture of rubbish, or broken stone, and the above described mortar. But if the waves or the violence of the sea does not permit of keeping the boxes in their position, a solid platform must be thrown up from the land or shore dam, which is to be constructed for one-half of its length in such a manner that it will form a level with the sea, while the outer half should be sloping. Walls should then be erected along the platform of one foot and a half in width, and of the same height as the latter. The intermediate space is then filled up with sand. On the surface thus produced, a block cf the necessary dimensions is formed, which, after its completion, is left to dry for not less than two months; but after that, the breast wall, which affords a hold to the sand, is torn down, the submerging of the block being left to the waves that wash the sand away."

From the time of Pliny (who reproduces the report of Vitruvius) up to the fifteenth century, no further mention is made of hydraulic mortar. During the fifteenth and sixteenth centuries, Leon Battista Alberto, the founder of the Renaissance, Palladio Scamozzi, and Philibert De Lorme, made precisely the same reports as the Latin authors. Since the latter part of the seventeenth century, the Dutch, the condition of whose country render hydraulic constructions especially desirable and necessary, first used domestic (in place of Italian) cement, from the neighborhood of Coblenz. Next to Holland, the application of water mortar was first resorted to in France and England; but up to the middle of the eighteenth century, nothing further became known about its use and application than what had already been familiar to the Romans; for the work of the celebrated engineer and architect Belidor (*Architectura hydraulica*, Paris, 1753) contains nothing of interest except that which had before been explained by Vitruvius. Since the end of the last century, however, a lively and general interest in the subject has manifested itself.

The impetus to new experiments with hydraulic mortar was given, in 1791, by the celebrated John Smeaton, the builder of the Eddystone light-house. "The Eddystone light-house," says Michaëlis, in his excellent treatise on hydraulic mortars, "is the corner-stone on which the knowledge of hydraulic mortars has been built; it is the pillar of modern architecture. Not only to mariners, but to the whole world, this *pharos* has become a landmark of most beneficent effect."

Smeaton was required to solve the problem of constructing a high and colossal structure, exposed to the fury of a tremendous sea; for which he had to select a mortar capable of permanently resisting the action of water. For this purpose, he subjected the best specimens of English limestones to chemical tests. Upon finding that in treating them with dilute nitric acid, an argilliferous residue remained, he was able to declare that "all limestones which leave a residue of clay on dissolving them in acids, will, if calcined, solidify under water, while all limestones not deporting themselves in this manner, are unavailable as hydraulic mortar." (*John Smeaton: A Narrative of the Building, and a Description, of the Eddystone Light-house, etc., 2d edition, London,* 1793.)

In the year 1796, the so-called Roman cement was discovered by James Parker; and, regardless of its cost, it was for a quarter of a century nearly exclusively used in England for building on land and in the sea. The same was prepared from the spheroidal concretions of marl, occurring in the so-called London clay; in composition, it is similar to the volcanic earth of the ancients.

In 1822, two Frenchmen, Giralt and St. Leger, and in 1824, Joseph Aspdin, in England, produced for the first time artificial cement of decidedly superior quality. The latter, a common mason, secured on October 21, 1824, a patent for a new improvement in the making of artificial stones. He first gave to his cement the name of Portland cement, from the fact that it was very similar in appearance and quality to the Portland stone, the uppermost strata of the English chalk formation, from which the most beautiful and imposing buildings of Great Britain have been erected.

The making of artificial cements, in spite of the patents secured by Aspdin and others, would probably have remained a mystery for a long time, had not scientific men begun to examine into the process of solidification, the composition and the requirements of hydraulic mortar. How difficult these investigations were is proved by the fact that numerous examinations by the most skillful chemists were necessary to establish a few facts, which might be related to you in one-tenth of the time occupied by my paper. We may pardon the manufacturers for their caution, since they acquired, almost exclusively by long study and great sacrifices, the necessary certainty in the fabrication. Should they freely lay before the world their costly experiments? This was certainly not in their interest.

Great merit is due to the French engineer Vicat for making the most extensive use of the hydraulic limestones of France, of which he discovered numerous deposits. The savings, caused by their application in the building of bridges, locks, viaducts and canals, were in his time enormous; and only to mention one instance, France saved, in the cost of bridge building until 1845, almost seventy millions francs. The credit, however, of having established the first scientific explanation of the process of solidification, and of having indicated the way of composing hydraulic cement, from materials occuring almost everywhere, in the shortest and most certain manner, belongs to the German chemist and academician, Justus Fuchs. His investigations are published in two memoirs, both of which were published in 1828, in "*Ueber Kalk und Mörtel*" (On Lime and Mortar), and in "*Ueber die Eigenschaften, Bestandthelie und chemischen Verbindungen des hydraulischen Mörtels*" (On the Properties, the Composition and the Chemical Combinations of Hydraulic Mortar). The results of the latter essay being of the utmost importance for Holland, the Dutch Academy of Science resolved, a few years later, to award him their golden medal. The credit for further valuable information on this topic is due to the Frenchmen, Berthier, Frémy, Mêne, Rivot, Chatoney; to the Englishmen, Pasleo, White & Sons and Macleod; and to the Germans, Pettenkofer, Winkler, Feichtinger, Manger, Heldt, Michaëlis, and others.

Hydraulic Mortars — Their Adaptability for Useful and Ornamental Purposes.

The last named author divides the hydraulic mortar into the following three classes:

1. Pozzuolana, or pozzolana mortars, are prepared from pozzuolana and lime. The pozzuolana, for a long time the only and still an important substance for the preparation of hydraulic mortars, is a volcanic tufa, and was first used by the Romans, as mentioned above. This name has become a collective name for volcanic tufas in general, pyroxenic minerals, calcined clay, slate (the *psammites* of the French), and clays, brick-dust, volcanic sand (*les arenes*), ashes and slags; and it is the more justified, as the Italian pozzuolana must be regarded as prototype of these materials.

2. Hydraulic limes are such natural and artificial limes which solidify more or less under water, and which are not so strongly burned that vitrification has taken place. They yet contain free lime in their calcined state. To these belong, among our American cements, the Rosendale, and the cements from the following named localities, viz.: Cumberland, Maryland; Louisville, Kentucky; Coplay, Pennsylvania; Sheperdstown, Virginia; Round Top, near

Hancock, Maryland, etc. To this group belong, also, the so-called Roman cements.

3. With the name Portland cements we designate those artificial and natural hydraulic mortars which are so strongly burned that softening has taken place, and which, in their burned state, contain no free lime. They possess, furthermore, a specific weight of over 3. As mentioned above, it was Aspdin who first manufactured such a cement, but the name given by him for his product has now become a collective name, it being used for all mortars here defined.

Neat cement, that is, cement without any admixture, is but seldom used. The ordinary admixture is sand, a material employed for that purpose from time immemorial. As regards the quantity which may be admixed to hydraulic cements in general, it is almost impossible to lay down strict rules; in many cases it may, therefore, be advisable to resort to an experiment to ascertain what mixture answers best for the object to be attained before carrying out works on a large scale. With reference to Portland cement, however, we would state that it may be mixed with three to four times its quantity of sand, but that this must be considered the extreme limit whenever it is intended for solid structures. Not every kind of sand is fit for the preparation of mortar. Scarcely more than five per cent of clay are, for instance, sufficient to reduce the strength of the solidified cement considerably. Such sand ought, in all cases, to be carefully washed before used. With regard to the shape of the grain, pit sand is preferable to river or sea sand, since its surface is largest in proportion to its quantity. Sea sand and river sand, though very clean in most cases, consist of spherical bodies, which, as well known, offer the smallest surface to the quantity. Sand assuming the form of leaflets is preferable to any other. From a chemical point of view an admixture of feldspar or feldspathic minerals (gneiss, granite, syenite, diorite, etc.) might be recommended, inasmuch as where free lime is present the potash or soda in the feldspar will be replaced, a silicate of lime being formed, which, in combination with the silicate of alumina in the feldspar, possesses great cementing qualities.

In preparing cement for use it is always best to mix the dry sand as uniformly as possible with the cement before adding any water to it. Since the strength of a mortar depends directly upon the quantity of water present during the moment of setting, the quantity of water must not exceed what is barely sufficient to convert the mortar into a stiff and plastic paste. This end is best attained by mixing machines, especially devised for the purpose; and it has been found that a combined pressing and rolling motion secures the best results.

To speak of the application of hydraulic cements, they are especially useful for the manufacture of building stone. In Europe, especially in England, numerous buildings of the kind have been erected; in London, for instance, the celebrated College of Surgeons, in Lincoln's Inn Fields. In this country, buildings constructed of cement stone made by the process of George A. Frear, have been erected in Brooklyn, Toledo, Buffalo, Chicago and New Orleans. In the various cities of the west upwards of 300 buildings have been constructed of this stone during the last three years, and they have satisfactorily stood the test of the severe climate which is more severe in the west than on the Atlantic coast. In Brooklyn fifty-nine buildings are in process of erection at the present time. We are informed that in the great fire in Chicago the Frear stone stood the test better than any other building material in that city. Every stone left standing in the walls was found to be in perfect condition, and builders are now drawing away the blocks to be used in the re-erection of other structures.

Messrs. Bandman and Jaffé in New York are about going to erect entire buildings with chimneys and cooking place of béton or concrete, by which name an aggregate of gravel or broken stone, lime and hydraulic mortar is commonly designated. A building of this kind was first constructed in 1830 by the architect Lebrun in Alby (Départment du Tarn, France), and since then thousands of small and large houses have been constructed of béton in England and on the continent. According to Mr. Joseph Tall, of London, the principal advantages of this system of building seem to consist in the following:

1. The cost is only half of the construction in brick and mortar.
2. The walls are impervious both to wet and damp.
3. The chimney flues being round and smooth, internally, smoking chimneys and defective draught will be effectually prevented.
4. No bond timber is required for joists; no wood lintels nor brick arches over doors, windows or other openings.
5. The walls can be increased in thickness every inch, instead of being obliged to be made of four and a half, nine or thirteen and a half inches, as in brickwork.
6. The doors and windows are built into the wall and have a light and neat appearance, as any moulding may be moulded thereon while the work is progressing.

7. The kitchen floors can be formed of concrete, having a neat and clean appearance.

Cement stones have also been largely employed for constructions in the sea, especially for harbor dams, breakwaters and quay walling. We refer to the moles of Dover and Alderney in England, of Port Vendre, Cette, La Ciotat, Marseilles and Cherbourg in France, of Algiers and Port Said in Africa, and to those of Cape Henlopen at the mouth of the Delaware. For the breakwater at Cherbourg (one of the most remarkable), artificial stone blocks of 712 cubic feet each were immersed. The harbor of Cherbourg being exposed to heavy gales, the largest blocks of natural stone which could be brought from the shore would be mere play balls of the waves. There are instances known where blocks of thirteen cubic yards were not only pushed far above the slopes, but also turned over at the head of the mole; hence the necessity of employing blocks of immense size. Such blocks can scarcely ever be obtained from quarries, to say nothing of the difficulty and expense of transporting them.

To speak of other uses of hydraulic mortar, I will mention that the beautiful fortifications before Copenhagen are wholly constructed of béton, and competent artillerists assert that for fortifications it is far superior to any other work. This béton is more largely used for foundation walling, especially in water, for sluices, aqueducts, bridges, floors, sidewalks, terraces, roofs, cisterns, reservoirs, water pipes, etc. The first sluice which was entirely built of concrete is the Francis Joseph sluice on the Danube, in Hungary. This work forms a reservoir, the bottom and the sides of which consist of one piece. Its length is 360 feet and width thirty feet. Its construction, begun in 1854, was completed within ninety days, the work being pushed forward both night and day.

Of unusual interest in the line of structures of béton, because demonstrating their great strength, is the monolithic test arch of St. Denis, near Paris. This arch forms, like the Francis Joseph sluice, one piece. The material used is known at the *béton aggloméré, système Coignet*, the last being the name of the inventor. The span of the arch is 196 feet, its elevation nineteen feet, and length forty-nine feet. The stone possesses a fine texture, and is perfectly impervious to water.

M. Coignet's system of "monolithic construction" has also been applied for the erection of the aqueduct of La Vanne, which now carries pure water from the river of La Vanne, in the department of the Aube and of the Yonne to the city of Paris. The distance from

Paris to La Vanne is over 135 miles; and as there were hills, valleys, woods, rivers, etc., to be crossed, it is easy to understand that the construction of an aqueduct through that country required many fine works of engineering. The section which traverses the forest of Fontainebleau alone comprises three miles of arches, some of them as much as fifty feet in height, and eleven miles of tunnels, nearly all constructed of the material excavated on the spot. So successful has M. Coignet been in his undertaking that other sections of the work, formerly intended to be built of masonry, of cast iron, and of boiler iron plates, have been allotted to him, to be made entirely of his *béton aggloméré.*

Hydraulic cement, instead of copper sheets, has been applied to cover the bottoms of ships. Railroad sleepers are being replaced by sleepers of cement. For ornamental work (statues, fountains, etc.), compositions of hydraulic cement have certainly a great future, since the most elaborate forms of art, of great durability and strength, may be most artistically and economically produced in them. For this purpose, only the very best qualities of cement can be used. By the admixture of proper colors, variously colored stones may be obtained. Although this industry, like everything new, had at first to struggle against suspicion and prejudices, it has gradually made its way by the excellence, beauty and durability of its products, and is now carried on in many places. In the Paris Exposition of 1867, there were statues of Socrates after Tabacchi, the bust of Raphael after Magni, and Gothic church windows of immense size. Most in demand are, however, door and window caps, ashlars, stoops, window sills, door sills, chimney tops, bowls and tables for wash stands, etc. Artificial rocks, grottoes, inclosures for wells or springs, and cataracts for parks, gardens and hot-houses are also now being produced in cement. Parks which present not a single rock can thus be converted, within a few weeks only, into the most romantic and picturesque scenery.

Although it may seem that the application of hydraulic cements was exhaused, many new uses for it will doubtless be discovered. Scarcely any technical journal of importance reaches this side of the Atlantic without containing new information on this topic, and its literature amounts already to scores of volumes.

I have aimed to dispel some of the prejudices entertained with regard to the use of hydraulic mortars or cements, and to excite a more general interest for the subject. The signs of the times point significantly to hydraulic cement as the building material of the future. For the use of students I present the following:

LIST OF WORKS PUBLISHED ON HYDRAULIC CEMENTS AND THEIR USES.

Loriot. Mémoire sur une découverte dans l'art de bâtir. Paris, 1744.

Bélidor. Architection hydraulique. Paris, 1753.

J. Smeaton. Narrative of the building and a description of the Eddystone light-house, etc. London, 1791.

Guyton Morveau. Recueil de divers mémoirs sur les puzzolanes naturelles and artificielles. Paris, 1805.

Fleuret. L'art de composer des pierres factices, etc. Paris, 1807.

John Smeaton. Directions for preparing, making and using puzzolano mortar. London, 1812.

Vicat. Recherches experimentales sur les chaux de constructions, les bétons et les chaux ordinaires. Paris, 1818.

John. Ueber Kalk und Mörtel. Berlin, 1819.

Rancourt de Charleville. Traité sur l'art de faire de bon mortiers.

Rancourt de Charleville. Les mortiers. St. Petersburg, 1822.

Treussart. Mémoire sur les mortiers hydrauliques, et sur les mortieres ordinaires. Paris, 1829.

Ch. Bérigny. Mémoire sur un procédé d'injection. Paris, 1832.

Vicat. A practical and scientific treatise on calcareous mortars and cements, with additions. By Count I. T. Smith. London, 1837.

D. H. Mahan. Elementary Course of Civil Engineering for the use of the Cadets of the United States Military Academy. New York, 1838.

Vicat. Resumé sur les mortiers hydrauliques. Paris, 1840.

Poirel. Mémoires sur les travaux à la mer. 1841.

Pasley. Observations on limes, calcareous cements, mortars, stuccos and concrete, and on puzzolana, natural and artificial; together with rules deduced from numerous experiments for making an artificial cement equal, in efficiency, to the best natural cements of England. London, 1847. Second edition.

C. Hartmann. Die Kalk-und Gyps-Brenncia, sowie die Mörtel-und Stuck-Bereitung, nach ihrem neuesten Standpuiskte. Quedlinburg und Leipzig, 1850.

Henschel. Gesammelte Erfahrungen über die Verarbeitung und Anwendung des Cements, aus der Cementfabrik von Ernst Koch in Hessen-Cassel. Cassel, 1851.

Toussaint. Encyclopédie-Roret. Nouveau manuel complet du maçon — platrier, du carreleur, du couvreur et du paveur. Paris. 1852.

G. R. Burnell. Rudimentary Treatise on Limes, Cements, Mortars, Concretes, etc. Second edition. London, 1856.

Chatoney et Rivot. Considerations générales sur les matiéres hydrauliques employées dans les constructions submarines. Paris, 1856.

Minard. Ouvrages hydrauliques des Ports de Mer.

Burnell. Treatise on Marine Engineering.

Joseph Bonin. Traveaux d'achèvement de la Digue de Cherbourg, de 1830–1853. Paris, 1857.

G. Feichtinger. Ueber die chemischen Eigenschaften mehrerer bayerischer hydraulischer Kalke im Verhältnisse zu Portland Cement. Munich, 1858.

John von Mihålik. Practische Anleitung zum Béton Bau. Vienna, 1859.

J. Manger. Die Portland-Cement, einige neuere Erpahrungen über deren Verarbeitung und Amvendung. Berlin, 1859.

W. A. Becker. Der feuerfeste Treppenbau von natürlichen und kunstlichen Steinen. (With sixteen plates.) Second edition. Berlin, 1861.

f. Coignet. Emploi des bétons agglomérés. Paris, 1862.

M. Claudel. Pratique de l'art de construire. Paris, 1863.

J. Manger. Der Stettiner Portland Cement in Versuchen und Erfahrung in dargestellt und beleuchtet. Berlin, 1862.

Q. A. Gilmore. Practical Treatise on Limes, Hydraulic Cements and Mortars. New York, 1863.

Von Gerstenberg. Die Cemente. Weimar, 1865.

W. A. Becker. Practische Anleitung zur Anwendung der Cemente zu baulichen, gewerblichen, landwirthschaftlichen und Kunstgegenständen. (With thirty-one colored plates.) Berlin, 1860–1868.

Victor Petit. Habitations champêtres. Recueil de maisons, villas, châlets, pavillons. Paris.

W. Michäelis. Die Hydraulischen Mörtel, insbesondere der Portland Cement in chemisch-technischer Beziehung. Leipzig, 1869.

H. Reid. A Practical Treatise on the manufacture of Portland Cement, with a translation of M. A. Lippowitz's work describing a new method, adopted in Germany, of manufacturing that cement. Philadelphia, 1869.

P. Löss. Bau von Kalk, Cäment, Gyps und Ziegelöfer. Berlin, 1870.

E. Böhmer and F. Neumann. Kalk, Gips und Cement. Handbuch für Anlage und Betrieb von Kalkwerken, Gipsmühlen und Cementfabriken. (With atlas.) 1870.

J. Mihálik. Die hydraulischen Kalke und Cemente; ihre Verwendung. (With five plates.) Pesth, 1870.

G. Hagen. Handbuch der Wasserbankurst. Third edition. Berlin, 1870. Consisting of several volumes and three atlases, with, together, 123 plates in folio.

The three following works form part of the reports of the United States Commissioners to the Paris Universal Exposition, 1867, published at Washington in the Government Printing Office, 1870:

Will P. Blake. Civil Engineering and Public Works.

J. H. Bowen. Report upon buildings, building materials and methods of building.

L. F. Beckwith. Report on Béton-Coignet; its fabrication and uses.

Q. A. Gilmore. A Practical Treatise on Coignet-Béton and other artificial stone. New York, 1871.

Dr. A. Ott exhibited specimens of Frear stone, and of his own artificial stone. The latter costs about half as much as quarried stone, and is relatively still cheaper for ornamental work, being as easily produced of any given form as cast iron. Frear stone now contains Portland cement.

The President said experiments by Dr. Calvert seem to show that no real hydraulic cement could be formed without magnesia. However, hydrated silicates are most essential.

Dr. A. Ott considered magnesia unnecessary, the important elements being silicate of lime and silicate of alumina.

Dr. L. Feuchtwanger said that the Frear stone had not stood the test. Dr. Ott's cement was much better.

The President stated that Frear stone contains shellac, an organic substance, and therefore unlikely to be permanent.

Dr. D. D. Parmelee said that unless the shellac were submitted to heat, it would not be in the condition to form cement. Ransom's stone has been found too porous for building stone, absorbing thirty to thirty-five per cent of water. Any stone that will absorb fifteen per cent of water is unfit for building in a climate where a heavy rain is often followed by freezing weather. The pavements around the New York City Hall look well now; but the time to judge of them will be after the disintegration from a winter's alternate freezing and thawing has had its effect.

Dr. L. Feuchtwanger stated that Ransom's stone had been much improved lately, and did not now absorb moisture. He employs an immense pressure after applying the chloride of calcium, and after that pressure the stone is steamed.

The President—An artificial stone containing Portland cement is like the old-fashioned receipt for making stone soup, the virtue not being in the stone, but in the meat that went with it. The virtue is not in the so-called improvements, but in the original hydraulic cement which nature has provided.

Mr. Harniepell considered Dr. Ott's artificial stone an improvement on those heretofore produced, arising from its semi-crystalline structure. Slags are produced of great hardness, but they are extremely brittle. But this stone combines the hardness with toughness. Granite is a conglomerate stone, of coarse structure, but a valuable stone for building; but in Dr. Ott's stone, which appears to be a species of conglomerate, the structure is much finer. It is not alkaline in its nature. The absorption of water is fully provided for; and there is nothing to produce the porosity which exists in some other stones.

The President—There is an entire absence of silicate of alumina. And there should be no water of crystallization in cement stone for ordinary buildings.

Dr. A. Ott—In hydraulic cements, as in all artificial stone, there is water chemically combined with it. It unites with the cement when it is used.

The President—That would not stand a fire.

Dr. A. Ott—The water can be expelled at a very high temperature. At the late fire in Chicago, the buildings of artificial stone stood the fire better than those of natural stone.

Dr. D. D. Parmelee—If it withstands fire, it does not contain water.

The President—Chemists should understand that what is wanted is not artificial stone, but something to take the place of Rosendale cement, of which 1,000 barrels a day are sent to the market.

Dr. A. Ott — The Rosendale cement is very inferior to the imported cements. It is unfit to be used for pavements. A good cement should be of a light gray color, with a greenish or bluish tinge, but never of a rusty color. But what is the use of searching for deposits of natural cement, when from the elements of lime, silica and clay, we can not only produce a cement superior to the best natural cement, but by varying the proportions can adapt it to harden in a longer or shorter time as required?

The President — We cannot do it as nature does it.

Dr. L. Feuchtwanger — It takes nature many years to make granite, gneiss, or sienite; and how are we to make these chemical combinations in a few hours? We have yet to learn how the combinations take place. We must use a soluble silicate to form an insoluble silicate. If we can do that we can make a good cement or artificial stone.

Adjourned.

December 8, 1871.

Prof. S. D. Tillman, in the Chair; Robert Weir, Esq., Secretary.

The following paper by Judge A. L. Hayes, of Lancaster, Pa., was read:

The Explosion of Steam Boilers; Causes and Prevention.

Vel, tu melius aliud reperi.—(Ter. And.)

Steam power is now generally employed in the most important industrial operations. It has added so much to the material force formerly required for the accomplishment of the diversified objects of labor, and, while it has relieved its severest toils, has so wonderfully augmented its products and the consequent wealth of communities, that it must be accepted as a permanent and indispensable auxiliary, with all the disadvantages inseparably incident to its ordinary use. Among these apparently incorrigible drawbacks, the most prominent and formidable are the explosions to which steam boilers are liable; and if there be any method of preserving the invaluable power exempt from that liability, it is surely a consummation devoutly to be wished.

Although the public are startled by every day's report of some destructive explosion, yet it is doubtful whether many are aware of the enormous sacrifice of human life and immense loss of property caused by those terrible disasters. "We gave," says a recent paper, "from the Hartford Locomotive, a record of the boiler explosions for the year ending October 1, 1868; the total of explosions was ninety-four, number killed, 240, number of wounded, 261." A later issue of the same journal gives statistics for the year ending October 1, 1869, which show a total of explosions, 108; killed, 158;

wounded, 218. Many of the smaller explosions are not included. In a list, published by the Hartford Steam Boiler Inspection and Insurance Company, of boiler explosions for the months of October, November, December, January and February, forty-five explosions are enumerated, beginning with that of the steam boiler in operation at the State fair, at Indianapolis, on the 1st of October, by which twenty-seven persons were killed, and forty-six wounded, many of them dangerously. The whole list represents eighty-one killed, and a very large number wounded. In one of these explosions, the boiler, which was nearly new, was thrown 300 feet; in another the boiler was thrown 300 yards. The buildings, in several instances, were totally demolished. Last February (1870), was especially prolific in these disasters; there were eighteen explosions, forty-seven persons killed, and sixty-seven wounded; and it is remarkable that eight of these boilers had been supervised by inspectors, legally appointed and charged with that duty.

The London Engineering, published May 7, 1867, states that "during the last ten years at least 500 boiler explosions have occurred in the United Kingdom, and nearly 8,000 lives have been sacrificed; while a far greater number (the wounded) have been struck down by the sudden catastrophe, more merciful to those who were killed outright."

Many associations have been organized in England for inspecting and insuring steam boilers. During the last ten years the Midland Boiler Insurance Company alone inspected and insured 16,411 boilers in England and Scotland. In this country, also, such associations have been formed, and have been for several years in operation. They claim to be able, by skillful inspection and instruction, to save those who employ them from the danger and loss attendant upon the use of steam power; and yet the explosions continue to occur, and even to multiply and increase in number, notwithstanding their caution and advice.

These associations insist that the terrific explosions, of which we so frequently hear, are simply attributable to two causes: defective boilers, and ignorant and careless engineers. They regard steam power as a generous steed, perfectly safe when handled by the skillful and discreet, and ridicule the notion of any occult force, beyond their ken, which may contribute to the explosion. It is only (they reason) when the force or pressure of the steam exceeds the strength of the boiler that any danger need be apprehended. The boiler being of the required strength, and due care being exercised in regulating the pressure, no explosion can ever occur. We doubt the truth of this theory to the extent asserted.

With all imaginable care and unquestionable ability in the engineer, and well constructed boilers of good material, explosions have, nevertheless, happened, if any faith is to be accorded to human testimony.

Although incompetent engineers have sometimes been placed in charge of steam-power, and weak and insufficient boilers have been often in use, yet the explosions are far too numerous and terrible to suppose that they are all owing to the imputed cause of negligence, ignorance or defective boilers. We could as easily believe that all the 700 shipwrecks which take place in the course of a year are owing to want of seamanship in the crews or sea-worthiness in the vessels cast away. Men engaged in the management of steam-engines are not ignorant, at any rate, of the dangers to which they are exposed, and have a natural regard for their own safety. Few men are utterly reckless of life; and it is not conceivable, when so much in such situations obviously depends upon care and skill, that any considerable number of engineers should be employed without the requisite qualifications. Therefore, when on the occurrence of many of those explosions the investigation of the facts fails to show either want of skill and care, or insufficiency of the boiler, we are fain to accept the verdict as it is given,— cause unknown.

The commonly received explanation, which ascribes the catastrophe to the expansion of steam, is not satisfactory to us for many reasons; some of which we shall endeavor to present. When first vaporized from water heated to 212 degrees, steam assumes a volume 1,700 times greater than that of the water from which it is evolved; and every added degree of caloric, though it does not raise the temperature of the steam, increases its expansion one 490th part, which is ascertained to be the regular rate of increase of all gases and vapors on the application of augmented heat. The expansion or pressure of steam, therefore, increases by regular gradation, and is measured with perfect accuracy. When the pressure rises to the point, or approaches that point, at which the boiler would give way, a valve is opened, and what is the result? The steam in the boiler is instantly diminished, and the danger ceases. If there is no such valve, or it is not attended to, and the boiler gives way and opens in some weak part, is it not the proper and natural consequence that the moment the steam finds an issue through the rent, the strain or pressure will be lessened by the escape of the steam, as it is when it escapes through the safety valve? In estimating the effect of this strain, we must bear in mind how force is modified by velocity, which constitutes so powerful an element of the momentum. The regularly increasing pressure of steam, is a gradually augmenting strain upon the boiler, in which the momentum is deficient in velocity; and the natural effect would seem to be, to rend or split, and not to burst up the boiler, much less to tear it in fragments, throwing it, as in many instances, hundreds of feet from its place, and scattering ruin in every direction. The telegraph to the press of Philadelphia has just communicated that, on the morning of the 7th of August, at St. Louis, the boiler of the Union Steam Flouring Mills, of Yager & Company, exploded, instantly killing John Scott, engineer, and James P. Jones, fireman, and that the entire eastern side of the building was blown out, and fragments of the boiler were thrown to the distance of half a mile. The idea that the water in the boiler, at the moment the case gives way, is converted by a sudden flush into steam, and thereby produces the explosion, we are able to show cannot be true. It is in every respect improbable; it is, indeed, equivalent to the supposition that the water of the boiler explodes, which is absurd. We will produce an instance of a disastrous explosion when there was no water at all in the boiler.

It must be understood that we do not deny that boilers have been bursted, that is, rent and split open, by steam. We very well know that this has often happened, and that it is inevitable when the pressure acquires a force beyond the strength of the boiler. Our notion is this, that in many explosions of steam boilers the facts are such as can only be accounted for by the application of a sudden, prodigious and explosive force, different from the graduated increasing strain of the pressure of steam. We shall take for illustration an instance of the explosion which occurred at the cotton mills on Duke street, Lancaster, Pa., in the summer of 1867. It was on the 13th of July; the weather was clear, a dry mist only prevailing in the early morning. It took place five minutes before six o'clock, at which hour the mill was to have been started. The mill and all the machinery were new; the engine and boilers, of which there were two, situated side by side, were of the most approved construction. The engine-house was of brick, one story high, built against the eastern end of the mill, the wall of which, eighteen inches thick, formed one of its sides; the other walls of the engine-house were thirteen inches thick. The boilers were sixteen feet long and fifty inches in diameter, each having twenty-two flues. There was a sufficiency of water in them, it being four inches above the lowest gauge, and the pressure of the steam was eighty-five pounds to the square inch, which was within the allowed maximum. The engineer, a careful and experienced hand, was engaged at the time, with his assistant, in oiling the engine. The boiler next to the street exploded, completely demolishing the engine-house. The larger portion, severed from the rest, was hurled through the northern wall, and, with two rebounds from the earth, landed at a distance of 700 feet against a tree, which probably saved the house before which it stood. The engineer, the mill agent, and two other persons were killed. The boiler weighed 6,300 pounds. It was parted by the explosion, and the other end, with a small section of the boiler-cased flues, was thrown south about forty feet. The engine-house was roofed with tin, which was torn to fragments and scattered in various directions, as were other parts of the building. The pulverized mortar appeared to have been plastered against the wall of a dwelling house sixty feet south on the adjoining lot. The other boiler was driven sideways through the eighteen inch wall of the mill and lodged ten feet within, much bent out of shape and about half of the flues broken. It was near this spot that the mill agent and two other persons were killed. Bricks were thrown to a great distance, some through the windows of the house across the street, and a hole was knocked in the wall of the house on the same side of the street, south, forty feet above the ground. The prodigious force of the explosion is shown by this detailed account. It is to be considered that the same force, so far as it was caused by the pressure of steam, was exerted in both boilers, for there is nothing to warrant the supposition that the pressure was not the same on each, or that one was not as strong as the other. If the force was irresistible in one, as shown by the event, why not in the other?

We do not think this question can be solved by the theory of the steadily increasing pressure. The immense force of steam is observed in all its regulated manifestations. The pressure it exerts is equal in all directions. When a breach in a boiler, caused by excessive pressure, occurs at one extremity, the issue of steam through the breach diminishes the pressure upon the other extremity as on the rest of the boiler, the pressure being an impelling force acting against opposite points, in all parts of the boiler. All these points react by resistance, and whatever diminishes the impelling force at any point necessarily weakens it at every other; and the effect of the pressure breaking through a boiler at one end could never be to drive the other end in an opposite direction; the tendency would be, by lessening the impelling force there, to give the reactionary or resisting power a movement in the same direction with the steam issuing through the breach. But in this instance which we have detailed, the walls opposite to each end of the boiler were prostrated, and while the greater portion of the boiler, weighing three tons, was carried 700 feet north, the other end, a smaller portion, weighing about 300 pounds, was sent through the south wall forty feet from its position. Had the explosion been caused by the gradually augmented strain of the steam pressure, it is plain to our apprehension that this small portion, though broken off from the rest, must have followed in its flight, going north instead of south. We repeat, when the restrained power of steam obtains an issue, the reaction of the boiler will tend toward and favor the movement of all the parts in the direction in which the steam issues. Now, the explosion of the boiler we have described shows that the force was exerted in opposite directions, and with an energy of immeasurable power. Three strong walls, south, north and east, were thrown down, the roof torn to pieces and scattered, and on the west side, the other boiler, weighing more than three tons, was driven sideways through an eighteen inch brick wall. It was a force radiating from the center, striking out on all sides like a hundred-armed Briareus. There was no evidence of a reaction; it was a centrifugal, impulsive, irresistible action, overwhelming on all sides every obstruction.

We have alluded to the theory maintained by some, that the explosions of steam boilers are often produced by the conversion of the water in the boiler, by a sudden flash, into steam. But the process by which water is converted into steam is well known. It commences at the bottom of the boiler, or wherever the greatest heat is applied, and ends at the surface of the water where the steam is evolved. Rapid or slow in its formation, this is the course and progress of steam manufacture; and we know not how it is conceived that water ever flashes into steam, or, in other words, explodes like gunpowder.

The explosion we mentioned of a boiler, in which there was no water at the time, occurred in a paper mill belonging to Mr. J. M. Black, of Marseilles, Ill. It was a rotary steam-bleacher that exploded. It was six feet in diameter, twenty feet in length, and was situated on the floor above the boiler in which the steam was generated, and almost directly over it. The pressure of the steam in the boiler at the time of the explosion was eighty pounds to the square inch. The steam was supplied to the bleacher by pipes entering at each end through hollow bearings. At the time of the accident (the bleacher being then first used and the mill new), there were 6,000 pounds of rags undergoing the process of bleaching. The bleacher exploded with tremendous force, prostrating almost the entire four stories of the building to the ground. Parting in the middle, one portion was blown 200 feet, tearing a large hole in a wall of a cotton mill, which stood near. Two persons were killed and twenty wounded by the explosion.

The writer, who published an account of the disaster, remarked that the theory of the water flashing into steam and causing an explosion was not applicable here, for there was no water in this bleacher. The water was in the boiler in another apartment on a lower floor; that boiler did not explode. We regard this instance (and another similar one has been recently reported) as settling the theory of the water suddenly flashing into steam, independently of the other facts in many of the narratives of explosion tending to the same conclusion. But his theory of the cause, from "a steadily increasing pressure" of the steam, is scarcely more satisfactory. A steadily increasing pressure might well account for the rupture of this bleacher and the escape of the steam, had such been alone the circumstances of the case; but can it be conceived how a steadily increasing pressure could have exploded it with such enormous violence, breaking it asunder, demolishing a new four-story brick building, casting one portion of the bleacher 200 feet against a mill and breaking a great hole in its wall? On the contrary, is it not manifest that these were the effects of an explosive force, a suddenly expansive power like that of gunpowder touched with fire, acting not with a strain, but with the irresistible energy of a mighty blow?

The reports of explosions represent the ruined boilers in various conditions of dilapidation. In some, the shell or case is only ruptured, or the head opened or forced out, or the flues collapsed without the boiler being lifted from its position. In such cases, we have the legitimate effects of excessive pressure and easily conceive how the steam acts to cause these results.

The reports which are published of the examinations, usually made of the causes of the violent and destructive explosions, are unsatisfactory, both in regard to the conclusions of the committees and the evidence submitted. We are always much disappointed in the explanations given, on such occasions, by scientific as well as practical engineers; which are generally remarkable for diversity of opinion and weakness of judgment. We have never seen anything in the reports, or the testimony accompanying them, which afforded even a plausible reason for the most disastrous and destructive explosions. The very calamitous and recent instance—that of the Westfield steamer in New

York harbor—is no exception. We have so strong a conviction that there is a cause for these tremendous disasters not explained in any investigation we have seen, and also a remedy for their prevention, that we have long felt it to be a matter of duty to give the public the benefit of our suggestions. These may, at least, lead others to pursue the same line of inquiry with more perspicacity and better success. In this spirit we proceed : *si quid novisti rectius istis, can didus imperti.* (Hor.) If you know anything preferable to the maxims laid down, candidly impart your knowledge.

The explosions of steam boilers may be divided into two classes, distinguished by the degrees of the violence or force which produces them. In one the boiler is slightly, if at all, removed from its place; the shell has been opened; some seam has given way; the rivets loosened or broken ; the end blown out, and the flues or boiler case collapsed—the steam having escaped through the opening, and the force having evidently, in the moment of escape, operated in one direction. These effects are such as would naturally follow in the excessive pressure of the steam causing a breach of the boiler. In the other class are those tremendous explosions in which the force appears to have been exerted in all directions, though the greatest violence may generally be traced in some particular direction ; the boiler is totally ruined ; often broken apart; sometimes into many parts, scattered all around ; very heavy portions carried to a great distance ; large and strong buildings leveled with the ground, which is covered, to a great extent, with the ruins. The destructive agency in these instances is prodigious and astounding. Nothing in nature approaches it in violence, if we except the earthquake and tornado; while, in the suddenness and celerity of its irresistible power, it is only equaled by the thunderbolt. It is to this class we propose to confine our attention.

In the production of steam, the ostensible agents are fire, water and air. To secure its available power, it is necessary to confine it in some vessel of sufficient strength to keep it under the control of the operator. The steam boiler intended for such a purpose must be so constructed as to restrain the pressure caused by the expansion of steam, while portions of it are let off in the required quantities. Thus constructed, and its soundness and strength ascertained by competent tests, it is placed in its position, and connected with the apparatus and appliances for generating the steam. As long as the boiler is sound and strong, and the pressure not allowed to exceed its strength, it must be safe from fracture, and as these conditions are always under the supervision of the engineer, the safety of steam power would, in the charge of a careful and skillful engineer, be assured, if there were nothing else than the steam, water and fire concerned in its use. But there is great reason to believe, that in the process of raising steam, an immense quantity of electricity is evolved. Galvanic and magnetic electricity, and electricity produced by friction, are now known to be the same, and identical with that of the clouds in summer. When a current of electricity is made to pass through a compound substance, its property is to decompose and separate the compound into its constituent parts. It is thus that water is decomposed by the galvanic battery, resulting in the production of the two gases, oxygen and hydrogen, in the proportions in which they combine to form that fluid. All atoms of matter are considered as originally chargeable with either positive or negative electricity; in water hydrogen is the electro-positive, and oxygen the electro-negative element; and as opposite electrical states exercise strong mutual attractions, this attraction being greater than that which unites the two elements, decomposition ensues. Recent experiments have shown that the electricity which decomposes, and that which is evolved by the decomposition of a certain quantity of matter, are alike. In contemplating the facts pertaining to the most violent disruptions of steam boilers, the theory that best agrees with them, we suppose to be that which ascribes them to explosive gases, and which involves two conditions: 1. The production and accumulating of such gases in the boiler. 2. The presence of an agent to explode them.

1. In regard to the first condition, it is suggested that the raising of steam affords an unlimited supply of material for the production of the gases demanded by the theory. Water is composed of two gases, and is converted into steam by the motion of its particles combined with the radiating heat of the furnace passing through the lower part of the boiler to the surface, and rising thence enormously expanded into the upper part above the water. Under all circumstances, when in motion it is a prolific source of electricity, which is produced in immense quantities by evaporation passing with the vapor into the higher regions of the atmosphere, where its agency is manifested in the formation of clouds and most conspicuously in the *cumulus* of the summer skies. The heat which increases evaporation increases the quantity of electricity evolved, and also its intensity; which is evinced by the phenomenon of the thunder cloud. The numerous discharges of electricity in that description of cloud are

proof of the vast accumulations which surcharge the masses or certain portions of the cloud, whence the lightning darts forth, followed by the explosion of thunder. In order to fortify our theory, we will endeavor to show, in the sequel, from the attendant circumstances, that this explosion is of volumes of gas which are produced by the currents of electricity passing through the watery masses, and by their normal operation effecting the decomposition of the water; and that it is the detonation of volumes of gas, fired by the lightning, which we recognize as thunder; each peal of which is a single report, for the most part, reverberated from the various masses of vapor with the prolonged roll so often heard. If the same cause produces the same effect, as philosophy teaches, it would seem to be a just conclusion that the application of heat to the boiler, for the raising of steam, produces in the process an evolution of electricity in such quantities as to decompose a portion of the water, converting it into the oxygen and hydrogen gases; that these gases accumulate in volumes in the upper part of the boiler, where, in their mixed condition, they assist by expansion the working pressure. The quantity of electricity combined with the atoms in water, and of most other substances, is marvelous. A single drop of water is said to have been shown by Faraday to contain more than is discharged in a flash of lightning. (Porter's Chemistry, § 252.) The change of form or state of bodies is one of the most powerful methods of exciting it. Water in passing into steam by artificial heat, or in evaporating by the action of the sun or wind, generates large quantities of electricity. (Wells' Nat. Phil., 393.) So substances of the same kind suddenly brought together, of different temperature, cause an abundant evolution of electricity. Various arrangements have been devised for the production and accumulation of electricity. High pressure steam, escaping from a steam-boiler, carries with it minute particles of water, and the friction of these against the surface of the jet from which it issues produces electricity in great abundance. A steam-boiler properly arranged and insulated, therefore, constitutes a most powerful electrical machine. By means of an apparatus of this description, constructed in London, flashes of electricity were caused to emanate from prime conductors, more than twenty-two inches in length. Another machine of this character has been constructed for the Faulty of Science in Paris; it is provided with eighty jets for the escape of steam. The sparks form brilliant jets of fire by their rapid succession, each spark being about a foot in length and several inches in breadth. The quantity of electricity existing in the water and steam is indicated by the name given to this apparatus, which is called the hydro-electric machine.

These considerations establish the probability of the evolution and accumulation of the gases, oxygen and hydrogen, in the upper part of the boiler, while the process of generating steam is going on, together with the production of electricity in large abundance.

2. In the state of mechanical mixture those gases are innocuous, at most operating only by increasing the amount of pressure; but when brought in contact with flame, red heat or the electric spark, no substances are more violently explosive. In the generation of steam, there is probably a double evolution of electricity; first in the conversion of water into steam, and again in its decomposition into its constituent gases. The immense quantity eliminated when it reaches the upper part of the boiler spreads, by a law regulating its diffusion, over the surface and is gradually conducted off; but the always present danger is of a surcharge. For bodies will only contain a certain quantity of electricity, there being, as has been demonstrated, a limit to their capacity in this respect.

A metallic ball charged from different sources with electricity, on the attempt to surcharge it, will discharge itself through the air into the nearest conducting body; a spark, describing apparently a zigzag course, will be observed traveling with immense velocity and an audible sound, and capable of giving a severe and dangerous shock. (9 Penny Cyclopedia, 337.) It is these surcharges, as we have supposed, which, in that great natural laboratory the thunder cloud, cause the lightning, and they occur, we do not doubt, occasionally, and are always in certain electrical conditions of the atmosphere liable to occur, in the operation of the steam boiler. The electricity, gathering and spreading over the inner surface of the boiler, passes away by means of the metallic connections into the exterior air more or less rapidly, and, when the safety valve is much used, very rapidly with the escaping steam. But the interior surface of the boiler, above the water line, is kept by the heated steam excessively dry, and its conducting power thereby modified; and when the exterior air is very dry, the diffusion of electricity is much obstructed. We can readily comprehend how the electricity may, under these circumstances, collect in such quantity on the surface of the boiler as to overcharge it, when the electric spark is sure to break forth (passing into the water beneath, which is a good and the nearest conductor), and fire and explode the accumulated gases. In confirmation, it is recollected that the most disastrous explosions of steam boilers have occurred in a dry electric condition of the atmosphere. If it be objected that, in the presence of so much conducting material, the metallic boiler with its metallic connections and surroundings, the electricity cannot accumulate to the extent of surcharging the surface, we may refer to what takes place in the thunder cloud for answer; where, although the watery globules, which fill the air and compose the clouds, constitute a highly conducting medium for diffusion, yet the surcharges do there occur, and cause very numerous and frequent discharges of electricity in the form of lightning. It is the superabundance of electricity in accumulation that sufficiently accounts for the phenomena. Indeed, the thunder storm so well illustrates our theory, that we must refer to its action at some length.

How clouds are formed and how they are sustained at their various altitudes above the earth, are questions not without difficulty. As water is far heavier than common air, and the clouds are composed of watery globules, why do they not fall to the surface, like dew, instead of ascending in the atmosphere? In some way the effect of their specific gravity is overcome, so as to keep them suspended at their elevated levels. We may infer that these globules are filled with a vapor lighter than common air, which cause them to rise until they reach an elevation where their weight is equal; but of what that vapor consists, besides rarefied air, we will not stop to explain; not because we concur with the French meteorologist, M. Pouillet, that the data are too few to render the attempt advisable, but because it is not necessary to the present inquiry.

A distant view of the clouds discovers a great variety in their positions, forms and movements. In Nicholson's Journal of Natural Philosophy they are classified according to their forms, and denominated cirrus, cumulus, stratus, cirro-cumulus, cirro-stratus, cumulo-stratus and nimbus. Some of these forms are among the most gorgeous and beautiful of visible objects, especially when irradiated by the rising or setting sun. But as we are about to speak of the thunder-storm we shall confine our attention to the *cumulus*, which is its peculiar theater, where,

> ———— in explosion vast,
> The thunder raises his tremendous voice.

This is the cloud which grows and increases from above in dense, convex or conical heaps; its masses are often of enormous proportions, of great elevation and every variety of outline. It has the appearance of more compactness than that of any other class, and is seen only when

> From brightening fields of ether fair disclosed,
> Child of the Sun, refulgent summer comes,
> And Cancer reddens with the solar blaze.

This is the principal laboratory of thunder, and hence the lightning of our summers most commonly proceeds. Of the vast extent of this laboratory we may form some conception, if we but estimate the height or depth, with the length and breadth, of these wide-spread masses and their innumerable circumvolutions, covering and moving over hundreds and thousands of square miles of the earth's surface. They are distinguished from other clouds by their form and color, but their chief characteristic is their wonderful accumulation of electricity. We cannot be far wrong in ascribing to the excess of this fluid the peculiar shapes assumed by those clouds, and from their infinite variety we may be sure that all the extraordinary variations of the earth's surface are reproduced and multiplied in those changing masses; there are eminences with round and pointed summits, promontories, bluffs, perpendicular walls, coves, caverns, plains, valleys, steep declivities, gradual slopes, lozenge and lens-shaped surfaces, convex and concave — in short, every various form that the imagination can conceive. Considering that the sun, flaming down upon these multiform surfaces, strikes some with rays direct, while his rays glance in every degree of obliquity upon others, we can comprehend how different portions of this mighty field of electrical operation may be variously affected, and how the accumulation of the fluid may be very unequally distributed. We can understand how a focus may sometimes be produced by means of a lens-shaped cloud, concentrating the sun's rays and causing intense heat. Among the many sources of electricity, the combined operation of heat and moisture and sudden change of temperature are known to be the most potential and prolific. These causes are present and acting together in the thunder cloud of our summers, which accordingly exhibit, beyond all comparison, the most magnificent displays of electrical action and the most abundant development of disengaged and current electricity that are ever witnessed. The various ingenious instruments and electrical machines, contrived for the purpose of developing electricity, present but minute imitations of these grand exhibitions of nature. In contemplating such splendid phenomena, the mind naturally turns to inquire whence those immeasurable quantities of the electrical fluid are derived.

The universal diffusion of electricity, whether considered as fluid or force, is conceded by philosophers. The marvelous properties manifested in its ready combination with heat, magnetism and light, its rapid transmission through the most opaque and solid substances, which it permeates (the earth for instance), with little or no obstruction, its velocity being far greater than that of light, the inexhaustible supply evinced by the readiness with which it may be evoked from the surrounding atmosphere, its tendency to equalization, when disturbed, all lead to the conjecture that this may be the mysterious element which the Almighty has provided, pure "effluence of bright essence increate," to fill all the spaces of the universe unoccupied by the solidity and compound masses of the planetary worlds, and which has hitherto passed under the name of ether. No such thing as sheer vacancy can be admitted to exist. *Natura vacuum abhorret.* Encke has ascertained that there is a resisting medium in the interplanetary spaces by the fact that his comet, which revolves round the sun in 1,207 days, has a regularly accelerated motion, by which the period of each revolution is shortened by about six hours. These considerations indicate the redundant sources from which the electricity of the clouds is derived. The manner in which it is accumulated in the thunder cloud may be understood by considering the causes which are assigned for atmospheric electricity. "Some have ascribed it to friction of the air against the ground, some to the vegetation of plants or to the evaporation of water. Some, again, have compared the earth to a vast voltaic pile, and others to a thermometrical apparatus." Many of these causes may, in fact, concur in producing the phenomena. Volta first showed that evaporation produced electricity. (*Ganot's Physics.*) The atmosphere always contains free electricity, sometimes positive, sometimes negative; but always positive when the sky is cloudless; and its intensity is greatest in the highest and most isolated places. The positive electricity of fine weather is much stronger in winter than in summer. The electricity of the ground has been ascertained by Peltier to be always positive, but in different degrees, according to the temperature of the atmosphere. But when the sky is clouded, the electricity of the atmosphere is not always positive; it often happens that it changes during the day from its positive to negative, or *vice versa*, owing to the passage of an electrified cloud.

The formation of positively electrified clouds is usually ascribed to the vapors which are disengaged from the ground and condense in the higher regions. This is but one of several co-operative causes, the others being far more potent; there is the heat of the sun, already spoken of, with its direct rays beating upon the opposite masses of cloud; the heated and ascending cloud coming in contact with the cold strata of the higher atmosphere; the numberless cavities of these irregular *cumuli*, seething cauldrons beneath the sun's rays; the motion of the clouds, agitated by the winds driving the masses into collision—all conduce to the production and accumulation of electricity and its unequal distribution. The tendency of electricity is to prominences and points; and when a surcharge occurs by an accumulation at any place beyond its capacity to contain it, it breaks forth in the form of lightning in the direction requisite to restore the equilibrium. This may be upward, downward, horizontally or obliquely, according to the situation of the locality negatively electrified, whether it be the earth, the adjacent clouds, the atmosphere beyond the borders of the clouds in the same stratum, or the region of the atmosphere above. Thus we often behold in thunder clouds some miles remote the streaks of lightning flying in every direction in lines variously curved, direct or zigzag. When we reflect that the most powerful spark that can be artificially produced is but a little more than a foot long, we may form some conception of the enormous quantity that is eliminated in a stroke of lightning, which reaches the earth in a continuous stream from a cloud more than a mile in height. These explosions are often repeated every few minutes for hours together. Hence it is evident that the accumulated quantity of electricity in these thunder storms is vast beyond description.

The theory of Franklin is, that the conductor draws electricity from the atmosphere and clouds, transmitting it to the earth and contributing to equalize the positive and negative electricity in regard to the earth and clouds; and that it thereby prevents the lightning stroke where it is placed. According to the theory of electric induction, accepted by the French *savans*, when a thunder cloud passes, positively electrified, it repels the positive and attracts the negative fluid accumulated in bodies on the surface of the earth, and which are, therefore, exposed to the danger of an electric discharge. By means of the lightning rod, the negative electricity withdrawn from the surface by the cloud flows off from the points of the conductor into the atmosphere, and, neutralizing the positive fluid of the cloud, prevents an explosion. By either theory the utility of the conductor is asserted.

The difference of opinion in regard to so notable an incident as the thunder is remarkable. In the Penny Cyclopedia (article Thunder) is to be found the following: "The identity of lightning with the electric fluid is now well known; but the physical detonation, which accompanies the flash, is still the subject of conjecture; in general it is considered that lightning, by its heat, creates a partial vacuum in the atmosphere; that the sudden rushing of air into the void space produces the sound; but various reasons have been assigned for its prolongation. It was formerly supposed that the rolling noise is merely the result of several echoes, caused by the sound being reflected from mountains, woods, buildings or clouds, or from the latter alone when a thunder storm takes place over the ocean. But though the reflections of sound are very probably in part or at times the cause of the prolongation of the report arising from the explosion, yet it must be admitted that these will not always afford a satisfactory explanation of the phenomena."

In truth, there is as great a variety in the sounds of thunder as in the flash of lightning or the direction and path of its motion. The sights and sounds of a thunder storm are presented with such force to our most observant senses, that, however men may differ in their judgment as to the causes, their perception of the facts will be the same; the phenomena are upon so magnificent a scale, that they rivet the attention and deeply impress the memory. Any true description would be recognized as recalling to the mind the visible and audible grandeur which such scenes have exhibited to all beholders. In dealing with those facts there is, accordingly, the advantage of being certain that we are not misunderstood in relation to our perceptions of the things we speak of; and, therefore, as in the search for the causes, a knowledge of which is the chief desire of scientific pursuit—*felix qui potuit rerum cognoscere causas*—we have to speculate on some facts which are not within the range of our senses. We shall not stop to describe the various colors or kinds of lightning, the dimensions of the sheet or flash, the lightning streak, chain lightning, or streams, or their various directions, or the variety of sounds accompanying them under the general name of thunder; but take it for granted that every reader has the same recollection of those sublime and beautiful displays.

The clouds are water in a state of vapor; and water, composed of the two gases oxygen and hydrogen, in the proportion of one volume of the former weighing eight to two of the latter weighing one, is subject to decomposition by currents of electricity, and to be converted into those gases, its constituent elements. The operation is greatly facilitated by raising the temperature of the water, and must be indefinitely facilitated when the water is vaporized and changed into steam. It is reasonably inferred that the strong currents of electricity passing through a summer cloud of the *cumulus* order must be productive of immense decompositions of the masses of vapor and evolution of those gases. We have before spoken of heat and moisture as among the most prolific sources of electricity. Every addition of caloric to water evolves it, evaporation carries off immense quantities of electricity into the air, and the decomposition of the particles of water in the form of vapor eliminates unappreciable quantities. It is not an unreasonable supposition that, in the varied position of the surfaces of the cumulus with respect to the sun's rays, the heat is often so intensified as to raise the vapor into steam. Electricity is exhibited in two forms: one produced by friction and manifested by the electric spark, to which form the lightning belongs; the other passes in silent currents, and is manifested chiefly in chemical action. This is said to be weak in tension, but great in quantity; the former to be small in quantity, but of powerful intensity. It is with this distinction in hand, that we are to weigh the statement that Faraday showed how a drop of water contains more electricity than is discharged in the most violent flash of lightning. (*Porter's Chemistry*, 104.) And if our wonder should shake our faith in the statement, we may find some relief in the acknowledgment of Faraday himself at a meeting of the British Association for the Advancement of Science: "There was a time," he said, "when I thought I knew something about the matter; but the longer I live and the more carefully I study the subject, the more convinced I am of my total ignorance of the nature of electricity."

It is certain, however, that from evaporation rising from the earth's surface, from the processes of vegetation, and from the action of everything that lives or moves upon the surface, currents of electricity are constantly ascending, filling the atmosphere and accumulating in the clouds. These operating upon the expanded and heated vapors of watery particles, those currents, as we believe, first decompose the water, evolving the constituent gases, and surcharging, by their redundant quantity, some prominent mass of cloud, or, excited by a collision, the electricity is discharged in its intense form of the electric spark-lightning, firing and exploding the gases with a concussion which causes the earth and air to tremble. For these gases, when brought together, we repeat, may continue in a mixed state without combining chemically, but, subjected to a flame or a spark of electricity, they instantly undergo a violent explosion, which unites them in due proportions by chemical affinity to compose water. Think how will the facts agree with the foregoing statement. When a broad flash of lightning is accompanied by a heavy roll of thunder, then follows immediately a remarkable increase of the shower of rain, the precise effect which must ensue from an explosion of those gases in the supposed abundance and their chemical combination. The sound accompanying the flash is just such as would result from an explosion, with a report much heavier than that of the loudest artillery. The height from which the sound comes, it will be remembered, is from half a mile to a mile and a half above us, and sound passes downward with much obstruction. The heaviest reports are often heard when the lightning evidently does not strike the earth. Usually the thunder is but a single report, and the rolling detonation is that sound reverberated from the numerous heaps or masses of the *cumulus*. This naturally and adequately accounts for the peculiar character of the sound, which is heard, alike and the same, on the level plains of regions without mountains or elevations of the surface, and over the level of the sea. To ascribe the prolongation to the reflection of the sound from the woods, the buildings, or the earth's surface, is hardly justified by the laws of acoustics, according to which such reflection would be with an upward rebound, and therefore inaudible to the dwellers upon the surface.

The lightning stroke which reaches an object near to us always has a sharp, violent, clattering sound, often if not always followed, to our preception, by the long, rolling reverberation of the distant explosion. The former sound, though first heard, is really preceded by the latter, which takes place on the explosion of the gases as the lightning touches them in parting from the cloud; and the latter is produced, as before noticed, by the resistance which the lightning encounters in its passage through the air to the earth. This double sound most frequently occurs when the sharp and smaller sound from the lightning, darting horizontally or upward from the clouds, as is often seen, is not audible to us. It will be recollected that, in such instances, there is a wide illumination of the cloud at the time the lightning appears to dart forth from its bosom, and we hear only the heavy roll of the thunder following. That blaze of light is the light of the explosion; the deep-voiced thunder is its report. It would seem, then, that there are present in the thunder cloud all the agencies requisite to the accumulation and development of electricity in superabundance, as heat and moisture, violent collision of masses, and masses of various temperature coming together. The material for the generation of gases is also present in the highest condition for the operation of the electric currents—the watery globules expanded with heat. Reasoning from the effect to the cause, we are brought to the conclusion, that there are, in fact, immense volumes of hydrogen and oxygen gases accumulated in the thunder clouds; and that the electric spark or lightning explodes them from time to time, with the astounding reports and vivid flashes by which our nerves are so often shaken. It is demonstrable that the volume of sound does not depend upon the quantity or intensity of electricity set free. The heaviest thunder we ever heard was not attended by the sharp rattling sound which indicates a lightning stroke; but it shook the house like an earthquake. Such concussions prove the prodigious force of the explosion. The circumstance to which we have already adverted, is to be considered in estimating the sound of thunder, namely, that it descends. If we were to imagine the largest ordnance ever cast to be discharged at such a distance from and above us, the report would be insignificant when compared to that of the loudest thunder. The successive peals of thunder in a storm are of various degrees of loudness, the natural effect of the varying dimensions of the volumes of gas that may be exploded. Sometimes we hear redoubled reports, the second not unfrequently being louder than the first, occasioned probably by the lightning in its course firing two or more separate volumes of those gases accumulated in different and remote sections of the clouds, and those subsequently exploded being larger than the first. What is called heat or sheet lightning, is not accompanied by thunder, at least such as is audible to us either from the distance, or the small quantity of gas exploded.

All artificial development of electricity, by friction, gives out the spark with a crackling sound, which is a miniature resemblance of the clattering, crackling sound that the lightning is always observed to produce when it passes very near to us through the air, and which is altogether different from the loud detonation or the "repercussive roar" succeeding it, that signalizes the heaviest thunder peals. The prolonged reduplicated sound, which when reverberated is but an echo of the original report, is so unlike that of the lightning, as we have always heard it when very near, that we cannot believe it to be caused by the passing of the lightning through the atmosphere; and it is only in this way that sound from lightning is caused, for its mere elimination from the point whence it is discharged gives out no sound as we suppose; it is the resistance of the atmosphere to so intense a force, darting with such unparalleled velocity through it, that makes the only noise that can be properly ascribed to the motion of the lightning. The reverberation is but an echo of the explosive sound, returning, as all echoes do, like for like. The idea that the prolonged, or any sound of thunder, is caused by the collapse of the atmosphere, after a partial vacuum produced by the passing of electricity through it, was never accepted as satisfactory, and it cannot be maintained by any show of reason. The supposition of there being but a single report for each volume of accumulated gases exploded, agrees with all the facts and phenomena of lightning and thunder, as seen and heard, and with the analogies of sounds proceeding from other causes, the explosions of artillery or magazines for instance, which, when occurring in hilly and mountainous regions, are followed by reverberations precisely similar.

If it be true that the prodigious quantities of electricity which are visibly displayed in the thunder storm ascend thither from the earth, and the loud thunder which shakes the firmament is the report of vast explosions, then there must be in the clouds immense accumulations of explosive gases; the clouds must furnish, by the combined operation of heat and moisture, the source of those gases; electricity the agency by which they are produced, and lightning that which explodes them. These facts appear to afford very strong corroboratory testimony in favor of the theory we have suggested in relation to the explosion of steam boilers. Newton perceived in the fall of an apple the principle of gravitation. Franklin saw in the zigzag course of the electric spark and its crackling noise the identity of electricity with lightning. How can we fail to recognize, in the numerous points of resemblance between the phenomena of the thunder storm and the facts of the boiler explosions, the identity of the causes which produce them all?

Recurring to the explosion of the steam boiler in Duke street, Lancaster, there was no occasion to fancy any defect in the material or construction of the boiler or deficiency of the water, or want of skill or care on the part of the engineer, in despite of all the testimony upon these points. On the hypothesis that volumes of the gases accumulated in the boiler were exploded by an electric spark, all that followed was a natural result; instantly the building was leveled to the ground and the ruins scattered with terrific violence, showing that the force was exerted upon all points and in all directions. Being an explosive force, it operated upon the parts affected by the expansive pressure of the gases, which was equal on every side, for the explosive energy is but the explosive force suddenly and indefinitely increased, striking every part at the same instant with a resistless expulsive power. The effect would necessarily be to overthrow all surrounding objects in opposite directions; and as the only point in which there could be sufficient strength to react against so mighty a force was the foundation, the reaction from thence naturally lifted the boiler from its position. In being thus lifted with the northern end probably first raised, the explosive force striking it at the instant, discharged it with the prodigious power that was sufficient to hurl it 700 feet, while the other end was sundered and driven in the opposite direction. All the debris of this destructive explosion exhibited, by the position of the fragments, the fullest evidence that the force had acted as we have indicated — forcing all things apart, just as an explosive power would naturally do.

We believe, then, as the facts are all reconcilable with the theory of an explosive force; as such force could only result from some collection or accumulation of gases in the boiler; as the water, by its decomposition, afforded an abundant source for the supply of explosive gases; as water is decomposed by currents of electricity passing through it; as immense quantities of electricity are generated in the production of steam; as no object can contain more than a certain quantity of electricity, and when a surcharge takes place an electric spark inevitably ensues, carrying off the surplus; as this electric spark fires and explodes the oxygen and hydrogen gases when it touches them, we believe that it was the explosion of those gases, accumulated in this boiler on the morning of July 13, 1867, fired by an electric spark, which caused that disaster; and further, we believe that all the most violent explosions of steam boilers which have occurred were owing to a similar cause.

If this be true, the most important inquiry remains: Is there no remedy, and what are the means of prevention? We think there is a remedy, and that it consists in very simple and direct means of prevention. Care and skill in the engineer are, of course, indispensable qualifications. The safety valve should never be neglected; but especially should there be an arrangement of metallic conductors, with points fixed within the boiler in close proximity to the upper surface and passing through the case of the boiler, be connected with some conducting material communicating with water or the earth, in order to lead the electricity off from the interior of the boiler, and thereby prevent an accumulation and discharge. By such means an electric spark within the boiler would be rendered impossible, and no explosion could take place.

In the year 1842 the French government granted a patent to one M. Tossin, of Liege, for an invention to prevent the explosion of steam boilers, which, for some unknown reason, was revoked in 1844. It was an invention of metallic conductors introduced into the boiler and armed with a sheaf of points, and connected exteriorly with a Leyden jar and a bar of metal immersed in water or moist earth. The position of the points was not precisely defined, nor did it appear from his specification that he had any knowledge of the peculiar action of electricity by which it immediately spreads itself over the surface of metallic boilers, or the least notion of the accumulation of explosive gases within the boiler. He appears to have fancied that boilers were exploded by electricity *suo propris vigore.* The invention proved a failure under his patent, but it, nevertheless, from the terms of our patent law, precluded, by anticipation, an applicant in 1869 from obtaining a patent from the United States Commissioners at Washington; though the American invention was founded upon the presence of accumulated gases within the boiler, the discharge of the electric spark as above explained, and the placing of electric points in proximity to the upper interior surface of the boiler. Under a strong conviction of the truth of this theory (which, by the way, we have partially demonstrated by actual experiments), we now submit the same, from the sense of duty to the public, in the hope that some one, with more leisure and better means, will institute a course of experiments upon an adequate scale to prove, beyond all possible doubt, that water is decomposed in the generation of steam in steam boilers, and that it is the electric spark which explodes the accumulated gases.

The President — It has formerly been asserted that water in the boiler is resolved into two gases by heat. This cannot be true, for it requires, to thus decompose it, a higher degree of heat than is found in the boiler.

Mr. Blanchard — One point much dwelt upon in discussing the cause of the explosion of steam boilers is the terrific force and suddenness with which they are exploded. And it is often said that if it were simply from a gradually increasing pressure, a boiler would give way at the weakest point. It is only good boilers which explode with such destructive force, and they have no weak point. The gentleman argues that if the boiler gave way from mere pressure within it, the whole boiler would go in one direction. An apparatus could easily be constructed to test this; and I think it would be found that the two ends would fly in opposite directions, as they do in boiler explosions. I have no method to propose to prevent boilers from exploding. It may be that we are making money by keeping at the very borders of danger. We can secure perfect immunity from danger, if we choose. We can make the shell so thick that it cannot give way; but we do not consider it expedient to do so. If we kept entirely clear from the borders of danger, we should never know where we were. We need something occasionally to warn us of the profitable line to pursue.

Mr. Hudson stated that while filling a soda fountain, it had exploded, the two pieces flying in opposite directions, although it was evident that the cause was over-pressure and not electricity.

Mr. Norman Wiard—It is unnecessary to inquire where the extraordinary force comes from, for in an ordinary boiler there is force enough stored up to raise 350,000 lbs. 750 feet high, which is a larger amount than has ever manifested itself in an explosion. There were some experiments in the Palace Garden a few years ago, in which electricity was derived from a boiler; but the boiler was insulated; and a spark could not be obtained from a boiler which was not. I do not, therefore, think it necessary to discuss the question of electricity. But I wish to say that Mr. Blanchard is mistaken in supposing that boilers can be made strong enough by using thicker iron. A shell an inch in thickness would not be so strong as a shell of one-fourth that thickness; for the reason that the unequal expansion of such thick plates would cause a rupture in a short time.

Dr. L. Bradley—I cannot assent to the proposition in this paper, that thunder is due to the explosion of gases that have been decomposed by electricity; the quantity of gas evolved is so small compared with the atmosphere around it, and it requires so small an admixture of common air to make the gases non-explosive.

The President—There may be an explosion without any increase of volume. For instance, mix hydrogen and chlorine in the dark. Expose them to light, and they will combine chemically with an explosion, although the volume is unchanged. Choosing partners for a dance causes a considerable stir in a ball-room, although the persons present take up no more room than before. A chemical selection of partners, by particles of matter, may be sudden and violent.

Mr. F. A. Woodson—It is always improper to look for the cause of a phenomenon at a distance, when there is adequate cause close at hand. In the relations of steam, water, metal and fire, we have adequate cause for the most violent explosions. I hold that the great Creator has given man means to control the elements, and that we may bring steam under absolute control. Mr. C. Wye Williams has illustrated the behavior of water in a boiler, and shown that when separate channels are not afforded for the ascending and descending currents, there is violent intermittent action. Steam does not conduct heat; and there is a film of steam formed between the iron and the water, first exceedingly thin, but which may become two inches thick. When this is broken through by the intermittent action, there is a tremendous force. Water, though fluid, is adequate, when thrown in bulk, to break any piece of iron that can be constructed. I have known one boiler out of fourteen to explode at a pressure of forty-five pounds. The boiler had borne seventy pounds for a year, but had a defective sheet, and the differential expansion had weakened it until it gave way. It is remarkable, if electricity is the cause of explosions, that it should always find the weakest boilers, and the weakest places in the boilers.

Mr. Wiard—It is utterly impossible that there should be a film of steam formed between the water and the iron. You can make a plate of iron so hot that when you throw water upon it there will be no contact, the water taking the spheroidal condition; but you cannot heat the iron while water is in contact with it, so as to drive the water away.

Mr. Woodson cited instances where he believed such a film had been formed.

The President—The writer of this paper says he does not believe that water will flash into steam. It is an established fact that if the pressure is high enough to prevent steam from forming, when the temperature is above 212 degrees, on removing the pressure, steam is instantly formed, sufficient to take up all the surplus of heat.

Mr. W. E. Partridge—It may be interesting to state the figures. If we reduce the pressure instantaneously in a boiler from twenty-five pounds to the square inch to fifteen pounds, twenty-one per cent of the water in the boiler will be changed into steam at the reduced pressure; and this will increase the bulk of the whole of the water sixteen times.

Mr. Wiard—And no matter whether it is done suddenly or slowly.

The President—One point of this paper is that electricity fills the celestial spaces instead of ether. Electricity is not a fluid. It is a force, manifested both through the ether and through solid, ponderable matter. It is difficult for dynamic electricity to leap through ether.

Another point is the formation of clouds. He asks why the clouds float. The vapor of water, as steam, has only one-half the weight of air. A certain amount of vapor is taken up, and remains suspended in the air; and when the air is saturated, the excess drops out in the form of rain.

The further consideration of the subject was postponed until the next meeting.

The Woodson Steam Boiler.

Mr. F. A. Woodson exhibited a model of his improved steam boiler, and explained its operation in separating the ascending from the descending current, so as to prevent intermittent action, and equalize the temperature of the boiler.

Adjourned.

December 15, 1871.

Prof. S. D. Tillman in the chair; Mr. Robert Weir, Secretary.

The President read the following scientific notes:

I. Carbonate of Soda.

A new process for the production of carbonate of soda has been invented by M. Swager. By the joint aid of highly superheated steam and red heat, he decomposes the double chloride of aluminum and sodium, previously fused, thus forming aluminate of soda and hydrochloric acid. The latter is condensed; the former, heated with carbonic acid, yields carbonate of soda and alumina.

II. Red Phosphorus an Absorbent.

It is stated by Mr. Testini that the red variety of phosphorus has the power of absorbing many substances without acting chemically upon them. For example, this phosphorus, when powdered, is poured into a violet-colored solution of iodine in bisulphate of carbon, and on agitation the solution will become colorless, if a sufficient quantity of phosphorus is present, thus showing that the iodine has been absorbed. Sulphur, rosanaline and other substances have been absorbed in small quantities by red phosphorus.

III. Antidote to Phosphorus.

Messrs. Eulenberg and Vohl have shown that phosphorus is so readily absorbed by carbon that, taken in the form of pills, carbon constitutes a complete antidote. The pills are made of animal charcoal, powdered and mixed with a little gum. In match factories these pills are found to relieve operators who have been poisoned by phosphorus, and to be a much better remedy than that proposed by M. Personne, the essence of terebenthine having been found to produce violent headaches by continued use.

Mr. T. D. Stetson—It may be interesting in this connection to call attention to the effect of charcoal upon human and animal physiology. A good deal depends upon its being fresh. If taken into the stomach in a fresh condition, it tends to correct acidity, and to vitalize and invigorate, although scientists may be puzzled to explain exactly why. The most plausible theory is that it promotes slow combustion, making the partially-decayed matter burn up and leave nothing but fresh. If a piece of meat is packed in fresh charcoal, and occasionally repacked, it will be all gone at last, but it will remain fresh. Charcoal will even restore meat partially decayed. Meat that has been overlooked until it is quite offensive, by washing and packing in charcoal is restored. Used in the mouth, some authors say it tends to prevent decay of the teeth. A considerably large piece held in the mouth, once in a few days, or even weeks, will keep the breath sweet, and tend to preserve the teeth.

Dr. .H D. Sheppard—I read long ago, an account of a man who was in the habit of taking a great deal of charcoal; and after his death, it was found packed in his intestines in lumps. I have preferred, when charcoal was needed, to take flour and char it; flour being more easily digested. I have sometimes found it useful to mix it with one-fourth part of uncharred flour, in order to give some nourishment also. It requires to be fresh, because it absorbs so much from the atmosphere.

Dr. L. Feuchtwanger—Carbon acts merely as an absorbent. It acts mechanically.

The President—It is well known that carbon absorbs many times its own volume of gases. Whether it will absorb them when it is wet in the mouth is rather doubtful. The use of charcoal, in a case of flatulency, will sometimes give entire relief. I hardly think it remains in the stomach undigested. A lady in Jersey City continued for years, to use as much as twelve cubic inches daily, of charcoal made from pine wood.

Dr. Sheppard—The system has no power to assimilate it. It does not remain in the stomach, but it is liable to catch in the folds of the intestines.

Dr. J. W. Richards—After charcoal has absorbed its full amount of one gas, it will absorb about the same quantity of another. I have stopped the decay of a tooth by whittling a plug of charcoal and putting it in. Charcoal undoubtedly tends to prevent flatulence; but I think it is not from its power of absorption. Like mustard, it probably stimulates the stomach.

Mr. T. D. Stetson—Charcoal has been fed to cattle, mingled with meal, with good effect, for many years. The theory of decay is that one particle starts another. Charcoal promotes *eremacausis*, or slow combustion; and the moment a particle begins to decay, it resolves it into gases and leaves the rest sweet.

Dr. J. W. Richards—Carbon is perfectly indigestible. In the lungs of miners it accumulates so as sometimes to destroy life, showing that it is indestructible in the system.

IV. Mellithic Acid.

Prof. Schultze recently made an announcement at a recent meeting of a German association, which was received with enthusiasm, it being regarded as a pioneer research in a new field, which is likely to be of great importance in applied chemistry. He has succeeded in obtaining mellithic acid by the direct oxidation of carbon with permanganic acid in alkaline solution. Oxalic and other acids had been also produced previously by the same process. Mellithic acid was obtained from various forms of carbon, including graphite, which, on distillation with soda-lime, gave benzole, and the latter upon nitration and subsequent reduction yielded analine.

V. New Form of Sensitive Flame.

Mr. Philip Barry, of Cork, Ireland, has devised a new method of making a sensitive flame, of which he writes to Prof. Tyndall as follows: "It is in my experience the most sensitive of all sensitive flames; though, from its smaller size, it is not so striking as your vowel flame. It possesses the advantage that the ordinary pressure in the gas mains is quite sufficient to develop it. The method of producing it consists in igniting the gas (ordinary coal gas), not at the burner, but some inches above it, by interposing a piece of wire gauze between the burner and the flame. The piece of wire gauze (thirty-two meshes to the inch) is supported about two inches above the burner. On turning on the gas and lighting it above the gauze a flame is obtained in the shape of a slender cone, four inches high, the upper portion giving a bright yellow light, the base being a non-luminous blue flame. At the least noise this flame roars, at the same time flattening itself upon the gauze, and becoming almost invisible; it is very active in its responses, and being rather noisy, appeals to the ear as well as the eye. It does not appear to distinguish the vowel sounds so well as the vowel flame proper. To A it is extremely sensitive, less so to I, but slightly sensitive to E and U; and O has no influence upon it whatever. To the sounds coming from a small music-box it dances in the most perfect manner, and is highly sensitive to most of the sonorous vibrations which affect other flames."

Prof. R. H. Thurston—Some interesting experiments have lately been tried by Dr. Mayer at the Stevens Institute. Several methods were employed for making the tubes, but the most successful one was to draw out one end of a glass tube, one-fourth of an inch in diameter, to a point, and file it, and try it, until it produced its maximum effect. The most successful one was a tube of 3-16ths of an inch internal diameter, tapered down nearly to one-eighth of an inch, and the flame was more than a foot high. The jingle of a key, or sounding the letter S across the room, would bring it down to about one-third, and it would then make the loud rustling sound that gas flames produce when the pressure is too great. He obtained uniform success with brass tubes one-fourth of an inch in diameter, by soldering a plate upon the top and reaming it out until the hole was the most successful size.

The President—These flames may lead to the discovery of one thing hitherto entirely unexplained, with regard to the production of sounds. We know that the pitch of musical sound depends entirely upon the rapidity of the vibrations of the air, the "middle C" producing, according to the French standard, 522 vibrations in a second. But consonant sounds do not depend at all upon pitch; and we do not know on what the expression of a consonant depends. The sound of S affects this flame very much, and this may help to solve the problem. The only theory I can conceive of is, that the consonant sounds produce a roughening of the waves, like the crest of waves breaking upon the shore. Prof. Helmholtz has recently shown that the timbre or quality of sound is determined harmonics or overtones.

Prof. R. H. Thurston—We found that when the flame was most sensitive, a variety of sounds, at different pitches, would produce the same effect. It may be that greater care will make the flame still more sensitive, and diminish the range, so that each tube will be affected by a particular kind of sound. The subject has not yet been sufficiently investigated to determine this. Within the limits of the room, we could not discover that the distance of the sound had any effect upon the result.

Dr. J. W. Richards—The statement that the vowel O did not affect the flame coincides with the statement of Prof. Thurston that sharp sounds do affect it.

Dr. P. H. Van der Weyde—I experimented on the subject ten years ago, and took out a patent for a gas alarm on the same principle, but it would not always act, and its unreliability made it useless. Take an Argand burner, and put it over a disc of wire gauze, and it will have the effects of a Bunsen burner. Put over that a tube of the proper length, and you will get a sound. With a stove-pipe it will roar like a lion. Above this was a very small flame always burning, so as to light the other when the gas was turned on by opening a door or window. In Philadelphia, we made an organ on the same principle, taking pipes of different sizes. Unfortunately, as the pipe was heated the pitch kept rising, and the discord was horrible.

The President—This invention of Mr. Barry's is only a modification of that of Dr. Van der Weyde.

VI. Sounds from the Aurora.

At a recent meeting of the French Academy of Sciences, Becquirel expressed the opinion that the aurora does produce sound, and in confirmation of this view cites the observation of Paul Rollier, æronaut, who started from Paris, in December last, and descended fourteen hours after in Norway, on Mount Ida, at an elevation of 4,000 feet. "I saw, through a thin fog, the moving of the brilliant rays of an aurora borealis, spreading all around its strange light. Soon after, an incomprehensible and loud roaring was heard, which, when it ceased completely was followed by a strong smell of sulphur, almost suffocating." Professor Loomis and other meteorologists have seen no satisfactory evidence that the aurora ever emits any audible sound, believing that the noises ascribed to the aurora are due to other causes such as the wind, or to that low temperature of snow and ice which sometimes produces sudden movement.

Dr. Van der Weyde—The aurora acts upon the needle like an electric current, and must be electric. It cannot be the reflection of the sun's light, for we find the solar lines in everything the sun shines on; but the aurora, when we turn the spectroscope upon it, does not give us the solar lines, but those of the corona. If the aurora is electric, it is probable that there will be sound.

Dr. Feuchtwanger—In cold climates, electricity is more developed than in warm climates; and that indicates that the phenomenon is probably electrical.

Dr. Van der Weyde—The center always corresponds to the magnetic pole, even when the magnetic variation is as much as 20°.

Dr. D. D. Parmelee—Two things render it very improbable that the aurora produces an audible sound; its elevated position, and its great attenuation. It extends to a great height; and it is so attenuated, that the stars are visible through it. It is highly improbable that there could be much sound produced under such circumstances, and still more improbable that the sound could reach the earth.

The President—This gentleman was up in a balloon.

Dr. Parmelee—He was not more than five miles high; and the aurora is stated to extend to a height of 700 miles.

Dr. Van der Weyde—A noise high up does not easily come down. I consider the aurora as a thunder storm in a climate so cold that that there is no water. Clouds are positively electric. In the far north, where no evaporation takes place, the upper atmosphere becomes charged with electricity. The medium above the planetary atmosphere is a good conductor of electricity; and this electricity may be discharged by the route to the equator through the rare atmosphere, which may extend 300 or 400 miles high. The question is whether the sound can penetrate the atmosphere so as to reach the earth.

Mr. Hudson—Why is it, if the aurora is so elevated, that the currents affect the telegraph wires?

Dr. P. H. Van der Weyde—By induction. They do not come down. When you have a current through a wire, there will be an induced current through a parallel wire, with any apparent connection. It depends on the variation of the current; for if the upper current is constant there is no lower current.

The President—Induction is probably produced by a change in the polarity of the atoms of the intervening atmosphere, or of the ether which pervades the atmosphere.

Dr. J. W. Richards—Medical experts consider it settled that the induced current has a different medical effect from the direct current. With regard to the noise, if direct testimony is worth anything, I stand here as a witness. In the middle of a pleasant September night, when there was a very brilliant aurora spanning the whole sky, I observed that, as the belt of light widened or narrowed, there was an evident noise, almost simultaneous with it. I stopped my horse, and spent about an hour in observing it. That was about the year 1830. It might have been a wind which produced the effect upon the aurora, which wind I heard; but there was certainly a coincidence between the sound and the motion of the aurora.

Dr. P. H. Van der Weyde—If the aurora was 600 miles high, it would take an hour for the sound to reach the earth.

Mr. W. E. Partridge—In the winter of 1860, 500 miles north of here, with the thermometer twenty degrees below zero, the snow two or three feet deep, on a perfectly quiet night, during a brilliant aurora, I heard sounds very like the clacking of two pieces of horn. I was watching for sounds from the aurora, and sounds I heard; but whether from that or from the movement of the snow in the extreme cold weather, I cannot say.

Mr. Hudson—During one of the finest auroras I have ever seen, in 1866 or 1867, when it was perfectly still, and I was entirely alone, with no wind, no snow, no ice, no intense cold, it seemed to me that I could hear a crackling sound. Still, I could not be sure that it was not imagination, having so often heard it described.

Dr. Parmelee—We have had three witnesses who have heard three different sounds, the clacking of two pieces of horn, the wind sighing through the boughs, and a crackling sound. I venture to say that any person, on any perfectly still night in the country, if he will listen, will hear a great variety of sounds, some of them perhaps in his own ears. Throwing the head back, may itself cause a rush of blood to the head, which will produce a roaring noise.

Mr. Partridge—I have listened for the same sounds on other nights, but failed to hear them.

Explosion of Steam Boilers.

The President—In the paper of Judge Hayes, read at our last meeting, the explosion of steam boilers is ascribed to electrical influences. He asserts that the evaporation of water produces electricity; but he does not give any reason why the electricity should remain in a metallic boiler having metallic connections with the earth. In the next place, he believes that the water is decomposed; that the gases are mixed inside the boiler, and that they are fired by the electric current. Steam discharged from a boiler will produce frictional electricity; but we have no evidence of the existence of electricity within a boiler.

Dr. P. H. Van der Weyde—The idea of electricity in the boiler has given rise to a patent for a lightning rod inside of the boiler. On the end of the rod magnets were placed, not only to prevent the boiler from exploding, but to prevent scale from forming. Another inventor put a copper plate in the boiler, so that the scale should form on this plate instead of on the iron shell; but it made such galvanic action that the boiler corroded at a fearful rate. I have put steel points in a boiler, but the result was negative.

Mr. Hudson—It would be reasonable to infer from the argument that the electricity developed in a boiler is part of its working power; so that withdrawing that electricity by lightning rods, or otherwise, takes away part of the power.

Dr. D. D. Parmelee—It would be easy to attach a galvanometer to an insulated rod inside of a boiler and test it. If we can get a spark in that way, we shall have something to work upon.

Dr. P. H. Van der Weyde—I thank the gentlemen for the suggestion. I have now in Philadelphia four or five boilers in which that can be easily tried. If there is electricity there the galvanometer will show it.

The President—The boiler might be entirely insulated, and then if any quantity of electricity is generated it must escape through the wire and manifest itself.

Dr. P. H. Van der Weyde—The theory that the gases are ignited by electricity is absurd. The presence of the gases in the boiler can be easily tested. We have only to draw steam, and see if it will all condense into water. There may be a little air mixed with it; but if there should be an explosive mixture left after condensation, it would settle that question.

Professor R. H. Thurston—I understand that Judge Hayes bases his whole argument upon the supposition that the pressure of steam could not cause the destructive violence witnessed in explosions. The report lying on your table, to the Secretary of the Navy, written by Mr. Isherwood, will sufficiently show whether that supposition is correct.

Professor R. H. Thurston then read the following report:

NEW YORK, *December* 12*th*, 1871.

SIR.—Agreeably to your orders of the 18th ultimo, appointing the undersigned a board to witness, report upon, and give all necessary information relating to the experiments being made at Sandy Hook, New York, by Mr. Francis B. Stevens, of Hoboken, New Jersey, on steam boiler explosions, we have the honor to submit a description of them as far as they have progressed, accompanied by our observations on their results

The experiments referred to were devised by Mr. Stevens in pursuance of the following resolutions, passed on the 11th of September last, by the executive committee of the United Railroad Companies of New Jersey, namely:

"That in order to attain greater safety in the steam boilers belonging to the United Companies, Mr. F. B. Stevens be authorized to continue the experiments on the strength and proper management of such boilers, and for this purpose to expend not exceeding $10,000, the vouchers for which to take the ordinary course.

"That other owners of steam boilers are hereby invited to contribute to the experiments to be made by Mr. Stevens, and that the wharf, shops, derrick and tools belonging to the United Companies at Hoboken may be used for this purpose, at cost prices, and a copy of the charges given by the auditor to the contributors.

"That Mr. Stevens be advised to invite the United States inspectors and other prominent engineers to be present at the experiments."

On the 20th of September last, Mr. Stevens received permission from the Secretary of War, at the instance of the President, to make the experiments on the government reservation at Sandy Hook, and to that place he transported the experimental boilers, with the necessary instruments, material and shed accommodation.

The boilers to be experimented with were nine in number; they were conveniently arranged on a well chosen piece of ground inclosed by a high board fence, and were provided with the requisite pressure and water gauges. The former were expressly manufactured for the occasion, and had been carefully tested. Five pressure-gauges were placed near each boiler tried, under the protection of two bomb-proof; and two, tested to a pressure of 500 pounds per square inch, were placed side by side, at a safe distance from the boilers (about 250 feet on the first day, and 450 feet on the second day of the experiments), with which they communicated by a pipe of suitable length; while in this position their indications were compared with those of the tested pressure-gauges at the boilers, and found to agree. All of Mr. Stevens' arrangements were judiciously made, and nothing was wanting to their accuracy and completeness.

Experiments of the 22d of November, 1871.

On the 22d ultimo, in accordance with a notification from Mr. Stevens, we proceeded to Sandy Hook, and witnessed the first experiments, in company with the following gentlemen, who are largely interested, practically and scientifically, in the design, construction and use of steam boilers: Joseph Belknap, Inspector-General of

Boilers; H. Birdsall, Inspector of Boilers; R. B. Davenport, reporter for the New York Herald; J. B. Collin, Mechanical Engineer of the Pennsylvania Central Railroad; Coleman Sellers, President of the "Franklin Institute," Philadelphia; Dr. Wm. H. Wahl, Jr., Secretary of the "Franklin Institute," Philadelphia; Professor Jacob Naylor, of Philadelphia; Wm. N. Henderson, of Philadelphia, mechanical engineer; E. H. Shallcross, of the Select Council of Philadelphia; Wm. Fisher Mitchell, of Philadelphia; Thomas J. Lovegrove of Philadelphia; R. H. Thurston, Professor of Mechanical Engineering, "Stevens' Institute," Hoboken; A. Fletcher, W. Fletcher, builders of steam-engines and boilers at New York; C. H. Haswell, Examiner of Steam Machinery for the New York Insurance Companies; Norman Wiard, John McCurdy, James Miller, Messrs. Phinney & Hoffman; David Saunders, of the firm of J. Nason & Co., New York; Erastus W. Smith, mechanical engineer; W. E. Worthen, mechanical engineer; Robert Allen, Ralph Walker, G. H. Clemens, John Stuart, C. M. Bolen, T. S. Crane, John Dunham, Andrew Fife, John Fish, John McGowan.

The first experiment was made on a boiler built by Fletcher, Harrison & Co., in 1858, and taken out of the steamboat *Joseph Belknap*, in July last, after having been thirteen years in use. It is of the ordinary upper return flue type, with a rectangular front seven feet eight inches long, six feet six inches wide, and six feet eleven inches high, containing two furnaces, each of which was two feet nine inches wide and seven feet long; the top of this front is semicircular and single riveted. The remainder of the shell is a cylinder of six feet six inches diameter and twenty feet four inches length, unbraced, single riveted, and with a flat end. The total length of the boiler is twenty-eight feet. The iron of which the shell is composed is a large quarter inch thick, and all the flat surfaces are braced every seven inches. The top of the furnaces is flat and braced to the semicircular top of the shell immediately over it; and from this semicircular top there rises the usual cylindrical "steam-chimney" or annular steam-drum surrounding the lower portion of the chimney and braced to it. The steam-chimney is four feet in external diameter, two feet eight inches in internal diameter, and ten feet nine inches in height above the shell. The lower flues are ten in number and fifteen feet nine inches long; two of them are sixteen inches in inner diameter, and the remainder are nine inches in inner diameter. The upper flues are twelve in number, twenty-two feet long, and eight and a half inches in inner diameter. The least water-space between the flues is two and three-quarter inches in the clear. All the flat water-spaces of the boiler are four inches wide, including thickness of metal. The grate surface is thirty-eight and a half square feet. The water-heating surface in the furnaces is 80.09 square feet; in the combustion chambers, 31.84 square feet; in the lower flues, 428.70 square feet; in the back connection, 76.92 square feet; in the upper flues, 587.48 square feet; and in the front connection, 57.98 square feet; making a total water-heating surface in the boiler of 1,263 square feet. The steam-superheating surface in the steam-chimney is eighty-four square feet.

The boiler, on the 2d of September last, was subjected, at Hoboken, to a hydrostatic pressure of 112 pounds per square inch, which broke a few of the braces without altering the form of the semicircular top of the rectangular front. After being repaired, it was again subjected, at Sandy-Hook, on the 4th of November last, to a hydrostatic test of eighty-two pounds per square inch, without the rupture of any part; and on the following 15th of November, it was subjected to a steam pressure of sixty pounds per square inch, without fracture.

In the experiment of the 22d of November, which we witnessed, the fuel used was wood, and it was intended to burst the boiler by steam-pressure under the condition of twelve inches of water above the top of the flues, but it was found that the pressure could not be raised above ninety-three pounds per square inch, owing to the excessive leakage of steam from the seam joining the steam-chimney to the boiler-shell. At the above pressure no fracture occurred, but the form of the semicircular top of the rectangular front underwent a change. The experiment was only of value in showing the strength of a boiler of this type and construction after thirteen years' service in a vessel.

The next experiment was made on a rectangular box, built to represent the flat water-space or water-leg of the Westfield's boiler, recently exploded at New York on board that vessel, with great destruction of property and life.

This box was six feet long, four feet high and four inches wide, over all. The two side-plates were of the best flange fire-box iron, five-sixteenths of an inch thick, manufactured by the "Abbott Iron Company." The plates were held together by a single row of rivets at their edges, passing through a frame made of wrought iron bars, mitered at their ends, and having the same outside dimensions as the box. These bars were three and three-eighths inches wide, two inches deep, and perforated at the center line by the holes for the rivets. The side-plates were braced together every eight and three-quarter inches one way and nine and one-fifth inches the other way of their surface, by bolts of one and one-eighth inch diameter with threads cut upon each end and screwed into corresponding threads cut in the plates over which both ends of the bolts were slightly—and but very slightly—riveted. The box was placed on one edge upon an eight inches thick brick-wall, and was inclosed with side-walls of brick and masonry, with the exception of a strip fifteen inches deep at the top and twelve inches wide at one side, which protruded into the air, and to which the gauges were attached. The inclosed portion of the box was heated by two small furnaces without intercommunication, the fire-grates of each being twenty-seven inches long and fourteen inches wide. The fuel was wood, and the products of combustion were discharged through two sheet-iron pipes. The surface of the box exposed to the fire was nineteen and a half square feet, and was all water-heating surface, as the box was filled with water to within nine inches of its top. Of the total interior height of the boiler, therefore, thirty-seven inches were occupied by water and seven inches by steam.

The fires being brought to steady action, and steam raised to the atmospheric pressure, the opening for the escape of the latter was closed, and the pressure rose as follows, for the corresponding times, namely:

TIME P. M.		Steam-pressure in pounds per square inch above the atmosphere.
Hours.	Minutes.	
3	18	0
3	20	4
3	21	5
3	22	7
3	23	9
3	24	11
3	25	13
3	26	15
3	27	18
3	28	20
3	29	23
3	30	27
3	31	30
3	32	34
3	33	38
3	34	44
3	35	49
3	36	51
3	37	54

Time P. M. Hours.	Minutes.	Steam-pressure in pounds per square inch above the atmosphere.
3	38	58
3	39	65
3	40	72
3	41	78
3	42	86
3	43	94
3	44	100
3	45	110
3	46	117
3	47	126
3	48	135
3	49	147
3	50	160
3	51	165

When the pressure reached 165 pounds to the square inch, the box exploded with a loud report, completely demolishing the brick-work by which it was inclosed. The two sides were hurled in exactly opposite directions, and to about equal distances, at right angles to their surfaces. The fracture had occurred in one plate only, and was along the whole riveted seam joining it to the frame. For a large part of the length of the seam this plate was torn out between the rivets, and for the remaining part the rivets were sheared. The other plate was not fractured, nor were the bars of the frame broken; the plate and the frame remained riveted together, but not uninjured, all the bars of the latter being bent considerably inward, forming an irregular curve of from four to six inches versed-sine. Both plates were bulged out irregularly, so as to be about nine inches dishing, and the bulging took place near the bars. Not one of the bolts was broken, and neither the threads upon their ends, nor the threads in the plates, were stripped or injured, but the slight riveting over the ends of the bolts was broken off in all of them.

The fact that the plates did not rupture at the center, under their great amount of bulging (and only one of them tearing off at the line of rivets along its edge), shows the excellence of the metal which endured this great, almost instantaneous and permanent stretching without fracture; and to this same extensive stretching must be attributed the escape of the screw threads on the ends of the bolts, and in the plates, from injury. The plate, by stretching, simply enlarged the diameter of the hole in which the threads were cut, until the bolt, thus left free, slipped through without injury to its threads, only breaking off the slight riveting over its ends. Had these bolts been secured by nuts on the outside of the plates, the box would have borne an enormously greater pressure than that which exploded it. Between the bolts there was a small permanent stretching of the plates, giving each space between the bolts a slightly dishing or bulged form, in addition to the general bulging of the plates, thus forming a system of secondary bulges, as it were; and around every bolt both plates were strongly marked by a congeries of circular crispations.

The conclusions from this experiment are, that a gradually accumulating steam pressure in a boiler can produce a true explosion, violently hurling its fragments, with a loud report, to a considerable distance, even though eighty-four per centum of its capacity be filled with water; and that screw bolts should not be used in boiler construction without nuts, or having, as an equivalent, a large portion of their ends formed into massive rivet-heads; because the stretch of the plates is sufficiently great, under a much less pressure than will fracture the bolts or strip the threads, to allow the latter to slip through uninjured.

Previous to this experiment the box had been subjected, at Sandy Hook, to a hydrostatic pressure of 138 pounds per square inch, and to a steam pressure of 102 pounds per square inch, without fracture.

EXPERIMENT ON THE 23D OF NOVEMBER, 1871.

On the twenty-third ultimo a last experiment was made, by exploding a boiler in the presence of the undersigned and the following gentlemen, namely: Captain W. W. Woolsey, superintendent of the Jersey City ferry; William and Andrew Fletcher, of the firm of Fletcher, Harrison & Co., engine and boiler makers; Anning Smith, superintendent of the North-Shore Ferry Company; J. B. Collin, mechanical engineer of the Pennsylvania Central railroad; William A. Dripps; Thomas Lingle, of the Camden and Amboy railroad; Wm. Brown, of the Camden and Amboy railroad.

The boiler that was exploded during this experiment was built by T. F. Secor in 1845, and taken out of the steamboat *Bordentown* in August last, after having been twenty-five years in use. When taken out the inspector's certificate allowed it to be worked with a pressure of thirty pounds to the square inch. It was a horizontal fire-tube boiler, with the tubes returned immediately above the furnace and combustion chamber.

It had but one furnace, and that was eleven feet five inches in width, with grate bars seven feet in length. The top of the furnace and the top of the combustion chamber were flat and braced to the flat top of the shell above them by rectangular braces two inches by half inch in cross section, placed seventeen inches apart crosswise the boiler and twelve inches apart lengthwise the boiler, each brace holding a flat surface of 204 square inches, to which it was attached by crow-feet so arranged that the flat surface between the sustaining rivets was twelve inches square. The flat water-spaces were braced at intervals of eight inches in one direction and twelve inches in the other by one inch diameter screw-bolts, each of which held a flat surface of ninety-six square inches. The iron plates of the boiler were a large quarter inch thick.

The tubes were of iron and 384 in number, arranged in eight rows, vertically, and forty-eight rows, horizontally. Each tube was two inches in outside diameter and twelve feet in extreme length. The total height occupied by the tubes from the lower side of the lower tube to the upper side of the upper tube was twenty-two inches. The tubes were divided into sixteen groups, and the groups were separated by water-spaces two one-sixteenth inches wide in the clear, vertically, and one and three-quarter inch wide in the clear, horizontally. From the lower side of the lower row of tubes to the top of the furnace and combustion chamber was a space six inches in width for water circulation. The bridge wall and the bottom of the combustion chamber were of brick. The furnace had no water-bottom, but its side legs of four and a half inches width rested in a pan which covered the entire area beneath the furnace.

The shell of the boiler was rectangular, with the exception that the vertical sides were joined to the flat top by quadrantal arcs of thirty-seven inches radius. All the seams were single riveted.

Upon the center of the top of the boiler was a cylindrical steam-drum of six feet diameter and eight feet and eight inches height.

The flat water-space at the front of the furnace was four and a half inches wide, and that at the brick end of the boiler was five inches wide, including thicknesses of metal.

The width of the boiler was twelve feet two inches, its length was fifteen feet five inches, and its height, exclusive of the steam-drum, was eight feet six inches.

The shell was braced very unequally. Each upper horizontal brace, one and one-eighth inch large in diameter, sustained the pressure upon a surface twenty-eight by twelve inches or 336 square inches; and each rectangular vertical brace adjacent the sides, two inches by half inch in cross section, sustained the pressure upon a surface nineteen by twelve inches or 228 square inches. These were the weakest places.

The following were the grate and water heating surfaces of the boiler.

Grate surface	$79\frac{1}{12}$	square feet.
Heating surface in furnace	180	"
Heating surface in combustion-chamber and back-connection	103	"
Heating surface in tubes	2,181	"
Heating surface in uptake	64	"
Total heating surface	2,318	"

On the 2d of September last this boiler was subjected to a hydrostatic pressure of sixty pounds per square inch, when twelve crow-feet gave way. After being repaired, it was again subjected on the 8th of November last, when erected at Sandy Hook, to a hydrostatic pressure of fifty-nine pounds per square inch, which it bore without fracture; and on the 16th of November last it was subjected to a steam-pressure of forty-five pounds per square inch, which it also sustained without fracture.

The fuel used in the experiment was wood, and the water-level in the boiler was fifteen inches above the highest point of the tubes. When the fire had been brought to a steady action the pressure of the steam gradually increased at the following rate, commencing with the pressure of twenty-nine and a half pounds per square inch.

TIME P. M.		Steam pressure in pounds per square inch above the atmosphere.
Hours.	Minutes.	
12	21	$29\frac{1}{2}$
12	23	$33\frac{1}{2}$
12	25	$37\frac{1}{2}$
12	27	41
12	29	$44\frac{1}{2}$
12	30	$46\frac{1}{2}$
12	31	$48\frac{1}{2}$
12	32	50
12	33	52
12	34	$53\frac{1}{2}$

At the pressure of fifty pounds per square inch, some of the braces in the boiler gave way with a loud report, and when the pressure of fifty-three and one-half pounds was reached, the boiler exploded with terrific violence. The steam drum and a portion of the shell attached to it, forming a mass of about three tons weight, were hurled to a great height in the air and fell to the earth at about 450 feet from the original position of the boiler, crushing several trees in their fall. Two other large fragments fell at less distances, while smaller ones were thrown much farther. Almost the whole of the boiler was literally torn into shreds, which were scattered far and wide, the only portion remaining where the boiler had been being the tubes. These, though considerably distorted, were otherwise uninjured. Both tube-plates had been blown from the tubes in opposite directions, and at the same moment, for nearly all the tubes were found lying in a heap on the ground immediately beneath the place they had occupied in the boiler, the riveting of their ends over the plates having been simultaneously stripped. The top of the furnace and the top of the combustion chamber, which, in the boiler, were immediately beneath the tubes, had entirely disappeared into debris, as had also the sides and ends of the shell. The boiler seems to have first yielded by the fracture of the upper row of horizontal braces. The loud report heard, when the pressure attained fifty pounds per square inch, was probably caused by their breaking. The larger masses were all thrown in one direction—at right angles to the side of the boiler; but the smaller fragments were projected radially in all directions, as from a center. Two heavy bomb-proofs, constructed of large timbers and sand for the protection of the other boilers, were dislodged, and a part of the fence of the inclosure was destroyed by the impact of the flying fragments. The crow-feet, in most cases, remained firmly attached to the shell, and the braces had parted—probably in the welds—leaving the ends still secured to the crow-feet. The screw-bolts, which braced the flat water-spaces, had slipped from their fastenings in the plate without injury to the screw-threads either upon them or in the plate. The latter was permanently bulged or dished between the bolts, and this stretching of the metal had, by its enlargement of the holes, allowed the screw ends of the bolts to draw out without injury to the threads either on the bolts or in the plates.

The ground beneath, and for a considerable distance around where the boiler stood, was saturated with the water of the boiler; in fact, made into mud, and the adjacent grass and small shrubbery were so drenched that an ordinary boot was wet through by walking among them. At seven minutes before the explosion took place, the water-gauge on the boiler was examined and found to indicate the water-level fifteen inches above the top of the tubes.

The conclusions to be drawn from this experiment are the following:

1st. An old boiler, containing a large mass of water above the highest point of its heating surface, can be exploded with such complete destruction as to reduce it into mere debris, and hurl the fragments in all directions with a force that no ordinary construction of building or vessel could withstand.

2d. That the pressure required for so devastating an explosion is the very moderate one of fifty-three and one-half pounds per square inch.

3d. That with only a wood fire, generating a far less quantity of heat in equal time than a coal fire, there were required only thirteen minutes to raise the pressure from the inspector's working allowance of thirty pounds per square inch, to the exploding pressure of fifty-three and one-half pounds per square inch, showing that a few minutes' absence or neglect of the engineer, coupled with an overloaded or inoperative safety-valve, are all that are needed to produce the most destructive steam boiler explosion, even with an old and unequally braced boiler, in which it might be supposed a rupture of the weakest part would precede other fracture, and allow the escape of the pressure without doing further injury.

4th. That in accounting for either fact of an explosion, or for its destructive effects, there is no necessity for hypothesis of low water, enormous pressures, instantaneous generation of immense quantities of steam, superheated steam, the formation of hypothetical gases, development of electricity, etc., etc. The most frightful catastrophe can be produced by simply gradually accumulating the pressure of saturated steam to a strain at which the strength of the boiler yields, nor need that pressure be much above what is ordinarily employed with boilers of this type.

5th. That there is no flashing of the boiler water into steam at the moment of an explosion. On the contrary, with the exception of the small portion of this water vaporized (after the reduction of the pressure owing to the rupture of the boiler) by the contained heat in it between that due to the temperature of the steams of the exploding pressure and of the atmospheric pressure, it remains unchanged, and is thrown around, drenching the objects near it, and scalding whomever it falls upon.

6th. The weakest portion of the boiler braces was in their welds.

7th. The equal stretching in all directions of the boiler-plates between the screw-bolts, due to their bulging under the pressure, was sufficient to permit the slipping out of the bolts without injury to the screw-threads either upon them or in the plates.

8th. That this experiment has conclusively disposed of several theories of steam boiler explosion, replacing vague conjecture and crude hypothesis with exact experimental facts, and, by thus narrowing the field for the search of truth, has made its discovery more probable.

All of which, together with drawings of the boilers experimented with, are respectfully submitted by, sir,

Your obedient servants,

B. F. ISHERWOOD,
E. S. DE LUCE,
SIDNEY ALBERT,
Chief Engineers U. S. Navy.

Hon. GEORGE M. ROBESON,
Secretary of the Navy.

To the conclusions contained in this report, Prof. Thurston added,

9. That a boiler may explode at a pressure lower than the hydrostatic test to which it has been subjected.

Adjourned.

December 22, 1871.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Secretary.

The President read the following scientific notes:

I. A SOLAR EXPLOSION.

Prof. Young, of Dartmouth College, on the 7th of September last, at 12.30 P. M., was examining, by means of his spectroscope, an enormous flame or hydrogen cloud, on the eastern border of the sun, about 100,000 miles long and 54,000 miles high, its lower surface being at least 15,000 miles above the visible border of the sun, to which it was connected by three or four bright columns. Such was its appearance when he left the telescope. On returning, within half an hour, he was surprised to find this vast projection had been literally blown to shreds by some inconceivable force from beneath. In place of the quiet cloud, the air, to use his expression, was filled with flying *debris*—a mass of detached, vertical, fusiform filaments, which continued to rise with a motion almost imperceptible until the uppermost were more than 200,000 miles above the solar surface. As they rose they gradually faded away like a dissolving cloud, and at 1.15 P. M. only a few filmy wisps, with some lighter streamers low down near the chromosphere, remained. In reference to the supposed disturbance of the earth's magnetism by changes in the sun's atmosphere, he says: Whether the fine aurora borealis which succeeded in the evening was really the earth's response to this magnificent outburst of the sun is perhaps uncertain; but the coincidence is at least suggestive, and may easily become something more if the Greenwich magnetic record indicates a disturbance precisely simultaneous with the solar explosion.

II. MAGNETIC PERTURBATIONS.

The so-called solar explosion recently described by Prof. Young, of Dartmouth College, did not (contrary to his expectations) produce a specially marked simultaneous disturbance of the magnets in Greenwich observatory. Professor Airy, of the observatory, in answer to Professor Young's inquiry on the subject, writes: "The day was one of magnetic disturbance, but it does not appear that any remarkable movement coincided with the beginning of your observation. There was a sudden movement nearly at the end." It seems probable, therefore, that these rapid and extraordinary movements of the most rarefied portion of the sun's atmosphere do not produce such magnetic disturbances at the earth as have been frequently observed when solar spots appear, which indicate that an actual opening has been made completely through the solar atmosphere.

Dr. P. H. Van der Weyde—In the spectroscope, the corona of the sun, the aurora borealis and the zodiacal light produce the same lines. There is a relation between the aurora borealis and also between solar disturbances and magnetic disturbances. That the aurora borealis affects the compass needle is well known. I have at my house a delicate compass needle, carrying a mirror reflecting a scale at some distance from it, so that the slightest motion of the needle is visible. On one occasion I saw, in the afternoon, that the needle was very uneasy, and concluded that there was an aurora, invisible in consequence of the daylight. As soon as it was sufficiently dark the aurora became visible.

Mr. T. D. Stetson inquired if it had been demonstrated, by any sufficient series of observations, that there is any relation between spots on the sun and magnetic or other disturbances on the earth.

Dr. Van der Weyde remarked that there had been solar eruptions observed, and at the same instant in two places a change had been observed in the magnetic needle.

The President—If the earth is a magnet, it is easy to conceive that any change in the form of the sun might affect the magnetism of the earth. But in the explosion seen by Professor Young, it was a movement of very light matter, and it is not surprising that the effect should have been so slight as to be imperceptible by means of the magnetometer. The most plausible explanation of the cause, the magnetism of the earth, is that it is due to thermo-electricity produced by the difference of the action of solar heat on different parts of its surface. I asked Prof. Meyer last night, after his lecture before the Institute, on magnetism, why he did not speak of the cause of the earth's magnetism. He replied that although the thermo-electric theory is very plausible, he was not prepared to indorse it positively; but he aimed simply to show the fact that the earth is a magnet. We had in that lecture one experiment which was never before made in the world; the minutest change of the galvanometer was visible to the whole audience.

Dr. Van der Weyde—A great many experiments in magnetism have heretofore been such that they could be seen by a dozen persons at most. But the use of the vertical lantern allows a whole audience to see the results of such experiments. The nearest approach to this plan was that which I have tried, throwing the image upon the ceiling: but Prof. Morton's improvement of Prof. Cooke's plan is far superior. The experiments themselves, which were exhibited last evening, were not new; but they have never before been exhibited to a large audience.

The first person to announce the theory that the earth's magnetism is caused by the solar heat was Barlow. But there are two objections to that theory. One is that the action of a sun-spot is so immediate. If it is the result of currents, it should take some time. It takes three hours to get the maximum of heat; it does not occur when the sun passes the meridian. The velocity of the transmission of this influence is very great. The velocity of light is slow in comparison to it. There is positive proof that the transmission of gravitation is instantaneous, proof as certain as that the three angles of a plane triangle are equal to two right angles. It is very likely that the transmission of magnetism from the sun to the earth is instantaneous. The second objection is that it does not explain the rotation of the magnetic pole around the geographic pole. There are two north poles; but the principal one is in this country now. Two hundred years ago it was in Europe; and it is now going back toward Europe. The cause of this is unknown. It may be that the earth is magnetic by induction chiefly.

The President—I do not accept the force of the first objection; for our knowledge of the time of the formation of a sun-spot is derived from vision, depending upon the motion of light. The instant a person can see a sun-spot, that instant the effect of the heat of the sun is felt upon the earth, and, of course, at that instant it should affect the needle. As to the other objection, the position of the magnetic pole, it will be found, upon examination, that if a magnetic pole were to be produced as the effect of the solar heat, it would be produced exactly where it now exists, and that is one of the strongest reasons for accepting this theory.

Dr. Van der Weyde—If the solar heat were the cause, I should expect the magnetic currents to run parallel to the equator, for at all seasons of the year the apparent rotation of the sun is always at right angles with the axis of the earth. Besides, the currents should be the greatest where the heat is the greatest. The magnetic meridians and parallels are very irregular indeed.

The President—That is another argument in favor of the theory, because the earth's surface is very uneven, and the thickness of the earth's crust is very unequal, and the currents produced by unequal heating should be the strongest where the heat is the least.

III. DISTANCE OF DOUBLE STARS.

The distance of nearly all the fixed stars being so great that observations of the same star, at opposite points of the earth's orbit, form no parallax, the astronomer has heretofore been baffled in his attempts to estimate, even approximately, the remoteness of these celestial bodies. Mr. Fox Talbot has proposed to use the spectroscope in the following manner for effecting this object in binary systems: Suppose the plane of the orbit of a binary system to pass through the sun, *i. e.*, that the observer is in the plane of the orbit, and that in the spectra of the individual stars there are lines belonging to the same element, the spectra of the two stars, taken through the same slit, should be observed and compared. When the stars appear in the same straight line, it is clear that their velocities, relative to the earth, are the same, since both are moving, perpendicularly, to the line of vision; the lines from the two stars will, therefore, coincide. But when their apparent distance from each other is greatest, the difference of their velocities relative to the observer is equal to the velocity of either star, in its velocity in its orbit about each other. This difference will produce a displacement of the lines, which may be observed and measured. This gives the value of that velocity; but we know, also, the periodic time. We have, then, at once, the circumference and the diameter of the orbit. We know the greatest angular distance between the stars; we have then the distance of the stars from the earth.

The President—Mr. Lewis M. Rutherfurd, of this city, has been quietly doing a work, at his own observatory, which will be consulted 50,000 years after we are forgotten, in photographing groups of stars, by which their positions are exactly recorded, without the error of personal equation. Mr. D. Chapman, the photographer, who assists him in his work, is present to-night, and we would like to hear from him some account of that work.

Mr. D. Chapman—The groups of stars are photographed twice a year; six months apart. The telescope takes directly a field of about two degrees. There is a little distortion, but that can be ascertained mathematically and applied as a correction. Some of the groups contain as many as 125 stars, down to the ninth magnitude, taken upon a plate five and one-half inches square. A star suspected of proper motion is placed in the center of the plate. The plate is exposed six minutes, and then the telescope is moved slightly and the plate is exposed six minutes longer, duplicating all the stars upon the same plate, so as to identify them from other spots upon the plate and verify their positions. Then the clock-work is detached, and, after a certain length of time, the clock is again attached and a supplemental exposure is made, which furnishes us the base line, or zero of position. With the micrometer, each star is determined in position by its distance from the central star and by the angle of the line from it to the central star with the east and west line. In order to get rid of any constant error from the direction of the telescope, we usually take the stars with the telescope first on one side of the pier, and then, when the stars are in a different position, with the telescope upon the other side of the pier. By repeating the groups six months apart, we hope, by and by, to ascertain the amount of parallax of some of them. We thus have an absolute map of these groups for future use. On a cloudy day, a young lady sits down and measures the positions of those stars.

Dr. P. H. Van der Weyde—Will you explain about making the telescope achromatic for the actinic rays?

Mr. D. Chapman—The first object glass, that which Dr. Gould now has at Cordova, was corrected for the actinic ray alone. The ordinary photographic lens is a compromise between the visual and the actinic rays. The thirteen inch objective we now have was first corrected for the visual rays as perfectly as possible. Then a flint glass meniscus lens was constructed to be placed in part of the objective, shortening the focus about one-seventh, which was corrected by the aid of the spectroscope, until the whole combination was perfectly corrected for the actinic rays.

Iron Deposits in Alabama.

Mr. Colton gave a description of the iron deposits in Alabama, and exhibited specimens of the ore, and read the following paper:

All the printed records one can find of the great mineral wealth of Alabama consist of two small pamphlet reports by Prof. Tuomey, and a few even smaller pamphlets of particular properties. I found everywhere the greatest pride in the mineral wealth of the State, and the most earnest desire for its development. The quantity of coal consumed is now really very large, and the price fixed at a moderate rate.

Alabama has three coal fields — the Warrior, Cahawba and the Coosa. The first and second I have visited; the last is at present inaccessible to transportation. The village of Montevalloo, on the Selma, Rome and Dalton railroad, is the point from which I reached the lower Cahawba field. This coal field has the shape of a pear with one side partially cut out. It is located between the S. R. and D. R. R. and Alabama and Chattanooga railroad, the large end being south toward Selma, thence running northeast about thirty-six miles. It contains about 300 square miles of coal lands, and supplied to the Confederate navy yard and foundries at Selma and elsewhere, from 200 to 300 tons of coal per day for two or three years. Its northern or northwestern edge is skirted by the A. & C. R. R. at a distance of two or three miles; its southern is distant from the S. R. & D. R. R. at Montevallo and southward about two miles. The North and South railroad runs through the northern neck. Montevallo is located just where the chop-out or sunken portion commences. I visited the openings near Montevallo, and then rode across the field and returned. carefully examining the geological structure and outcrops. On the south side the silurian rocks are pressed directly up to the coal, crowding out the sandstone and forcing the coal to a perpendicular, at some points even to an incline southward. A section through this broad part is represented on the blackboard, without indicating all the veins.

On the north side all is regular and in place, hence sixteen distinct veins are to be traced. Many of these were opened during the war and yielded quantities of excellent coal. In my exploration I was accompanied by Mr. Giles Edwards, of Roup's Valley, a Welsh Pennsylvanian, and to his exertions is due much of the accuracy of my information. The Cahawba river is shown; the Grand Trunk Air Line railroad from Mobile to the A. & C. R. R., at Birmingham, runs a little north. This road will, for twenty-five miles, run directly on the coal outcrops. Such is the location, and such the present and future facilities for transportation.

The openings now worked near Montevallo are conducted by the Cahawba Coal Mining Co., an association of Illinois capitalists, under the general management of Col. R. M. Moore, formerly Colonel of the 111th Illinois Regiment, and the immediate openings are superintended by his Lieutenant-Colonel, J. T. Black, of Salem, Ill. One mine is owned in Montgomery, the other leased from some party in the neighborhood. There are numerous other openings near this place, most of them above water level, and abandoned as soon as water came in. It is probable that the present building development of the Alabama coal and iron mines is due solely to the policy adopted by the Confederate government of exempting from army service all who supplied such products. There was the double inducement of making money and keeping out of the way of bullets. Such a system, however, may not primarily have caused judicious mining, but there were many whose loyalty to the Confederacy did not prevent them from putting their property in excellent shape at the expense of that establishment. At the same time there was much desultory mining; for instance, the perpendicular thirteen-foot vein was opened, but abandoned as soon as the water came in. Systematic work would have done much to prove the value of this field, as well as for scientific investigation.

The large vein worked by Colonel Moore is from three to four feet thick. It is worked by a drift running horizontally in a hill about one hundred and fifty feet high. Entering this tunnel about 200 feet, in a large chamber we find the engine and boilers—the smoke-stack and ventilation flue run up through the sandstone. The engine pumps the water from the slope workings of the mine and draws up the cars. It is certainly in a singular location, having more than ninety feet of rock and earth over it. The coal from this mine is a free-burning, non-caking coal, and has made a rather poor coke, due, perhaps, to the mode of making. It is said to yield about 8,000 cubic feet of gas in the Selma Works, but I was disposed to doubt the quantity. It has but little ash, and that of a light fawn color. It is certainly a superior steam coal. The miners are paid ninety cents per ton for delivering at mouth of tunnel. Thence it is conveyed by a narrow gauge road one and a quarter miles to the branch road from S. R. and D. R. R.; there it is dumped in cars for market. It is screened and affords some dust and nut. The lump sells at five dollars per ton at the branch road, the nut at two dollars, dust the superintendent would be glad to get out of his way by delivering at two dollars. A great deal of the last would answer well for steam-making in any manufacturing establishment, as it is not fine. The cars are conveyed to the dump by a small locomotive, which does the work of ten mules. The product of the mine is from sixty to eighty tons per day, and forty-two hands are employed. I estimated the cost of getting out the coal at about two dollars per ton. Sold at the dump at five dollars, there would appear to be profit; yet I was informed that the company were not making money. The price in Selma was seven dollars fifty cents and eight dollars, and in Mobile about one dollar and two dollars more. It should and can be delivered at one-half those prices. The railroad men say that if the business is carried on to such an extent as to allow them to run special coal trains they will make freights lower. It is certainly a very good coal for steamships, burning up entirely to ash without the slightest clinker; and, if English vessels run to Mobile or Pensacola, should be afforded there for them at less rates.

At the other mine, the miners receive one dollar per ton, as the vein is not so wide, but there the broad gauge branch road runs directly to the mine. It is worked through a tunnel, without steam power; the mine drains itself, and the miners work up a slope instead of down. The coal appears to be the same, though the ash is whiter, the vein narrower and the topographical position lower. Both the tunnels run in on the outcrops. I have never seen anywhere else such a wealth of fossil plants as are found here in the slates above the coal.

These are all the regular workings on the lower portion of the Cahawba field. It is evident there is to be found in it a good coal for coke, as from one of the openings made during the war on the northern side a very superior article of that grade was mined. This mining is distant from Montevallo about twelve miles. The corresponding vein must exist on the southern side, though dislocated by the pressure of the silurian strata.

The veins of coal in the Cahawba field across this broad part, counting from the middle of the field northward, number sixteen. These are, as we have stated, all in regular order and inclination. On the upper or narrow neck of the field most of these veins still exist, but some are disturbed so as to be vertical or to change their natural inclination. The following presents the position of these by a section through the point of which the North and South railroad passes over them, and also indicating the position of the immense beds of fossiliferous iron ore.

Leaving the line of the S. R. and D. R. R. going north, the country through which the North and South road passes is, for about twenty miles underlaid with limestone. This gives a rich soil well fitted for the small grains and grasses. The great market for any produce which may be raised there, and much more, will be at the mines and iron works which must eventually be worked on its line. Through the kindness of Mr. A. Shaw, superintendent of this road, I went over the greater portion of it on a platform car, very slowly, stopping whenever fancy dictated. The road cuts through the outcrops of eight coal veins, and runs so near the openings of several mines that a miner could, from them, throw a shovel of coal in a car passing along the track. Immediately on the line six mines are being worked, and four more two to three miles distant. The coal is shipped to Montgomery, and sold at eight dollars to eight dollars and fifty cents per ton. Some idea of the cost of mining may be had when one mine-owner offers to contract to deliver his coal on the cars at two dollars and fifty cents per ton in quantities. The coal varies in quality; some of it makes a beautiful coke; none yet mined seems to stand exposure to the weather. I have no doubt that good coal for iron making can be found here. Taken in connection with the fossiliferous ore, it must become a great iron-making section. The road at one point cuts through the edge of a mountain, and exposes a vein of this ore thirty feet thick. Taking the proposition of Mr. Gould, the mine-owner alluded to, and we have:

Four tons coal (two tons coke)	$10 00
Two tons iron ore	1 50
Limestone	50

Add labor and interest and we have the cost of making iron on this road. The ore need not cost one dollar and fifty cents, as it is not to be mined, but simply quarried. The railroad for more than half a mile is ballasted with thousands of tons of the ore, including a high embankment, built almost entirely of it, yet the rails on this road are of English iron.

The coal mines along the line of this road were worked during the war, it having been graded and an apology for track laid to them. It is said that every known species and shape of iron ever rolled was represented in that track, and many miles of it were simply hard wood sleepers. Yet even then it transported 100 tons of coal per day for nearly three years; now from 110 to 125 tons are daily shipped. Then there was along its route an iron furnace, with two stacks, and a rolling mill. General Wilson's raiders ended both of them. The former will be rebuilt; the latter never on its former location, but having excellent machinery, still undamaged, may yet be worked at some other point.

The conclusions taken from the Cahawba coal field are: It has at least seven veins of workable coal; these will vary from three to five feet in thickness; one or more of them are good for making iron without being coked; they can be mined at a profit of two dollars and fifty cents per ton of 2,240 lbs.; several of them are very superior as grate and furnace coal, burning up to ash without clinker; the veins are compact, without intervening slate or fire clay; the present means of transportation are good, the railroads proposed for the future will give still better. Iron ore is abundant, from hematite on the south-east and fossiliferous on the north. Then as to cost of delivering this coal in the market: The completion of the North and South road through this region gives it an access to the world; the completion of the Montgomery and Eufaula railroad makes a through line to Savannah and Brunswick. Therefore, as all these lines are of the same gauge, a car loading at any point between Calera and Birmingham, or on the A. and C. R. R., can run through to New Orleans, Mobile, Savannah, or any city south of North Carolina. Columbus, Ga., is by its superior water-power, destined to be the great manufacturing site of that State; hence we take it as a starting point. Mr. Shaw, superintendent S. and N. R. R., says he can deliver coal in quantities to Columbia; two dollars cost to miner, one dollar for profit, freight, three dollars and sixty-five cents—total, six dollars and sixty-five cents; Macon, seven dollars and twenty-five cents; Montgomery, four dollars and sixty cents; Brunswick, eight dollars and forty cents; Savannah, eight dollars; Mobile, seven dollars; Pensacola, six dollars and fifty cents; Eufaula, five dollars. In all these data two dollars per ton has been allowed as cost to the miner. If, by increase of manufacturing industries, the miner can sell his dust and nut coal, he will have ample profit at two dollars per ton, provided he is enabled to do a large business. The peculiarity of this Cahawba field is that so far it has been mined almost without pumping, that much coal may for years be gotten in the same manner; in the future, however, machinery must be used. I will now speak more directly of the iron interests, and the great Warrior coal field.

The geology of Alabama presents some peculiar features; features, however, which may be said to extend far northward in the same formation west of the great Atlantic water divide. The strata anticlinal and the water divides in Alabama, or at any rate this portion of it, are valleys. The location of Birmingham is one of the prominent instances of this fact, yet lower down the peculiarity is still more striking. The Alabama and Chattanooga railroad from the Georgia line runs down Little Wills' Valley, and thence into Big Wills'. The waters of these flow into the Coosa and Cahawba, the anticlinal divide being farther north in Big Wills', whence streams flow both into the Coosa and Tennessee, there being hardly any perceptible difference of elevation at their sources. Crossing the Red Mountain, which, seven miles above Birmingham, takes a sudden southward bend, the road enters Jones Valley; which is really nothing but a continuation of the Sequatchie Valley of Tennessee, and that long, continuous anticlinal valley that reaches down from Pennsylvania, but is thrown out of line by the convulsions which have taken place around Chattanooga. In this valley is located Birmingham, a place created by railroad progress. A large stream winds around and through the town, thus affording ample water facilities for the most extensive manufacturing establishments. I do not mean water-power, for it would be almost folly to use water-power at a place where the best coal can now be bought at two dollars and fifty cents per ton, and where in three to five miles a dozen mines are ready to supply that fuel. At present only the South and North and A. and C. R. R. are here, but two others are certain, and two more prospective Such is the location of a place which it is hoped is to be the great manufacturing center of the south. It certainly has great inducements, and the liberality of the property owners must make it a success.

From Birmingham the A. and C. R. R. runs down Jones Valley into Roup's Valley (really all are one valley, but the Jones Valley stream has traveled off to the Warrior river), which continuation immortalizes the name of Roup, by giving it to one of the most beautiful valleys in the world, because that gentleman had a mill on a stream in its limit. This same valley is, in fact, continuous down to Tuscaloosa, alternately throwing its streams into the Warrior or the Cahawba.

It has been stated that the Red Mountain takes a sudden turn south, and then again continues on its regular south-west course. This mountain derives its name from the immense vein of fossiliferous iron ore continuous through it. In Tennessee there are three or four distinct veins of the red fossiliferous ore; none of them of greater thickness than five to six feet. This great vein in Alabama continues down to near Birmingham to be about twelve feet thick, a distance of over 100 miles, and one to three miles north of the A. & C. R. R., where it makes the bend south, and again south-west it suddenly widens to the enormous thickness of thirty feet, and runs thus for over twenty-five miles. Then there is a singular drop in the mountain, hardly a trace of a hill being in a direct line for three miles; then the mountain rises again, but with a vein of ore only from two to three feet thick. But directly on the opposite side of the Jones Valley commences a new ridge, and this contains a vein of the red fossiliferous ore seven feet thick; and perhaps other veins, as only this one has been explored. These singular freaks of nature are of much interest, even to the unscientific. From this point the veins continue on regularly until they sink beneath the cretaceous formation of west Alabama.

At various points in this valley are beds of brown hematite iron ore, but near Tannahill station, on Roup's Valley, they are of such size as only to be described by the word immense. If one imagines a house 300 feet high and 600 to 800 broad at base, not going up cone like, but with a top say 100 feet broad, and this house eight miles long, and he will have some idea of the size of one of these beds. Make that house larger and six miles long, and he will have another. Mr. David Thomas, of Pennsylvania, said that he had seen all the great iron deposits of the world, and none equal to these. A mining engineer sent out by Fritz said, that if he went back and told the facts as they were no one would believe him. Messrs. Thomas & Sons; Fritz, Willbro & Edwards, and Ostrander, English & Cline, have bought large bodies of this ore, as well as of the fossiliferous and of coal lands; yet there are many more acres to be bought at comparatively moderate prices. The price of one tract was stated to me as fifty dollars per acre, very eligibly located, and others less advantageous at from twenty to thirty dollars. An original idea seems to have entered the head of one capitalist of controlling the beds, but as their immense extent developed upon him he retired from the contest. To Mr. Edwards I am indebted for many attentions and much information, as it is said no one knows the coal fields of Alabama more thoroughly than he does.

It is hardly probable that any part of the world will ever be developed offering better advantages for the manufacture of iron than this point. On the south, in four miles, is a workable vein of red fossiliferous ore. In the valley is the best of limestone. On the north the brown hematite pushes right up into the valley, and there is also a large bed of bog ore; beyond the hematite, passing over a little limestone and chert, we come to the seven-foot vein of fossiliferous ore; then, just beyond, the Warrior coal field. Here five distinct veins of coal have been opened, two and one-third, six, ten, eight and five feet in thickness. Then, for transportation, the A. and C. road will be had, and also a branch from the Grand Trunk. To the A. and C. road from the coal is a gentle ascent through a gap, hardly at any point more than sixty feet to the mile. Distance from A. and C. railroad to first coal outcrop, three miles; to the fossiliferous iron ore, one and three-quarters miles; to the brown hematite, 100 yards to one mile.

Of these veins of coal, one of them I proved to be a very superior coking coal; two to be rather poor for coke, semi-bituminous, and burning up with a white ash; hence I think these last would work well in the furnace. Others were not determined. The dip is very slight, and at no point in the whole Warrior field is it at all likely that the coal is over two hundred feet under ground, unless from cap of some hill, and it is most probable that at most points it is much shallower. All these veins have some shale in them, but I have given the clear thickness of the coal as I measured it. This eastern edge of the Warrior coal field did not have any attention paid to it by Professor Tuomey in his reconnoissance, but I infer that the five and eight feet veins were measured by him on the western side, thus: Coal, thirty-four; shale, five and one-half; coal, thirty-one inches. Another coal, forty-eight; shale, fourteen; coal, ten inches. He also found a vein containing seven feet of coal, but with more shale than any of those I examined. The basin of the field where I examined it is thickly covered with a most superb growth of yellow pines—tall, straight and large-bodied. Building stone of the best quality is abundant, of the red sandstone on the interior basin, and of limestone or white sandstone under the coal. A strata of the white sandstone is a very superior fine stone. Prof. J. L. Tait, Commissioner of Industrial Resources for Alabama, and a chemist of considerable talent, examined this western edge of the Warrior field for the S. & N. railroad, and found similar outcrops of coal to those I have stated, he being full thirty miles north of the most northern point of my observations at Roup's Valley. He found the coal characteristics as I have stated, some semi-bituminous, but with him my six feet vein of rich coking coal is only five and one-half feet thick. He makes a sample of this coal analysis: Moisture, .82; volatile matter, 33.40; carbon, 64.00; sulphur, trace; ash, 1.60.

Prof. Mallett, formerly of the State University, at Tuscaloosa, makes the vein near that place richer in volatile matter and poorer in carbon. The coals examined by him in the Cahawba coal field are also all of them rich bituminous coals. Prof. Tait states the seams observed by him to be five, in thickness as follows: Thirty inches, thirty-six, forty-eight, fifty-two and sixty-six inches, clear of shale. The area of the Warrior coal field is about 4,000 square miles of available coal, though it is contended that an accurate geological survey will increase this area 1,000 square miles. It stretches along the A. & C. railroad from Tuscaloosa to seven miles above Birmingham, at no point distant more than five miles. At the point stated, above Birmingham, the Red Mountain intervenes, and the coal is thrown a little farther of, but above Attala coal is found on both sides of the road in the Raccoon and Lookout Mountains.

Just two miles south of Birmingham, on the South and North road, is the cut of that road through the Red Mountain, there showing distinctly the immense thickness of the vein of fossiliferous iron ore. I have constantly called this ore the red fossiliferous, as that is its common name. It is sometimes called "lenticular argillaceous," and Prof. Tait insists that it be called "pisolitic." The common country name is dyestone, as crushed in water it yields a rich red dye. This ore does not require any wasting. In Tennessee it makes a cold short iron with raw coal, and also with charcoal. The iron made from it in Alabama, with charcoal, is not cold short. This may be due to difference in the ores, as that of Alabama has but little phosphorus, while all, so far used in Tennessee, has very considerable quantities. Prof. Tait's analysis of that at Gracie's Gap, the point stated on S. and N. R. R., makes it yield: Moisture, 2.88; sesquioxide of iron, 60.31; alumina, 8.34; carbonate of lime, 9.21; phosphoric acid, .21; sulphur, .16; insoluble p, 18.95; metallic iron, 42.02.

Prof. Mallett gives several analyses of this ore from various points:

	One.	Two.	Three.
Peroxide of iron..................	88.02	82.67	61.87
Silica	11.59	13.44	37.58
Alumina.........................	.07	3.09	.26
Lime............................	.05	Trace.	.03
Phos. Acid.......................	.09	.06	.03

It will be seen, therefore, that this ore varies very much in quality, and it might be good policy in a buyer to have the ore of a property analyzed before buying. The last sample by Professor Mallett came from near a property lately bought by a capitalist without such precaution. There is another vein of this ore in Alabama, near the Coosa coal field and south of Lookout Mountain. It is of very superior grade.

From Gracie's Gap, southeast, is one of the most wonderful sights ever beheld by the eye of a geologist. The extreme summit of the ridge is a bluff cap of this fossiliferous ore. It looks like great massive piles of granite rocks. I could not believe my eyes until I sent for a hammer, and climbing over these vast masses for miles, continually broke pieces from them to be assured that it was really what I was told. It was at no point less than twenty-five feet thick, and at many points the bluffs rose out of the mountain more than thirty feet in height. There were dozens of vast detached pieces, laying as if chiseled off, any one of which would run the largest furnace in Pennsylvania for weeks. It was no mere uplift, a mere spurt, but far down the southeast side of the mountain it came to the surface again and again, while shafts of more than twenty feet had failed to pierce through its thickness. It lay like a great flat board all on the southeast side of the mountain, nowhere more than a few feet under the earth. I believe it to be the concentration of all the scattered veins which have come down from East Tennessee, here drawn together and uplifted. The Red Mountain Iron Company formerly had a furnace within two miles of this ore vein, and owned a mile and a half of it. They made fourteen tons of iron per day with charcoal, using from two to two and a half tons of ore to the ton of pig. A gentleman formerly connected with them told me that an old Irishman and a colored man would get out and break up in a couple of hours all the furnace could use in a day. I cannot see how it should cost twenty cents per ton to mine this ore, and it breaks up very easily.

Dr. Litton, State geologist of Missouri, says the iron mountain contains 1,665,280,000 cubic feet of ore, or 230,187,375 tons. If we put the thickness of this vein of fossiliferous ore, at this particular point, at only twenty feet, its length at twenty-five miles, and the slope of the mountain at only three hundred yards, we shall have 3,372,000,000 cubic feet, while it is only one-third less heavy than the Iron Mountain, and requires no roasting. There would be, then, in this short space alone, full 400,000,000 tons of ore, and this is but a tithe of what exists along the line of the A. and C. R. R., and elsewhere in the State of Alabama. There is a further singular relation between these two great deposits of Alabama and Missouri. This makes a cold-short iron, that of Iron Maintain a red-short; hence, to make a neutral iron they must be united.

The old Red Mountain Iron Company's furnaces are located five miles from Birmingham, on the S. and N. R. R., and in a few yards of that road. These furnaces are forty-two feet high, and have twelve and one-half feet boshes. One has never been used; the other had been in blast eight months when the works were burned by General Wilson. They are well built of excellent sandstone, and the company own large bodies of iron ore and coal lands, as well as 7,000 acres for charcoal. I shall use these furnaces as an illustration. They can be started so as to make each twenty tons per day. From the company's 12,000 acres of coal land, also immediately on the line of the railroad, coal can be mixed and burned into coke at $1.10 per ton. Four tons of coal to two tons of coke is $4.40; for railroad transportation and handling add sixty cents, and we have for a ton of pig:

Two tons of coke	$5 50	
Two and one-half tons ore	2 50	
Limestone	50	
Interest and general expenses	3 00	
Labor, etc.	5 00	
		$16 00

Whether this estimate be correct as to interest on capital, etc., I leave old iron men to judge; as to the other items, it is not below cost. But while iron can be made here so cheaply, the great market for it is north and west; hence we must add to the above, say, ten dollars for transportation. Suppose a sale at thirty-two dollars, and with furnaces making forty tons per day, there should be a profit of full $120,000 for the 300 days usually allotted to the yearly working of a furnace; certainly enough to induce capital to come here, even if the product has to be sent north for sale. The transportation has been put at ten dollars per ton, because that is the price stated by Mr. Barney, of the S. R. and D. R. R.; but Mr. Shaw, of the S. and N. R. R., says it can be done for less if sent in quantity. I do not expect some of my Pennsylvania friends to believe these statements. All I ask for proof is, that they go and see the country, and they will say I have not told half of its wonderful wealth. East Tennessee has vastly the advantage in the cheapness and ease with which her coal can be mined, but the iron ores of Alabama are surpassed by no region of the known world.

It is contended by many that Birmingham offers many advantages for the erection of iron furnaces; that a furnace erected here could draw its ore, coal and limestone by contract, if it chose, from at least four different directions; that thus a furnace might be run without the trouble of mining, and on less original capital; or, if deemed best, mines of all might be owned, and this place still have an advantage in point of facility and variety of transportation. A gentleman, who owns a mile and a half of the great ore vein, told me he would put it into any such company, rating it at $25,000, and other parties to put in $75,000 — certainly not a bad proposition.

The vein of fossiliferous ore is underlaid by limestone, and still lower is found a fair vein of white and some very handsome red and variegated marble. Lead and zinc are also found, but in what quantities they may exist has not been determined. A cherty limestone decomposes into Tripoli, used for polishing, and other minor minerals are known.

The Irondale Furnace, six miles from Birmingham, has been leased by some northern men, and is now in blast. They will use the fossiliferous ore, with charcoal for fuel. It was built since the war at unnecessarily great cost, and has been out of blast near two years. They work with cold blast, and expect to average twelve tons per day.

The country around Birmingham is not a strict cotton-producing region, though the staple is grown in the valley to considerable extent. Farther down it is the special crop. A cotton factory here would pay well, using the coal of either field as a fuel for generating steam. A mine owner could deliver it at $1.50 to $2 per ton. As is seen, I have covered only the outer and southern edge of the great Warrior coal field. As is stated, the inclination of the veins of this coal strata is so slight that the depth of only a few feet will at any point in its area bring the miner to workable veins of coal. At the same time this vast field is cut through by the Warrior river and its numerous forks, which afford ample water facilities. As to lands: on the great vein it is doubtful if any lands are not taken up, except such sections as the railroad may own or may be reserved for school purposes, but on the smaller veins and in the coal fields there are thousands of acres yet belonging to the State and the United States. The last can only be obtained under the homestead act, whereby one hundred and sixty acres may be entered upon "actual settlement;" said actual settlement is, however, frequently a mere farce. Much valuable farming land can yet be obtained by the genuine settler in this way. Many of the present inhabitants are willing to sell at moderate rates, as they look longingly to a home in the Texas Paradise.

Mr. Abram S. Hewitt—The region in Alabama to which our attention has been called to-night is unquestionably the most interesting region in the United States, with reference to the interests of iron manufacture in this country. It is in fact the only place upon the American continent where it is possible to make iron in competition with the cheap iron of England, measured, not by the wages paid, but by the number of days' labor which enter into its production. The cheapest place, until now, on the globe for manufacturing iron is the Cleveland region in Yorkshire, England. The iron, produced from a fossiliferous ore, containing phosphorus, making it cold-short, costs there about thirty-two English shillings on the average per ton, which represents about ten (10) days' labor. The distance of the coal and the ore from the furnaces averages there about twenty miles.

Now in Alabama, the coal and the ore are in many places within half a mile of each other. The sandstone formation thins out toward the south, and in Tennessee and Alabama appears to be replaced by this bed of fossiliferous iron ore, which commences in New York with a thickness rarely exceeding two feet, but steadily thickens toward the south, averaging four feet in Pennsylvania, seven or eight feet in Tennessee, while in Alabama, probably because the formation was crushed back upon itself in some way, there are places where the iron has been measured 150 feet in thickness.

The manufacture of iron is carried on as yet in rather a crude way in Alabama, but the cost of the iron is only about ten days' labor to the ton, or not far from the labor cost in Cleveland. Throwing aside, then, all questions of tariff for protection, here is a possibility upon the American continent of producing iron at as low a cost in labor as in the most favored region of the world, and, allowing for the expense of transportation to compete with them, paying a higher average rate of wages than is paid in Great Britain.

The consumption of iron is increasing at a rate so wonderfully rapid, that in ten years it will be impossible for Great Britain to supply the demand. There is no other country in the world which can make iron as cheaply as Great Britain. In fifty years, then, the United States must be the source from which the iron of the world will be derived. Instead of importing a million of tons per annum, as we now do, in fifty or a hundred years we shall export five or ten millions per annum. This region, so exhaustless in its supplies, so admirably furnished with coal, so conveniently communicating with the gulf, will be of infinitely more consequence to us for its iron than it has ever been for its cotton. There is the foundation for an industry and a prosperity which no curse of slavery, no rebellion, no interference with commercial laws can ever overturn.

One word about the applicability of the ores. As I have said, they all contain phosphorus. The quantity is too great to permit its being made into steel by any known process. It is useless to talk about its producing steel. It is hard because it contains phosphorus; and what is bad iron can hardly be good steel. It is fitted admirably for the face of rails, and for bar iron generally. By mixture we can make these cold-short irons neutral. I think this will be a region of coke-made iron on a scale grander than has ever been witnessed on the inhabitable globe. The present production in the Cleveland region, where in 1853 there was not a furnace, is now two millions of tons; and very soon it will be four millions. The production here will far exceed that.

The difficulty in the south at present is the want of a market from the incomplete state of the lines of railway which are now extending in all directions, and which will soon connect this region not only with the north, but with the gulf.

These remarks apply to the region of east Tennessee with equal force as to Alabama. In conclusion, let me testify to the spirit of perfect frankness with which Mr. Colton has presented this interesting subject to the Association, to whose thanks he is justly entitled.

Adjourned.

December 29, 1871.

Prof. S. D. Tillman, in the chair; Mr. Robert Weir, Secretary.

The President read the following scientific notes:

I. Apparent Volatilization of Silicon and Boron.

Messrs. Troots and Hautefeuille have presented a memoir to the French Academy of Sciences, containing an account of experiments made with pure silicon and boron, each by itself, placed in porcelain tubes, kept at a very high temperature (in a slow current of dry and pure hydrogen gas), and the reaction which ensues by the admission into the tube of flouride of silicon, chloride of silicon and flouride of boron. Silicon is, under these conditions, apparently volatilized, forming a brown-colored smoke, which, in a cooler part of the tube, is condensed sometimes as amorphous silicon, sometimes in a crystalline state. The same occurs with boron; but the apparent volatilization is due to a simple mechanical effect, conjointly with the presence of compounds of silicon with chlorine and flourine, which are only formed at a very high temperature, and disassociated at a red heat. It has been supposed that silicon and boron could not be brought into a liquid or gaseous state. These experiments merely show that, under certain circumstances, an apparent volatilization takes place.

II. PREPARATION OF DEXTRINE.

O. Ficinus has described, in Dingler's Polytechnic Journal, a cheap mode of preparing pure dextrine. A mixture, consisting of 500 parts of potato-starch, 1,500 parts of cold distilled water, and eight parts of pure oxalic acid, is placed in a suitable vessel on a water bath and heated until a small sample, tested with iodine solution, does not produce the reaction of starch. When this is found to be the case, the vessel is immediately removed from the water bath and the liquid neutralized with pure carbonate of lime. After having been left standing for a couple of days, the liquor is filtered, and the clear filtrate evaporated upon a water bath until the mass becomes quite a paste, which is removed by a spatula, and having been made into a thin cake, is placed upon paper and further dried in a warm place; 220 parts of pure dextrine are thus obtained.

Mr. T. D. Stetson—What becomes of the rest of it?

The President—It remains in the form of starch. Mr. J. Hirsh, one of our members, was manufacturing starch very largely at Chicago before the fire, but was burned out. He used principally corn, of which he could buy cargoes in a partially damaged condition, which answered every purpose for making starch. Oswego is another point where large quantities of starch are made, and which affords the same facility for procuring the materials at a low rate. Wheat is not much used for starch. The principal substances used are corn and potatoes.

III. ACTION OF HEAT ON GERM LIFE.

T. Crace Calvert, in a paper "On the Action of Heat on Protoplasmic Life dried on in Cotton Frabrics," published in the London Chemical News, relates a series of experiments which have a direct bearing on the question of the disinfection of fabrics and wearing apparel in heated stoves, with the object of destroying contagion or animalcule life. To carry out these views, a piece of ordinary gray calico was treated chemically and washed until free from any sizing material and dried. This prepared cloth was then steeped in a solution of putrid albumen containing abundance of animalcule life, wrung out and drid at the natural temperature; it was then cut into small pieces five centimeters square. Each of the pieces was rolled up and introduced into a strong glass tube which was hermetically sealed. Some of these were exposed to a temperature raised successively to 100, 200, 300, 400, 500 and 600 degrees Fahrenheit. Other pieces were placed in pure distilled water, and another series of pieces were placed in tubes containing an albumen solution, each being successively subjected to temperatures varying from 100 to 600 degrees Fahrenheit. In all cases it was found that at 300 degrees Fahrenheit vibrios were present in small numbers, while in the water series *bacteria* were also detected. At 400 degrees Fahrenheit no evidence of life was found. In order to ascertain what changes the calico had undergone, one of each of the small tubes which had been heated to the different temperatures was broken, and its contents carefully examined. The pieces heated to 200 degrees were quite sound, whilst those heated to 300 degrees were of a slightly brown color, much injured, and, for practical purposes, completely spoiled. At 400 degrees the cloth was very much charred. These results show that the temperature which will not destroy germ life is quite sufficient to materially injure cotton fabric; hence it is concluded that no beneficial results can be obtained by the employment of public stoves as a means of destroying germ life and contagion.

Dr. J. W. Richards—Some experiments have been made in this city in relation to fumigating ships by steam, wherein it was presumed that that would be a perfect and an inexpensive mode of disinfecting them. It seems that it is not effective. There are certain disinfecting elements by which vegetables and many animalcules are destroyed at the temperature of boiling water. There are cryptogams which are readily destroyed by boiling water. A bunch of mouldy grapes may be made sweet, safe and pleasant to eat by holding it for a moment in boiling water. I have heard housewives say that boiling clothes will not destroy nits, but that baking them will.

The President—A very small quantity of carbolic acid will destroy animal and vegetable life.

Mr. Dudley Blanchard—In Dr. Bastian's experiments on germ life, with a view to ascertain whether animal life could originate by spontaneous generation, he heated his elements to 212 degrees, which was supposed sufficient to destroy all germs of life. These experiments would seem to prove that Dr. Bastian's experiments were not conclusive.

The President—Dr. Bastian has been pursuing the line of experiments commenced by Crosse many years ago, and continued by Pasteur and others. He takes the ground that life can be originated in matter; but in some of his later experiments, in which a higher temperature was applied to the solutions, the same results were not obtained.

IV. A Valuable Alloy.

Dr. E. Dingler has made an alloy resembling gold by mixing three metals in the following proportions: Copper, 58.86; zinc, 40.32; lead, 1.90. It is said to be malleable and durable, and is evidently prepared with little expense.

Dr. Van der Weyde—On the face of it, I should not have much confidence in an alloy of brass with lead.

The President—There is less than two per cent of lead.

Dr. J. W. Richards—I do not like to hear an alloy judged in that way. We know that sometimes a small proportion of an inferior article will produce a more perfect result. An alloy sometimes has properties different from the metals of which it is composed. For instance, we can make an alloy fusible at a temperature lower than that at which either of the metals of which it is composed will melt.

V. Meat Extracts and Beef Tea.

Dr. P. Muller has given, in the Moniteur Scientifique, an account of his researches, and his conclusions are as follows: Meat extracts are neither directly nor indirectly food, for they do not contain albumenoid matter, neither do the nitrogenous principles which they contain arrest disassimilation—that is, they do not prevent the waste of the organic matter which composes the body. In small doses these extracts are useful by the stimulant action of the potassa salts, which promote digestion and circulation; in strong doses—too large at once—these substances may have a very injurious effect. When given to convalescents from serious diseases, especially if the system is exhausted by prolonged abstinence, the potassa salts present in these extracts in large quantity will act more injuriously, because the system has lost a great deal of chloride of sodium. Instead, then, of promoting digestion, these substances will interfere with it (1) by the direct action of the salts of potash on the blood globules, whereby the absorption of oxygen by these globules is greatly decreased; (2) by the predominance of such salts in the serum of the blood which only physically dissolve carbonic acid, and do not allow the normal quantity of that gas to be exhaled, and thus impede the access of oxygen. Medical men should bear in mind that if given alone, these extracts, and likewise beef tea, are no nutriment, and only tend to keep the convalescent weak, being thus ill fed, or, rather, not fed at all. These conclusions are substantially those entertained by Liebig and many other investigators in the same field.

Dr. P. H. Van der Weyde—The extracts of meat, brought from Texas, do pretty well for making a hasty plate of soup, but have not the power of the meat. The excess of potash is injurious. We want sodium and not potassium. For instance, we use the sulphate of sodium, or Glauber's salts, but give the sulphate of potassium to horses. The iodide of potassium produces eruptions, and the iodide of sodium does not. While it is even asserted that all the potash, compounds are poisonous, we need the chloride of sodium, or common salt, in the system ; and if we do not supply it, it is recomposed in the system.

The President—Potash seems to play an important part in vegetable life and sodium salts in animal life.

Dr. Richards—Potatoes, which are highly charged with potassium, are especially recommended to sailors for scurvy. Potash is a valuable medicine. In a recent experiment, a very small amount of potash injected into the veins, stopped the motion of the heart and killed the animal. An equal quantity of soda had no effect at all. Potash, is used as a medicine, and so are arsenic and mercury, although they are deadly poisons.

Compound Propeller Pump.

Mr. Thomas Shaw, of Philadelphia, exhibited and explained a model of the compound propeller pump, exhibited at the Fair of the American Institute. It has first a revolving propeller blade, which lifts and rotates the water; then a stationary propeller blade, with the angle reversed, to counteract the rotary tendency; then another revolving blade, a short distance above it, and a stationary blade immediately above that, and so on to the top of the tube. The maximum pressure produced by each pair of blades is three pounds to the square inch.

Mr. T. D. Stetson—What is the gain in duplicating the blades all the way up, over putting them all at the bottom ?

Mr. T. Shaw—You can put them all at one end, or scatter them all along; it makes no difference. But you can only raise water six feet by one pair.

Dr. L. Bradley—Will you explain why one pair will not lift it more than six feet?

Dr. P. H. Van der Weyde—One turn of a screw propeller is as good as that of twenty. So, if you put twenty of these together, the last one will lift it six feet, and that is all. Some months ago I was invited to witness experiments at the Novelty Works, and I hold in my hand an invitation to make another investigation to-morrow. I found that a certain velocity of the propeller would not lift the water more than three feet; and that the velocity must be very great to raise it six feet. The great objection to this instrument is that it must be rotated at so great a velocity. And where there is a column of water one hundred feet high, the friction of the pivot below would be enormous. But here comes in the important invention of the water-bearing. It does not stand upon a pivot, but is suspended by a disc, under which water is forced with sufficient pressure to support the weight, so that it is lifted from its bearings and is suspended on the water, and revolves with little friction. Observing that the water discharged from this bearing was raised in temperature by the friction, I measured the amount of water, and its elevation of temperature, and found that the loss by friction, in doing the work of a steam-engine of forty horse-power was only two horse-power. Without the water-bearing, it would be impossible to work this pump practically.

The President—It was settled as early as Fitch's experiments, about the year 1784, that one paddle was just as good as a dozen together in the same right line. He found that the first paddle moved the water, and was as effective as the series of paddles he at first proposed. In the ordinary chain pump there is no friction, except at the sides of the tube; and, if worked at a sufficient velocity, it produces excellent results. But in the common pump the water has to turn in two different directions, and this consumes more power than is required to lift the water.

Mr. T. Shaw explained the water-bearing, and stated that in the first experiment of the large pump at the Novelty Works, he had holes bored twenty feet apart all the way up the tube. The pressure was found to be nearly the same throughout the whole tube. The current of water through the holes was very weak.

Mr. T. D. Stetson—I should think that one propeller would do just as well as forty.

Mr. T. Shaw—With one propeller there is a maximum height which you can lift the water.

Prof. R. H. Thurston—It seems to me that, theoretically, Mr. Shaw is right. Starting at the bottom, with the water at rest, rotating the screw, it meets the water below this first guide curve or stationary blade. If that were not there, it would give the water a motion of revolution; and as soon as that becomes equal to the motion of the screw, we have reached the maximum elevation possible with that screw. But this guide curve takes the water, and from its rotary motion it rises directly upward, to a point where the pressure due to the height prevents its rising farther. At this point there is placed a second propeller, which finds the water quiescent, and repeats the operation, lifting the water again to this point, when the third propeller takes it, and so on. Now, suppose we begin again, with the blades brought nearer together. The water rises above the first guide curve with a pressure sufficient to take it up six feet; that is, with a pressure of three pounds to the square inch. The second propeller finds the water rising directly upward, and adds its pressure of three pounds to the square inch, so that the water rises above the second guide curve with a pressure of six pounds to the square inch. Still rising directly upward, the third propeller adds its force, making the pressure nine pounds, and so on. This view of the theory is corroborated by the statement of Mr. Shaw, that that is the actual fact.

Dr. Van der Weyde—That would be true if the water were not in motion; but the second propeller finds it in motion, and cannot add to that motion. The second propeller must be placed where the ascending motion has reached its highest point, and then it will carry it still further.

Mr. Dudley Blanchard—I think the effect would be the same as if we were to station several men on a ladder to pass up bricks from one to another. A dozen men placed far enough apart could toss a brick up to a considerable height. But place them together near the bottom, the lower ones throw it up a foot, the last one as far as he can, and that is as high as it will go.

Mr. T. Shaw—I do not think that is a parallel case.

Mr. T. D. Stetson—Let us consider for a few moments the question of friction in this pump. The friction which Dr. Van der Weyde measured by the heating of the water escaping from the water-bearing, was only one element of friction in the machine. That was only the friction from the end pressure, whether at the bottom or the top, in supporting the pipe and its contents. In addition to that, there is the friction of the blades. With regard to that it does not appear to make any difference whether the work is done by one pair or by many pairs; for, in the latter case, although the friction of each will be less, that must be multiplied by the number, which will bring about the same result. Nor does it appear to matter much, in this respect, whether the blades are distributed through the length of the pipe, or accumulated at one point.

But, in the third place, there is friction upon the pipe, and, in respect to that, it does matter where the blades are placed. The friction upon the pipe varies with the pressure. If the blades are distributed along the length of the pipe, each lifting the water only two or three feet, and then another taking it, there is a gentle pressure the whole length of the pipe; as Mr. Shaw tells us was actually observed on boring the holes in the pipe at the Novelty Works. But, on the other hand, if the water is lifted the whole distance by one pair of blades, or by a number of blades placed together at the bottom, assuming that, with the exception of this element of friction, the effect would be the same, it is evident that the pressure upon the pipe would be very great; for it would be, at each point in the pipe, the amount due to the height of the water from that point to the top of the pipe. As the friction would be correspondingly great, I should judge that the whole amount of friction of the pump would be at least ten per cent greater from placing the blades at the bottom of the pipe.

The President—This subject will be again taken up, after we have a report on the further investigation which is to be made.

Adjourned.

January 12, 1872.

Prof. S. D. TILLMAN, in the chair; ROBERT WEIR, Esq., Secretary.

Dr. Lewis Feuchtwanger read the following paper:

THE POTASH, SODA AND MAGNESIA COMPOUNDS IN THE ROCK-SALT DEPOSITS OF STASSFURT.

[Illustrated by many specimens of minerals.]

The most interesting and important mineral deposits of recent discovery are those of the salt works at Stassfurt, in Prussia. They have produced quite a revolution in domestic economy, giving to the chloride of potassium, which is found at the depth of a thousand feet, a great commercial value. This, with other peculiar salts, was discovered accidentally by the chemist H. Rose, in the waste of the salt mine. The matter was at first lightly esteemed, the chloride of potassium being even regarded as a nuisance; but it is now thrice as valuable as the rock-salt, which was formerly the only product sought. Over 30,000 tons have been extracted and sold in Germany, France and England; 3,000 tons were brought last year to the United States, to be used in manufacturing saltpeter, by converting the chloride of potassium into the nitrate.

Pearlashes and potashes were formerly exported from the United States to all foreign countries; but our forests are getting cleared, and these products are no longer largely prepared. Sweden likewise has failed to supply France and England with vegetable ashes, and the development at this juncture of the great potash mineral deposits of Stassfurt is a striking providence.

The salt deposits of that locality underlie the new red sandstone of the Triassic period (called the *Bunter sandstein*), and comprise four distinct levels, having a thickness of nearly 1,000 feet. Beginning at the lowest level, we find:

1. *Anhydrite* (sample shown). The bed comprises rock-salt and sulphate of lime, which is anhydrous, 350 feet in thickness.

2. *Polyhalite*, 100 feet in depth, elsewhere frequently of a brick-red color, but in this locality white. It is composed of sulphate of potash, lime and magnesia; has a weak, bitter taste, and fibrous appearence, and is here likewise imbedded in rock-salt.

3. *Kieserite*, a sulphate of magnesia, associated with salt. This bed is seventy-five feet in thickness, and has carnallite also in the gangue.

4. *Carnallite*, the potash salt of greatest value. It is properly a double chloride of magnesium and potassium, associated with the rock-salt in the following proportions: Fifty per cent of the potash salt; twenty-five per cent of the magnesia salt; twenty-five per cent of the rock-salt.

5. *Tachhydrite*, an amphorous salt, composed of chloride of calcium and magnesium.

6. *Sylvite*, a pure chloride of potassium.

7. *Kainite* contains the hydrated chloride of potassium and sulphate of magnesia.

8. *Boracite*, a borate of magnesia, but in this locality containing more of borate of lime. It is amphorous, and unlike the boracite crystals found in the gypsum of Luneburg, in Germany. It resembles more the *Hayesine* of Peru. This mineral has also been called

Stassfurtite. It is found below the carnallite and only at one locality.

The extent of the great mass of carnallite, which is of a flesh-red color, has been proved by exploration to be equal to 6,000,000 tons of chloride of potassium.

It is quite remarkable that the salts found below the proper salt stratum are mostly hydrated, while the salt and anhydrite are anhydrous. The salt-beds in a large body cover the surface, and on passing downward we meet with the different strata in the following order: Kainite, carnallite, sylvite, kieserite, polyhalite anhydrite with rock-salt.

These deposits have been found also in shafts sunk at Anhalt, half a mile distant from Stassfurt.

Caustic potash and carbonate of potash are produced extensively from the chloride.

There are five products prepared for the trade from these saline materials. 1. Chloride of potassium. 2. Sulphate of potash. 3. Carbonate of potash. 4. Sulphate of soda. 5. Potash compounds to be used as manures. To these must be added bromine and bromides.

The carnallite, which is the main substance yielding the chloride of potassium, is treated in the following manner: The crude mass contains sixteen per cent of the latter salt. By treating it in a limited quantity of water a hot solution is formed, containing the chloride of potassium, and leaving the common salt undissolved. This, on cooling, will deposit the crystals of the chloride of eighty to ninety per cent, like the present specimen, brought into our market. The mother-water is now concentrated and treated with ether, which dissolves the bromine. By adding caustic potash to this ethereal solution, the color at once disappears. On evaporation, the bromide thus obtained is decomposed by sulphuric acid and peroxide of manganese, and the pure bromine is distilled over of specific gravity 2.966. The bromine and bromides of potassium and sodium have likewise proved a great source of revenue; and yet, since the manufacture at Stassfurt began, the price of these articles has been reduced to a quarter of its former amount.

The origin of the Stassfurt deposits is yet a great mystery. The grounds for believing that sea-water was the prime cause, and that this locality was, in former ages, an estuary of the sea, are not very valid. Nor does it seem likely that salt water has been produced from saline efflorescences, through which the concentrated waters were gradually evaporated, and that the waters at a later period were interrupted by a change in the configuration of the surface of the country.

The presence of boracite leads us to suppose that the various bodies of salts were deposited after their subjection to an internal heat, which caused the diminished hydration mentioned above, the boracic acid being introduced by the eruptive phenomena, whereby hydrochloric acid may also have been generated, to which the chlorides may owe their existence. It is well known that rock-salt is one of the products of volcanic emanations and of springs in volcanic regions; and it has been shown, also, that salt may be traced to a certain depth associated with lavas.

Many brine springs rise through strata of sandstone and red marl. We find in England large beds of rock-salt, and brine springs which have been flowing for 1,000 years.

In the Triassic period we find salt, gypsum and magnesian limestone more or less associated, while the gypsum and salt lie in many localities in the blue clay, without the red sandstone. After consideration of the subject, I cannot think but that the origin of rock-salt is derived from the evaporation of lakes and lagoons communicating with the ocean.

A salt lake on the Abyssinian frontier, exposed to the unmitigated rays of the sun, is known to have been shrunk into an elliptical basin seven miles in its transverse axis, which is half filled with water, and the other half with a sheet of snow-white solid salt.

The Dead Sea is known to contain pure salt in its water.

In the United States, the rock-salt deposits of Louisiana are of immense depth. In Nevada are salt deposits fourteen feet in thickness and five miles square. The salt springs of Illinois pass through five strata of coal, and then through the new red sandstone, and discharge daily thousands of gallons.

The President—During the war the southern portion of our country was very much troubled to get saltpeter for the manufacture of gunpowder. Nitrate of sodium exists in large quantities in this country and in South America, and it seems, from the paper which has just been read, that the chloride of potassium exists in large quantities in Prussia. Now we only want these two substances, to produce the nitrate of potassium or saltpeter, and the chloride of sodium or common salt.

Etching on Glass.

Dr. Feuchtwanger exhibited specimens of glass etched by Mr. C. A. Stade with hydrofluoric acid, by a new process.

Prof. John Phin stated that microscope lenses may be cleansed by washing them with weak hydrofluoric acid.

Dr. D. D. Parmelee stated that a common method of etching is by printing the pattern with printer's ink on soft paper, transferring it to the glass, and etching the spaces with hydrofluoric acid.

Mr. W. E. Partridge—This is done by a stencil plate.

Dr. Parmelee regarded the use of the stencil plate less convenient than printing; since the stencil plate necessarily leaves many places which must afterward be connected by an expert engraver.

Mr. W. E. Partridge regarded the stencil-plate process as cheaper in consequence of the fact that an etched glass pattern seldom requires to be duplicated.

Mr. Stade, not being present, further discussion was postponed until he should appear to explain his process.

The President read the following items of scientific news:

I. Silica, in All its Varieties, Diamagnetic.

Prof. Dove has successfully suspended, between the poles of a powerful electro-magnet, sections cut from colorless rock-crystal, smoky quartz, agates composed of alternating layers, chalcedony, jasper, amethyst, and other varieties of quartz. Their uniform behavior in the magnetic field shows that all the different kinds of native silica are diamagnetic.

II. Pyro-electricity of Crystals.

Herr W. Hankel has examined over sixty varieties of topaz, particularly in reference to their pyro-electric properties, and has been led to the conclusion that pyro-electricity is unnecessarily correlated with hemimorphism, but is a general property of all crystals. In hemimorphic crystals the opposite extremities of the principal axis, being dissimilar, assume opposite polar conditions; while in crystals having the two ends physically similar, the same polar condition is found at each extremity. In hemimorphic crystals the distribution of electricity seems to depend on the asymmetry of the molecules, and is therefore not altered by an external change of form; while in those crystals which are not hemimorphic, the distribution of electricity depends in a great degree on external form and arrangement, and may, therefore, be modified by a change of shape.

III. Selenitic Mortar.

Col. Scott, of South Kensington, England, has invented a mortar for which several advantages are claimed. It is made by simply mixing with the water used in the preparation of the mortar a small quantity of sulphate of lime, in the form of either natural gypsum or plaster of Paris (burnt gypsum); instead of sulphate of lime, proto-sulphate of iron (green vitriol) may be used, or, better still, sulphuric acid; for the secret of the process is the effect produced by this acid. However, sufficient acid is contained in gypsum to accomplish the end desired, and the use of gypsum is much the most convenient. The mixture is prepared in the pan of the ordinary mortar mill, lime is added, and after being ground for three or four minutes, the sand, burnt clay or other ingredients are added, and the whole is ground for ten minutes more. Thus ordinary lime is at once converted into a cement-mortar which sets rapidly, and can be used for concrete in brick-laying or in plastering at a cheaper rate than lime prepared in the usual way. Lime thus treated with sulphuric acid or sulphates will take up twice as much sand as when slaked. Tiles joined together by Portland cement, after fourteen days were separated by a weight of fifty-six pounds, while selenitic mortar, containing one part lime and five parts sand, under precisely the same conditions, required a weight of 158 pounds to overcome adhesion.

Dr. Feuchtwanger—That is quite new; for it has always been taken for granted that lime and gypsum do not agree in mortars.

Dr. Parmelee and Professor Phin expressed a doubt whether the mortar would be as strong as that made by lime and sand.

Mr. T. D. Stetson—In this connection it may be interesting to state how gypsum has been used alone as a mortar. In the sinking of the piers of the Harlem bridge, which were sunk by a modification of the pneumatic process, having cast iron tubes joined together, pushed down into the mud under a pressure of air sufficient to keep the water out, they reached the hard bed about fifty-four feet below mean low water. Then came the job of filling up with masonry inside. This was done under the care of Erastus W. Smith, whose jobs never attract attention because no accident ever happens to them. In England it has been the practice to build up with masonry. Here the plan has been adopted of filling up with hastily laid material, on which grouting was poured and allowed to set. But Mr. Smith found that ground gypsum had the property of swelling enough to make it bind inside of the tube very much more than ordinary mortar would. In the construction of the Harlem bridge, therefore, he built up with gypsum alone. If gypsum in prepared state, called plaster of Paris, had the cohesive strength of mortar, it would be very desirable for building in other places. In that case very little cohesive strength was required.

We should make a broad distinction between inventions demonstrated to be of practical utility, and mere theories. As I understand it, this selenitic mortar is only a scheme propounded by somebody, backed by a few petty experiments, and therefore does not stand in a position to be received as an addition to our knowledge.

The President—It is read only for the purpose of inducing any one, having the opportunity, to test its merits.

IV. Electromotive Force of Induction.

Dr. L. Hermann has given, in Poggendorff's *Annalen*, the results of a series of experiments undertaken by him for the purpose of ascertaining whether the electromotive force of induction, demonstrated by Faraday in liquid conductors, was the same as that in metallic ones, other conditions being the same. Since in the latter instance the inducing force is independent of the nature of the metal, the question arises, does this independence of the nature of the induced conductor also extend to liquids, and therefore to all conductors? Dr. Hermann made three experiments with three different arrangements, all with the same result. He describes the most successful in detail; and then adds, these experiments show with certainty, since the resistance in the induced circuit in all cases is the same, that the electromotive force of the induced current is, in the widest sense of the word, entirely independent of the nature of the induced conductor.

V. To Prevent Spontaneous Explosion.

Dr. Zaliwski, in a recent memoir, states that the explosive property of some inflammable substances depends upon the hygrometric condition of the atmosphere; that gunpowder and other explosive materials may become spontaneously explosive, even without any elevation of temperature of the air, but that the smallest quantity of oxalic acid mixed with such explosive material will prevent spontaneous action. He further states that this fact may be experimentally proved by adding to any explosive mixture — sulphur and chlorate of potash, for example — a certain quantity of oxalic acid, after which the mixture can be heated to the point of fusion without exploding. A fair inference seems to be that the treatment suggested by Dr. Zaliwski actually impairs that property in explosives on which their value depends.

Prof. John Phin—That the hygrometric condition of the atmosphere may produce spontaneous combustion is well known to chemists.

VI. A Spiral Leyden Jar.

Mr Frederick Guthrie, in a note to the Philosophical Magazine (London), thus describes its construction: A strip of tin-foil four feet long and eight inches wide is placed upon a strip of vulcanized caoutchouc four feet long and one foot wide, in such a way that along both sides there is a margin of four inches of tin-foil. A second piece of caoutchouc, exactly similar to the first, is placed exactly over the first upon the foil. A second piece of tin-foil, of the same width as the first, but four inches shorter, is placed on the second caoutchouc above the first foil, with its right-hand end above the right end of the first foil; its left end, of course, falls four inches short. A brass wire, carrying a knob, is laid across the end of the upper foil. The whole is rolled up from the right end and bound. What was the lower of the two foils projects between the two layers of caoutchouc, and may be prolonged around the circumference of the roll; it forms the outer coating or earth-surface. What was the upper coating of foil now forms what corresponds to the inner coating of the ordinary jar, and is entirely covered, excepting where it is prolonged as the wire and knob at the center of the roll. If the sheet of caoutchouc be an inch in thickness, a jar of very great electrical capacity is obtained, in a very compact form, and one which is free from the risk of fracture, and is less impaired than the ordinary jar by atmospheric moisture. A very serviceable modification of this form has been constructed, by using for the insulating material sheet ebonite. The ends of the spiral roll are capped with dry mahogany disks. The earth-foil is connected with a brass girdle around the center of the cylinder, and is not visible. The electric capacity is between four and five times as great as that of a glass jar of the same volume. It has been in use for several months, and appears almost incapable of injury.

VII. Permanence of Silver Prints.

Mr. M. Carey Lea, in a communication to the Philadelphia Photographer, says: At brief intervals the question of the permanence of ordinary silver prints comes up again and again for discussion. The loss, when the fading takes place, is almost always serious, often irreparable; and those on whom it falls are apt, and not unnaturally, to express themselves with indignation. He repeats the conviction, often before expressed, that a well-made silver print, on albumenized paper, is perfectly permanent if kept with ordinary care. A print placed in an album or portfolio, or laid within the leaves of a book, and left in an atmosphere no damper, or otherwise more contaminated than that of an inhabited room, ought to last indefinitely. If it does not, the fault is with the maker of the print and not with the process. Seven years ago he printed some silver positives by different processes, cut them in pieces, and toned these pieces in various ways, which he recounts, and then subdivided them and treated them with various destructive agents. All of these specimens so treated, as well as the originals for comparison, were fastened into a note-book, and the mode of production and after treatment carefully registered. After an interval of between seven and eight years the originals—that is to say, the portions of the prints which were not subjected to any destructive agency—are fitted to give useful information as to their resisting powers to time. Not a single specimen produced by any of the ordinary methods of printing and toning has faded. He therefore concludes that when prints, made by the methods described, after a longer or shorter interval give indications of perishing, there has been a grave want of care on the part of the printer. That fault lies, as every photographer knows, in the employing of hyposulphite that has been previously used; in fixing too many prints in a given quantity of hyposulphite, and in insufficient and badly managed washing. The wrong that has been done to photography by a neglect of these simple precautions has been incalculable. Even at the present day no one feels any certainty that a purchased photograph will last more than a year or two. There should be some way of reaching and punishing those who impose on the public with half-washed, sulphur-toned prints.

VIII. Russian Sheet-iron.

Dr. John Percy, in his pamphlet on the manufacture of Russian sheet-iron, recently published at London, has collected several descriptions of the process employed by the Russians in manufacturing the sheet-iron of high polish which is extensively used for stoves and pipes in this country. The ores used in the Russian iron-works are magnetic oxide of iron, red and brown hœmatite, and carbonate of iron, which are reduced by means of charcoal. The puddled bars are rolled into sheets and cleaned with a wet broom of green fir leaves. Powdered charcoal is then spread between the sheets, three of which are placed together, reheated, and passed through the rolls. This process of heating and rolling is repeated several times, after which the sheets are cut to a uniform size and brushed over with a mixture of birch-charcoal powder and water. From seventy to 100 sheets are then brought together in one packet and placed in a heating chamber of peculiar construction, where the temperature is slowly raised for several hours, while oxidation is prevented. The packets having been thus heated are placed under a tilt-hammer. The sheets, after being hammered, are alternately inserted between finished sheets and again subjected to the hammer. This final operation removes the wavy appearance resulting from the first hammering, and produces a smooth and polished surface. When the sheets have been again cleaned with the wet broom and cut to the standard size, they are ready for the market. The extreme ductility and highly polished surface, by which this sheet-iron is distinguished from all other varieties, is said to be chiefly the effect of a peculiar kind of charcoal powder applied as described. The facts set forth by Dr. Percy have been known for some time to American manufacturers of sheet-iron, yet they have not succeeded in giving their product the peculiar dark-blue glaze invariably found on every sheet made in the great iron-works of the Ural Mountains.

Mr. Dudley Blanchard—It is not at all strange that American genius has not succeeded in producing such sheet-iron as we get from Russia. The secret, and all the secret, is, that there they have cheaper labor.

Steam Boiler Explosions.

Mr. Blanchard—I was very much gratified by the report of the experiments on boilers, which we have had before us, from the fact that it places the ordinary common-sense view of the subject in a favorable light; for the boilers were shown to be burst from over-pressure. One boiler yielded suddenly and at once in a great many places, very much like the "one-horse chaise" described by Dr. Oliver Wendell Holmes in a poem, which was so equally strong in every part that when, at last, it failed, it all went to dust at once. (Laughter.) This boiler was so well constructed that when the pressure rose to a sufficient point, the joints began to leak in a great many places, and it could not be much of an explosion.

There was one remark made in connection with the report, which I think ought not to have been made; that a boiler may stand a certain hydraulic pressure, and afterward, when exposed to steam pressure, burst at less than the hydraulic pressure. You might as well say that after filling a jug with two quarts of water, you might afterward find that it would hold but three pints.

The President — Might not unequal heating tend to burst the boiler?

Mr. D. Blanchard — The heat would reduce the strength a little.

Mr. T. D. Stetson — It has been asserted that heat increases the strength of iron up to 500° Fahr.

Dr. D. D. Parmelee — On a question like this, we want practical facts. John Matthews, the soda-fountain man, told me, a few weeks since, that some years ago he had the brilliant idea of making steel receivers to hold carbonic acid; for steel would be light, and give a great amount of strength. He brazed them, and subjected them to 150 pounds pressure. His father suggested to him to keep up the pressure for a while, for they might burst. They were allowed to stand, and the pressure gradually diminished until ultimately it came to about half that pressure, when the receiver exploded with great violence. Why was this? The theory is this: there is no alloy of two metals the molecules of which have the same cohesion those of pure metals have. Probably the molecules of different metals tend to roll around each other. When the hydrostatic pressure is first applied, it does not move them at first, because they require time to move. You may put millions of tons upon a glacier, without moving it, and yet it is constantly progressing. In the boiler, you apply the pressure and see no result. You afterward apply a lower pressure, continuously, and the atoms continue to move, the joints becoming gradually weaker, until at last the weakest point gives way, and you have an explosion, although a pressure equal to the hydrostatic pressure may have never been reached since the original test.

Among the causes of boiler explosions, I have met with one in my own practical experience, which I have never heard mentioned among all the theories advanced; for I had a boiler which was accidentally left, in the winter, filled with water, and cold, instead of heat, burst the boiler. (Laughter.)

Mr. D. Blanchard — I do not deny that chemical causes may weaken a boiler, after the hydrostatic test; but I object to the glamour of the supernatural in the theory that a boiler which will stand a certain test to-day, will to-morrow, without any change, explode at a materially lower pressure.

Prof. R. H. Thurston — Very fortunately I received to-night the proof-sheets of an article I prepared for the Journal of the Franklin Institute, upon this subject, and I will read a portion of it:

"*Third.* That a steam boiler may explode, under steam, at a pressure less than that which it had successfully withstood at the hydrostatic test.

"The last boiler had been tested to fifty-nine and one-half pounds. This fact, too, although frequently urged by some engineers, was generally disbelieved. It has now been directly proven."

In a foot note I say:

"A number of instances of this kind, though not always producing an explosion, have been made known to the writer.

"Two boilers at the Detroit water-works, in 1859, after resisting the hydrostatic test of 200 pounds, with water at a temperature of 100° Fahrenheit, broke several braces each at 110 and 115 pounds steam pressure respectively, when first tried under steam.

"The boiler of the United States steamer Algonquin was tested with 150 pounds cold-water pressure, and broke a brace at 100 pounds when tried with steam.

"A similar case occurred in New York, a few years ago, and the boiler exploded with fatal results.

"These accidents are probably caused by changes of form of the boiler, under varying temperature, which throw undue strain upon some one part, which may have already been nearly fractured."

In the same article I say:

"More than thirty-five years ago, a committee of the Franklin Institute made a series of experiments of such extent and accuracy that the republication of their reports, and their circulation among engineers, would to-day be a public benefaction.* Their report, together with the paper of F. A. Paget, on the "Wear and Tear of Steam Boilers," † and the little book of E. B. Martin ‡ on explosions, should be in the library of every engineer.

"The experiments of the committee of the Franklin Institute were made upon a small scale, and upon constructions quite different in form from most steam boilers, and, although the information obtained was invaluable, it still remained desirable to repeat their experiments, and to make other investigations with boilers of full size, such as are used in steamers, on our railroads, and in our manufactories."

After describing the experiments I continued:

"Having briefly described these experiments, it may be well to notice what bearings their results have upon existing beliefs, and how far they extend our knowledge of the causes and conditions of explosions.

* *Vide* Journal Franklin Institute, 1836, Vol. XVII.

† Ibid., 1865, Vol. I.

‡ Records of Steam Boiler Explosions; E. B. Martin. London: E. & F. N. Spon, 1871.

"In the first experiment, we probably have an illustration of by far the most usual behavior of steam boilers, when yielding to over-pressure. The pressure gradually rising, ruptured the boiler at its weakest point, which happened to be a spot of merely local weakness; the rent extended toward stronger portions, but soon became large enough to discharge the steam as rapidly as it was made. The strength of the metal in the direction of the line of fracture being sufficient to resist further extension at the maximum pressure attained, no greater injury was done. The spot being patched, the boiler is still probably capable of doing good service for a considerable length of time.

"When boilers give way from excessive weakness or from steam pressure, they very generally do so in the manner described. The explosion is the exceptional case, and the frequency with which old boilers "blow out" in every part, though usually about the stayed surfaces, and the apparent impunity with which they are kept at work after being frequently patched, has probably been the most influential cause of the existence of the belief, which is, unfortunately, wide-spread among engineers, that the mere pressure of steam cannot cause explosions, and that, if the boiler contains a sufficient quantity of water, it is perfectly safe, except against sundry mysterious forces, which are probably, like the fairies and ghouls of earlier times, existent only in the imaginations of those whom they terrify.

"In the second and third experiments, we have illustrations of the comparatively rare cases in which explosions actually occur.

"The second was a perfectly new construction, in which corrosion had not developed a point of great comparative weakness, and the fracture occurring simultaneously, and very equally on all sides, the two halves were completely separated and thrown far apart with all the energy of unmistakable explosion, although there was an ample supply of water, and the pressure did not exceed that frequently reached in locomotives and on the western rivers, and although the boiler itself was quite diminutive.

"The unexpected circumstance of the drawing out of the stay-bolts, without breaking and without stripping their threads, was one of the most interesting points of the experiment.

"In the third experiment, as in the second, it is probable that the weakest part extended very uniformly over a large part of the boiler, either in lines of weakened metal, or over surfaces largely acted upon by corrosion. Immediately upon the giving way of its braces, fracture took place at once in many different parts.

"We may conclude, then, from the result of Mr. Stevens' experiments:

"*First*, That 'low water,' although undoubtedly one cause, is not the only cause of violent explosions, as is so commonly supposed, but that a most violent explosion may occur with a boiler well supplied with water.

"This was shown on a small scale by the experiments of the committee of the Franklin Institute above referred to.

"*Second*, That what is generally considered a moderate steam pressure may produce the very violent explosion of a weak boiler, containing a large body of water, and having all its flues well covered.

"This has never before, we believe, been directly proven by experiment."

The third result I have already read.

Professor T. proceeded to give a calculation, roughly made, of the force manifested in the explosion of one of the boilers, compared with the pressure of the steam; and continued:

Mr. Stevens suggested that as this large boiler had been under steam for a week at low pressure, there might, perhaps, be a portion of that heat stored up, which was developed in the explosion; but the calculation, which I intend to repeat with more accuracy hereafter, shows that the work done in the explosion was not assisted by any such superfluous heat.

Dr. Richards—How do you explain the bursting of a boiler at a pressure less than the hydrostatic test?

Professor Thurston—I have very little doubt that the reason was that the strain was thrown differently upon the braces, when heated to the temperature of 300 degrees than when it was cold. I have no doubt that Mr. Wiard is correct in attributing many explosions to unequal expansion; but I would no sooner ascribe all explosions to that cause than give one medicine for all diseases. I think we know the causes of all explosions, and that with proper care and intelligence on the part of those who design, those who construct and those who manage boilers, explosions can be avoided, except in those exceedingly rare cases in which accidents occur notwithstanding the most careful management.

Mr. J. K. Fisher suggested the bursting of a boiler by forcing air into it, so that the rupture might take place at the temperature of construction.

Professor Thurston—It is proposed to explode one boiler by the pressure of the steam in another boiler; also, to observe the effect of raising the safety valve suddenly, and to pursue the experiments upon various points, just as far as the funds contributed will enable the experiments to be made. I will here present a paper prepared by me for the Journal of the Franklin Institute.

EXPERIMENTAL STEAM BOILER EXPLOSIONS.

[Discussion of the third experiment at Sandy Hook, New York.]

BY PROF. R. H. THURSTON.

The violence with which the third boiler, experimented upon at Sandy Hook, exploded has raised a doubt in the minds of many engineers whether some extraordinary and unfamiliar cause may not have operated in the production of such astonishing effects. No positive proof of the non-existence of such causes can be given, but the following considerations will at least indicate that we may find, in well understood and certainly existing causes, ample power to produce all of the effects noted.

The steam boiler referred to weighed 40,000 pounds, and contained about 30,000 pounds of water and 150 pounds of steam, all of which had a temperature of 301° Fahr., when, at the moment before explosion, the steam pressure was fifty-three and one-half pounds above that of the atmosphere.

When the explosion took place, the whole mass at once liberated its heat, until it had cooled down to the temperature of vapor under the pressure of the atmosphere.

In this act the water gave off $30{,}000 \times 89° = 2{,}670{,}000$ British thermal units, and the steam lost the difference between its total heat at 301° and that of 212° Fahr., or $150 \times 27.2° = 4{,}080$ thermal units. The sum $2{,}670{,}000 + 4{,}080 = 2{,}674{,}080$ thermal units has an equivalent in mechanical energy of $2{,}674{,}080 \times 772 = 2{,}064{,}389{,}760$ foot-pounds, and this was sufficient to have raised the whole boiler and contents, weighing 70,000 pounds, to a height of 29,491.282 feet—*more than five miles.* This represents the *maximum* possible effect.

The *least* effect would have been produced had the liberation of heat and the production of additional quantities of steam, within the mass of water and at its surface, been so sluggish as to have given no assistance in propelling the fragments of the ruptured boiler—the whole destructive work being done by the simple expansion of the steam which filled the steam spaces.

The total amount of mechanical energy set free from the steam alone was $4{,}080 \times 772 = 3{,}149{,}760$ foot-pounds, or sufficient to raise the whole boiler through a space of 78.74 feet; and, water included, 44.99 feet. Owing to the greater inertia of the lower part of the boiler, and particularly of its inelastic burden of water, the principal part of this work was undoubtedly performed upon the upper portion and steam chimney of the boiler, weighing probably 6,000 pounds; and, if entirely expended in this direction, the work thus done was equivalent to raising this 6,000 pounds to a height of 525 feet.

This latter case is capable of treatment in quite a different way from the above. As the boiler was completely torn in pieces, the steam must have expanded pretty equally in all directions, except where checked in its downward movement, and may probably be treated as if forming a rapidly expanding hemisphere of vapor, its center being in the steam space of the boiler.

The expansion of this hemisphere would have continued until the tension of the steam was reduced to that of the surrounding atmosphere, and would have continued through a mean distance, as given by an approximate estimate, of 4.5 feet. The mean pressure would be twenty-five pounds above the atmosphere nearly.

The area of cross-section of the steam drum was 4,071 square inches, and $4{,}071 \times 25 \times 4.5 = 457{,}987.5$ foot-pounds, the amount of work done in its projection.

The weight of the steam drum, which was one-quarter of an inch thick, six feet diameter, and eight feet and eight inches high, was, with its braces, 2,500 pounds, and $457{,}987.5 \div 2{,}500 = 183.2$, the height, in feet, to which the drum might have been thrown by the simple expansion of the confined steam. In fact, the steam drum had attached to it, when found after the explosion, a considerable part of the boiler top, which, being comparatively light, and being acted upon by similar pressures, must have considerably accelerated, rather than retarded, its ascent.

Still another calculation may be based upon the observed effects of this explosion. The steam drum was observed to rise at a high "angle of elevation," and fell at a distance of 450 feet from the starting point.

If this angle of elevation was sixty degrees — and the general impression was that it was not less — the height due to the range, 450 feet, neglecting the resistance of the air, would have been

$$h = \frac{R}{2 \sin 2a} = \frac{450}{2 \times .866} = 260 \text{ feet.}$$

The retarding effect of the atmosphere causes our figure to be somewhat less than the true value, and it may be more nearly correct to take 275 feet as the height due to the noted range. The work done in raising the steam drum to this height was 687,500 foot-pounds, and the pressure which, acting through a space of 4.5 feet upon the base, would correspond to this amount of work, is 37.5 pounds.

This figure is in excess of the real pressure required, for the reason, as already stated, that a part of the shell was attached to the steam drum, assisting in its propulsion to an extent which is a matter of mere conjecture, and which not improbably reduces the given pressure several pounds.

The actual height of ascent of this piece was variously estimated by the spectators at from 200 to 400 feet, and, by one individual at least, even considerably higher. As, in such cases, heights are usually over-estimated, the lower figure is most likely to be nearest the truth.

It would be impossible to make the last two estimates so closely approximate to accuracy as to entitle them to great confidence, and the other calculations are merely estimates of improbable actual effects.

The writer is, however, inclined to conclude:

1st. That it is very certain that the energy of this explosion, and all of its tremendous effects, were principally due to the simple expansion of a mass of steam suddenly liberated, at a moderate pressure, by the general disruption of a steam boiler of very uniform but feeble strength.

2d. That, *in this case*, the liberation of steam throughout the mass of water contained in the boiler, and which took place by the evaporation of one pound in every thirteen of the water, and which resulted in setting free nearly 70,000 cubic feet of steam, would not seem to have taken place promptly enough to greatly intensify the effects of the explosion.

3d. It would seem very doubtful whether Zerah Colburn's hypothesis—which explains the violent rupture of steam boilers by the supposition that the steam, liberated from the mass of water in cases of explosion, carries with it, and violently projects against those parts of the shell immediately adjacent to the point of primary rupture, large quantities of water, which, by their impact, extend the break and increase the destructive effect—can have had an illustration in case under consideration.

We have no right to conclude that such an action as Colburn described may not occur in many cases of explosion; on the contrary, the simple experiment described in all text-books on natural philosophy, in which water in a closed vessel, and near the boiling point, is caused to enter into violent ebullition by the reduction of pressure following the application of cold to the upper part of the vessel, exhibits very plainly the probability of an action taking place such as Colburn describes.

The expulsion of the contents of a bottle of effervescent wine or fermented liquor, which occurs frequently on drawing the cork, is another illustration of such a phenomenon. There can hardly be a doubt that cases do occur in which the same action greatly increases the destructive effect of boiler explosions.

In the case above considered, it seems probable that the effect of the explosion was somewhat intensified by a generation of steam at and near the exterior of the mass of water contained in the boiler, but not by the expansion of steam formed near the center of the mass.

Adjourned

January 19, 1872.

Professor S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

Extract of Beef.

Dr. P. H. Van der Weyde exhibited a can of extract of beef from Buenos Ayres, which he opened for examination. It is made upon the same plan as Liebig's extract. The difference between the extract of beef, diluted with hot water, and ordinary beef soup, is that the extract of beef contains no gelatine. Gelatine is contained in bones, and affords so little nourishment that it has been asserted that if the poor are fed upon soup made largely from bones they will starve to death; not that the gelatine does any direct harm, but that it takes the place of nutriment, while it is not nutriment. At Buenos Ayres meat is exceedingly cheap. The finest cattle are killed simply for the skin and the fat, the rest being thrown away. A company has been formed, which takes the beef and boils it down into beef tea, which is boiled down until it is sufficiently thickened. It is derived from the muscle of the animal, and contains no fat and no gelatine. The nutritive power of the meat is considered to be concentrated into one-twentieth its volume. It has been proved that in animals which have not yet developed their teeth, the stomach is not capable of changing the starch as it is required for digestion. Many children are starved to death because they are fed with starch instead of beef tea or milk.

A man cannot subsist wholly upon starch. He must have three kinds of food to sustain life.

Prof. John Phin—I understood that the soluble portion only is retained; that is, that which is soluble in water, not that which is soluble in gastric juice, and the rest is thrown away.

Dr. Van der Weyde—There may be in the meat some portions soluble in gastric juice which are not here, such as the fibrine. A large portion of the muscular fiber is thrown away. The meat is first boiled at the ordinary boiling point, and the surplus of water is then slowly evaporated below the boiling point.

Prof. Phin—The boiling in the first instance would have a tendency to render insoluble the albumenous portion of the meat.

Dr. Van der Weyde—I do not pretend that it is as good as good roast beef.

Dr. J. J. Edwards—In the case of a sick child or sinking patient we see the importance of beef tea or Liebig's preparation, as a nutriment to lift them over the sinking point and hold them up. All meat is in one sense a stimulant; this is a nutriment as well as a stimulant, and in cases of great weakness the concentrated beef acts like a charm. The admitted practice now is to chop up beef, or to give raw beef; and this is better, because such patients can stand this when they cannot stand the meat prepared in the ordinary way. This does not distress or irritate the stomach. It does not stimulate, as alcohol does, but simply holds the patient up while you cure him. At twenty-five cents an ounce measure, it is often the cheapest medicine you can get. At the price at which this extract of beef is sold, there is no saving to the poor, but it can be used when nothing else can be done.

Dr. A. Ott—I have seen it stated that the extract of beef contains salts of potash and soda in a larger proportion than the meat itself. Large quantities of potash have a stimulating and often a poisoning effect. After having used the extract of beef for some time, I found that I was getting very nervous, and I had to abandon its use.

Prof. J. Phin—There is one mistake frequently made in giving beef-tea, and in preparing food for the sick, that we do not give solids with the liquid. I am strongly inclined to believe that the stomach requires some solid matter in it. It is not like the birds, which have no teeth, and which take pieces of sand or quartz to grind up the corn which they cannot masticate. It is not like the ruminants, which require solid food, and will become diseased if fed largely upon liquids. Yet, I am satisfied that the human stomach also requires solid material;

and that it is a great mistake to feed a sick person for days or weeks upon nothing but gruels and liquid food. In using the extract of beef, I do not think it should be used alone; but that solid matter, vegetables or meat should be mixed with it.

Dr. Van der Weyde—The gentleman is perfectly correct. No doubt solid food is necessary. One of the best things is to take good bread, toast it quite hard, and put it in the beef tea. The great point in diet is to balance properly the three kinds of food that we need, the carbonized food, the nitrogenized food, and the fresh vegetables. When we are sick the first thing that gives out is the muscles. Our flesh wastes away, and the shortest way to replace it is with the flesh of animals. Men cannot afford to change vegetable food into the more highly organized muscles. I have noticed that people who try the vegetable diet after a while get exhausted, and return to animal food. To change vegetable tissue into animal tissue, nervous action is necessary. It is, therefore, a greater tax upon our nervous system to digest vegetable food. Man cannot afford that tax, while there are animals whose life is spent in doing the work for us. When I see a cow lying in the pasture chewing its cud, I think, "that cow is making animal tissue for me." Then we must have carbonaceous food. Consumptive people, whose lungs are weak, require a great deal of fat. They need plenty of fuel, and that is the advantage of cod-liver oil. We require fresh vegetables to stimulate the liver and kidneys; and, besides, fresh vegetables contain a great many alimentary substances that we need.

Dr. H. D. Sheppard—I only want to criticise one expression. It is said that beef tea "acts" in a certain manner. Is it not rather the fact that whether in food, or drink, or medicine, it is always the living system that acts, and not the dead matter taken into it? If this were merely a question of the use of terms, I should not consider it important; but I believe that this mistaken mode of speaking, leading people to believe that substances act upon the system, is the cause of the foolish and injurious taking of tons of medicine.

Professor Phin—The action is reciprocal, as in the case of a flame. We may burn gas in the air, or we may burn air in a receiver filled with gas. Substances act upon the body, and the body acts upon them.

The President—It will probably be found that the true explanation of the value of the extract of beef is that given by Dr. Ott, that it contains an excess of alkalies, which are stimulating, and, if taken in large quantities, detrimental.

THE SOREL ARTIFICIAL STONE.

BY DR. ADOLPH OTT.

It is characteristic of Portland cement to form with water a stone, similar in composition and physical properties to some of the species of the zeolite family, which we find in various igneous rocks, in sandstone and metalliferous veins. In that stone, nature is imitated, as it were, but it is very different with the Sorel cement. The stone produced by this cement is not met with in nature, although in strength and hardness it is equalled by few, if any, of nature's rocks. The cement in question is the discovery of Mr. Sorel, in Paris, and is produced by mixing a solution of chloride of magnesium of from fifteen to thirty degrees Baumé, in the proper proportions with oxide of magnesium or magnesia. The result obtained is a hydrous basic oxychloride of magnesia.

That calcined magnesia possesses remarkable hydraulic properties, had already been discovered in 1826 by Macleod, an employé of the East India Company in Madras, by which he had probably been authorized to search for domestic substitutes for the hydraulic mortars of the mother country.

These experiments were repeated in England with magnesite from Salem, in 1835; the results previously obtained were confirmed, and it was furthermore stated that, if the burned magnesite was mixed with sand in the proportion of one to one and a half, it will furnish a stone, adapted for structures of all kinds. In 1836 Vicat stated that pure limestone may be rendered hydraulic by the addition of a sufficient quantity of magnesia. He remarked that the proportion between the burned magnesia and the lime must be from thirty to forty parts of the former to forty parts of the latter.

In 1847, Pasley in his work, "Observations on Limes, Calcareous Earths, etc.," mentioned that he had also produced a good although slowly setting cement, from previously burned carbonate of magnesia. From these remarks it follows that the discovery of St. Claire Deville, of the hydraulic properties of magnesia, communicated to the Academy of Sciences, in 1865, is not new, as expounded by him and accepted by most chemists. The alleged discovery consists in the fact that a specimen of magnesia, prepared from the chloride after having been exposed to flowing water for some time, had acquired such a degree of hardness that it would scratch marble, and although subjected to atmospheric action for six years, it underwent no change. The fact, however, was settled conclusively, that magnesia is not near so efficient, in uniting inert bodies, as lime, and that would not bear a large admixture of sand.

The speaker said that he had deemed the previous observations necessary, in order to show that the mere fact of Sorel's using oxide of magnesium in his cement, was not sufficient to account for its great strength; and, furthermore, that it was not because "certain hydraulic limestones owe their hardness and power of setting under water to magnesia," or "because geologists agree that some of nature's most indestructible rocks contain that substance." He alluded to the fact that *talc* also contains magnesia, and yet that it is the softest of all minerals.

The process of making the Sorel artificial stone was then minutely described. It was divided into four different operations:

1st. The preparation of the oxide of magnesium.

2d. The mixing of sand with inert materials.

3d. The mixing of the afore-mentioned materials with chloride of magnesium.

4th. The moulding of the resulting mixture.

These operations were described as carried out by the Union Stone Company, in Boston, the owners of Sorel's patent for the United States.

Strength.

From experiments made by Major-Gen. Gillmore (vide his Practical Treatise on Coignet-Béton and other Artificial Stone, New York, 1871), it follows that in strength and hardness, the Sorel artificial stone surpasses all other known artificial stones and is, equaled by few, if any, of the natural stones adapted to building purposes.

The following figures express the crushing pressure per square inch in pounds.

Natural Stones.

Granite, Quincy	15,300
Marble, Montgomery county, Tenn	8,950
Sandstone, strong	5,500
Granite, Patapsco	5,340
Sandstone, Connecticut	3,319

Artificial Stones.

Sorel, Union Stone Company, Boston	21,562
Sorel, Union Stone Company, Boston, magnesia by weight fifteen per cent, inert material: fine marble	11,556
Sorel, Union Stone Company, Boston, magnesia by weight ? inert material: marble with colored veneer	7,680

Béton-Coignet, best	7,495
Béton-Coignet, average	4,670
Concrete, Ransome	6,720
Frear Stone	4,500
Brick, first quality, hard	4,368
English Portland cement, consisting of 1 vol. sand and 1 vol. cement, age six months	3,455
English Portland cement, same mixture, age 3 months	2,518

The strength of the Béton-Coignet was determined by Michelot, that of Ransome's concrete by Ansted, the one of English Portland cement by Grant, and that of the other stones by General Gillmore.

The principal business of the Union Stone Co. up to the present time has been the manufacture of emery wheels. Regarding the tensible strength of the material, General Gillmore says that it may be inferred from the fact, that in the proof trials the wheels are made to revolve with a velocity of from two to three miles per minute at the circumference. They do not usually begin to break until a velocity of from four to five miles per minute is attained.

Durability.

In order to test the durability of building materials under exposure to the vicissitudes of the seasons, the so-called frost test, indicated by the French chemist, M. Brard, is very generally followed. In this test the crystallization of the sulphate of soda (Glauber salt) is substituted for the freezing of water. The specimens of stone are immersed into a saturated solution of this salt, and after being withdrawn are left to dry. The solution is kept boiling for half an hour each time, and the test is made daily for a week, when the specimen is weighed and the loss determined. Dr. C. T. Jackson, one of the State assayers of Massachusetts, has made these tests with the Sorel stone, and reports as follows:

"From this test it is evident that your stone will withstand the action of frost more perfectly than any sandstone or ordinary building stone, now in use. I see no reason why it will not stand as well as granite."

Dr. Ott doubted the reliability of this test, and, in support of his view, read a passage from a work by Prof. Fuchs, written in 1829. But, said he, whatever may be the case, it is a fact that, in Boston, building blocks made of Sorel stone have resisted two winters, and at the present time appear, it is said, harder and stronger than before they were touched with frost.

Cost.

The total cost of one cubic foot of finished building block varies from seventy-nine and one-half cents to eighty-four and one-half cents If, however, large pebbles and small cobble stones are incorporated into the mixture, the price may be reduced ten or fifteen cents per cubic foot. For these reasons, the Sorel system has been limited in its application to articles like soap-stone stoves, whetstones, medallions, emery wheels, window caps, sills and other articles of small bulk and great relative value.

"For the peculiar purposes to which it is adapted," says General Gillmore, "it supplies what has heretofore been felt a great want, and in this field, which is neither narrow or unvaried, it has no prominent rival."

Prof. J. Phin suggested that in making not only artificial stone, but mortar, it is important that the sand should be sharp; and as common sand is, much of it, rounded, it might be advantageous,to use quartz stamped or crushed into fine particles, instead of sand.

The President remarked that the specimens exhibited were very much softer than natural stone.

Adjourned.

January 26, 1872.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

Water Gauge.

Mr. George R. Osborne exhibited and explained a model of a new water gauge for steam boilers, by which the height of the water in the boiler may be indicated at a distant point, and at a different level from that of the boiler. The gauge itself contains a large bent tube, containing mercury in the two legs, standing at an equal height when the water in the boiler is at the desired level. One end of the tube is bent again, and reduced in size in the descending leg, containing a colored fluid lighter than water, to multiply and make more conspicuous the changes in the mercury, and attached to this is a graduated scale. The lower end of this tube is filled with water, and connected with the water in the lower part of the boiler; and the other end of the tube, also filled with water, is connected with a perpendicular tube within the boiler, the top of which rises nearly to the top of the boiler. The steam pressure acts equally upon both surfaces of the mercury in the syphon; but if the water in the boiler gets lower than the top of the tube, the difference of level of the water is balanced by a difference of level in the mercury about 1-13th part as great; and this is multiplied upon the scale in proportion to the reduction of the tube; so that the scale can be made of any desired length.

The President — I have never seen anything like this in the books, and it strikes me as a remarkable combination. The tube in the boiler will always be kept full, by the condensation of the steam.

Dr. Van der Weyde — This resembles a barometer which I have seen in Europe. It is a syphon barometer, and to the lower cup is attached a small tube, filled with a colored fluid. In this way the scale may be enlarged to the whole length of the barometer. Glycerine, which will not evaporate, may be employed in this tube.

Mr. J. K. Fisher — For my own use, I would prefer not to have the enlargement of the scale. One-thirteenth of an inch, for an inch of water, is sufficient for practical use. But this would be useful in the office of the captain or chief engineer. The more of these tell-tales there are about, the more watchful the engineer will be.

Dr. Van der Weyde — The mercury gauge is there, and there must be this syphon. It will do no harm to put in the colored fluid, and then you can look at which you please.

Mr. R. Weir described Massey's Low-water Detector, which admits steam to a pipe, and expands it, blowing a whistle when the water reaches a point too low for safety.

The President suggested that this gauge might be made self-recording, like Edson's Steam-pressure Gauge.

Mr. R. Weir suggested that a modification of this instrument might be applied to registering the tides.

The following paper was then read:

A Hypothesis Relating to Heat.

By Prof. P. H. Van der Weyde.

I propose to commence my remarks to-night with a theory, and then to explain a new hypothesis, which will illustrate the difference between a theory and a hypothesis. Gravitation is not a theory; it is a stubborn fact. The law of gravitation, that it increases in inverse ratio with the square of the distance, is as much a mathematical necessity as that the sum of the three angles of a plane triangle equals two right angles. It may not seem a necessity to a mind not familiar with mathematical truths; but it is no less a necessity in fact, that any force coming from a point and diffusing itself into space, must diffuse itself in inverse ratio to the square of the distance. So much for the law of gravitation, miscalled a theory, but simply a fact.

The modern conceptions of heat are a theory. The old theory was that heat is a caloric fluid. That theory is totally exploded, for the simple reason that if there were such a fluid, we could not produce it *ad infinitum.* The first man that pointed out that heat can be produced continuously was Count Rumford. In his experiments on friction, he found that he could keep water boiling day after day, and produce any amount of heat. Where did that heat come from? It was not a fluid, or it would have been exhausted. By the modern theory, it was the power exerted by the friction, which was changed into heat. Pursuing that idea, Mayer, Joule, Helmholtz, and others, adopted the theory that there is a relation between heat and motion; that heat is only a mode of motion; that heat is molecular motion. When the motion of a mass is changed into a motion of the molecules of the mass, the peculiar molecular motion causes all the phenomena of heat.

Now my hypothesis relates to the character and velocity of that molecular motion. But before I enter upon that, let me explain further the theory of heat. One important point was the adoption of the unit, which is the amount which will raise one pound of water 1° Fahrenheit.

It requires different amounts of heat to raise the temperature of different substances 1°. Three pounds of water require exactly the same amonnt of heat as 100 pounds of mercury, ninety-seven pounds of gold, fifty-four pounds of silver, thirty-two pounds of copper, twenty-eight pounds of iron, or sixteen pounds of sulphur. Or, three pounds of hot water will melt as much ice as 100 pounds of equally hot mercury. It will be observed that, excepting water, the numbers are the chemical equivalents of the substances. Now, if we consider that all the other substances are elementary, and that water is composed of three atoms, H. O. H, which raises it to nine, the old chemical equivalent, we see the reason of the exception.

What does this teach us? If the chemical theory is correct that atom combines with atom, 100 pounds of mercury contain as many atoms as sixteen pounds of sulphur. It also shows that all simple atoms have the same specific heat, no matter what the substance is.

Latent heat, which has more direct relation to the hypothesis I have to present, is that which is necessary to change a solid into a liquid, a liquid into a gas, or a gas into its elements. Water, in its natural form, without heat, is a solid. It may have any temperature, from

—460° Fahrenheit, which is probably the point of absolute cold, up to its melting point. At thirty-two degrees Fahrenheit it begins to melt, and the heat which it absorbs while melting is called latent heat. It is found that it takes 142 units of heat to change one pound of ice into water. If we take a pound of water at 174° and a pound of ice at 32°, and put them together, we have two pounds of water at 32°; the 142° having been absorbed in melting the ice, without raising its temperature. The water has a molecular motion that does not exist in the ice, and to produce that motion has taken up 142° of heat.

The next change is to convert water into steam; and in that process, 962 units of heat become latent. A very useful application of this fact may be made to ascertain whether the water primes in a steam boiler. If the water does not prime, the steam will heat water according to the theory. If we take five pounds of water at 32° and blow steam into it until we have six pounds, it will be boiling hot; but if any water is mixed with the steam, it will not heat it so much.

If we heat steam to a certain point, it will be decomposed, and a certain amount of heat will become latent in its disassociation. Spectroscopic observations of the sun, show that all the substances we have on the earth, exist there in a state of disassociation. St. Claire Deville ascertained that when steam is heated to 5,600° Fahrenheit, it is decomposed into its elements, hydrogen and ozygen; and that in that disassociation not less than 8,000 units of heat become latent. We have, thererefore:

Water = Ice at 32° + 142 units of heat.

Steam = water at 2129 + 62 units of heat.

H + O + H = Steam at 5,300° + 8,000 units of heat.

Water is the only substance which has been investigated. There is a fixed temperature for every compound substance at which it is decomposed. There is an extreme degree of cold at which chemical affinities do not act, and an extreme degree of heat at which they do not act. Between that range chemical combinations take place, and above it they are decomposed by heat.

We have hydrogen and oygen uncombined, and cause them to combine, the latent heat of disassociation is set free, just as the latent heat of steam is set free when it is condensed into water. It was once thought that some of the specific heat was set free in combustion, but that has been shown not to be true. The specific heat of water, where the combustion has taken place, is as great as that of any substance in nature. But if we accept the statement of St. Clair Deville that 8,000 units of heat are set free in the combustion of hydrogen, that sufficiently accounts for the heat of the combustion, and there is nothing mysterious about it.

I now come to my hypothesis. Heat being a mode of motion, the question arises, what kind of motion it is. It must, of course, be a motion of the molecules. We have substances in four forms: solids, liquids, gaseous and disassociated gases. In the solids we find a tendency to crystallization. There is a certain polarity of the particles, of which the crystal form is the expression. I propound the hypothesis that in solid bodies the atoms are all the time oscillating, and that when we raise the temperature of a solid body we simply increase the amplitude of oscillation. We know that as we raise the temperature bodies expand, and oscillation with a greater amplitude of course requires more space. The velocity of the oscillation is very likely 400,000,000,000 in a second, between that of the electric and of the luminous waves.

Mr. Blanchard—Suppose the atoms are round?

Dr. Van der Weyde—They are *not* round. How can an atom, or rather molecule, of water be round, when it is composed of two atoms of hydrogen and one of oxygen? Molecules of water are not round; they have poles. They are centers of forces, but they have polarity; otherwise crystallization could not take place. The incredulous man may examine the forms of snow flakes, and see the polarity of atoms of ice.

Now let us raise the temperature of our oscillating atoms of ice, increasing the amplitude, until, when they reach the melting point, they oscillate so far as to go far over, and then they revolve. So I propound the hypothesis that in liquids the atoms are all the time rotating. They roll around one another, and are easily moved. Now, in the freezing of water, there is what I may call a paradox; that the point of greatest density is not the freezing point. To explain that, we have simply to suppose that the center of oscillation is not in the middle of the molecule, but that it is eccentric; that it is the least eccentric at forty degeees, the point of greatest density, but becomes more eccentric both below and above that temperature; for the more eccentric it is the more space will be required either for oscillation or for revolution. When we freeze water the rotation becomes slower as it cools, until, at thirty-two degrees, there is not force enough to carry it over any more, and then, like a revolving pendulum, it ceases to go over, and oscillates. As it becomes colder the oscillation becomes less; and, at –460° Fahrenheit, it ceases altogether.

When we heat water up to the boiling point, the rotation of the atoms around each other becomes more rapid until at last they fly apart, and then they move in straight lines. That is a point that is not new. Prof. Barker, in his new chemistry, states that the atoms in gases move in straight lines. That motion becomes more rapid as the temperature rises; and as the force of impact increases with the square of the velocity, that explains why the pressure of steam increases so much when we raise the temperature. It has been shown, also, by the diffusion of gases, that the particles must move either in continuous rectilinear motion or in very much elongated ellipses. Hydrogen gas moves with greater velocity than other gases. Gases diffuse differently according to the square root of their density, The density of hydrogen gas is 1-16th that of oxygen gas; and therefore four times as much hydrogen will pass through a given space as of oxygen, in the same time. All these facts tend to show that the particles of gases move in straight lines.

Let us go a step further, and apply that to the heat of disassociation. It has been suggested that the spaces between the atoms, compared with the sizes of the atoms, are as large as the planetary spaces compared with the sizes of the planets. In steam, the particles move in straight lines, but they move in triplets, two atoms of hydrogen and one of oxygen all sticking together and forming an atom of steam; but when we reach the heat of disassociation, the atoms of hydrogen and oxygen move independent of each other. On the other hand, if the disassociated gases, above 5,000° Fahrenheit, are cooled to that point, they will unite, or combustion will take place. That is continually taking place in the sun, as shown by the spectroscopic observations upon the corona; and it takes place in the stars. But a few years ago you will recollect that a star in the northern crown suddenly shone out with great brilliancy, and it was ascertained that the light was from flaming hydrogen. They cool down until they reach the point where association can take place, and then they burst into flame. The heat developed by the combustion may raise the temperature to the point of disassociation again; and then it may require a long period before it will cool down so that combustion can again take place.

We may consider the formation of hydrogen and oxygen first into steam, then into water, and then into ice, as a descending temperature along inclined planes and precipices. The elementary gases descend an inclined plane until they reach the point of association. They then fall down a precipice, and 8,000 units of heat are set free. Then they come down another incline for 5,000° until the steam reaches 212°, when the steam condenses, and there is another precipice, and 962 units of heat are set free. Coming down another incline for 180°, a third precipice, on the formation of ice, sets free 142 units of heat; and from that point the descent is continuous to the point of absolute cold. Tyndall compares the falling of the atoms of oxygen upon carbon to the falling of meteorities into the sun in explaining the production of heat.

The President—The theory of the oscillation of atoms was long ago advocated by Rankin. The revolution of atoms in a system was first presented before this Society in a new theory by Professor Walling.

Dr. Van der Weyde—I do not claim as my hypothesis that heat is atomic motion; but I have never seen any consistent explanation how the oscillating motion of atoms in solids is connected with the motion in straight lines in gases.

Dr. J. W. Richards—This hypothesis gives a better explanation of the paradox that water begins to expand at forty degrees than I have before met with.

Dr. Van der Weyde—One point about the velocity I forgot to state. As the temperature rises, and the velocity increases, chemical decomposition takes place. In the spectrum, where the velocity of the undulations is the greatest, chemical action takes place.

The President—It is amplitude of the æth-wave, and not its velocity, that produces intensity of heat.

Dr. Van der Weyde—So long as the velocity of the wave is below 400,000,000,000 in a second we do not see anything. At that point we see red light. When it reaches 900,000,000,000 it has passed through the spectrum, passed the violet, and again reached a point where we do not see anything. At any temperature, there may be waves of lower velocity mixed with those of higher velocity. There may be invisible waves mixed with visible waves. With the higher velocities the waves are so short, perhaps they get between the atoms, and therefore chemical decomposition takes place.

Mr. D. Blanchard—One point seems to me inconsistent. The difference between great oscillation, through nearly the whole circle, and rotation, is infinitely small, and yet a great amount of heat is employed to produce that difference.

The President—Intensity of heat is produced entirely by the amplitude of the wave, and not at all by its length. The pitch of a sound depends upon the number of waves in a given time; but the loudness of a sound does not depend at all upon that, but wholly upon the strength with which the air is condensed to make the wave. When you strike a bell, you not only hear the original sound but many harmonic sounds above it, which the Germans call overtones. So light itself may be the result of overtones generated by the lower vibrations distinguished as heat-waves.

Dr. Van der Weyde—You may have a strong luminous wave of great amplitude without heat. A violet or blue ray may be very strong and have no heat.

The President—There are three different effects in the spectrum. Whatever the effect is, it becomes stronger by the amplitude of the wave.

Dr. Van der Weyde—That does not agree with the experiments with the solar spectrum. With a certain velocity you have heat. But make your blue wave ever so intense, and you have no heat at all. In heat, you have rays of all possible amplitudes and all possible velocities. Commence heating a cannon ball, and when it reaches a low red heat, it shows that among the waves there are some of 400,000,000,000, whatever their amplitude, and however many waves of less velocity there may be. As the temperature rises, you pass through all the colors, and finally reach a white heat, where rays of all the velocities exist together.

The President—That reminds me of a recent series of experiments by Budde, reported in Poggendorff's journal, that the higher waves of light, the violet rays in the upper part of the spectum, which are supposed to have no heating power, when thrown into chlorine gas, produce heat.

Dr. Van der Weyde—It was known long ago that a mixture of chlorine and of hydrogen gas will explode when exposed to the violet ray.

The President—That is true; but that heat can be produced by the higher waves of light, in certain gases, is an entirely new fact.

Dr Van der Weyde—A substance may become fluorescent upon being exposed to violet rays, and will afterwards emit red rays.

Adjourned.

February 2, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

ROAD STEAMERS.

Mr. J. K. Fisher read a paper describing the various carriages proposed for the use of steam upon common roads.

Dr. P. H. Van der Weyde—I saw in Paterson sixteen horses, driven by half a dozen men with whips, drawing a large locomotive up quite a steep hill, and I saw one of these little steam carriages attached to another locomotive of equal size, and drawing it up the same hill apparently with great ease. The contrast was very striking.

Mr. Dudley Blanchard—We are gradually perfecting the arts which tend to the perfection of steam carriages; and, perhaps, it will not be long before we shall arrive at the point when they can be made profitably for common roads; but of that I have some doubt, for it seems to me that the power necessary to run a steam carriage over a soft surface like a meadow is too great for economy. It will certainly be a losing operation for the first undertakers of the project. My idea of a steam carriage would be to make the boiler only three or four inches deep, and to heat it with kerosene lamps fitted into slides to run under the boiler. I believe that kerosene will give more power for a given weight than coal. I would have a water tank to prevent the heat from reaching the carriage above, and under the boiler I would have two small engines operating the opposite sides of a crank.

Prof. J. Phin—The horse is the worst animal in the world to go over soft ground, because his hoofs cannot expand; but you can make the wheels of the locomotive as broad as you please.

Prof. J. S. Whitney—I have seen the two leading traction engines in operation — that of Mr. Thompson and that of Messrs. Aveling & Porter. That of Mr. Thompson had a horizontal boiler and India rubber tires. Both that and the engine of Messrs. Aveling & Porter work extremely well. I have seen them plow, with seven plows, a foot furrow, and do it well, and if they could rely upon a uniform consistency of the ground underneath, they would be very useful. But in this experiment one of them came to an ant hill, and there it stopped and took nearly half an hour to get it out. They will travel across soft plowed ground without the slightest difficulty, and on a hard road will draw heavy wagons or pass up a steep bank. There is very little to choose between the two, excepting to adapt them to special conditions and circumstances. Some of them have been sent to California and some to Utah. I do not think they will work well in either of those countries, because all through California and Utah you will find the hole of the gopher and prairie dog, and no traction engine could plow across those fields. In order to be used there the roads must be made good, and upon a good hard road they may be successful.

Dr. J. W. Richards—Mr. Baxter, the inventor of a boiler, has formed a company to manufacture engines and cars for common street railroads. His boilers are the safest, I think, that I have ever examined.

Mr. J. K. Fisher—I omitted to state that the boilers I have represented are intended to be so safe that they may be burst purposely with out doing any harm.

ARTIFICIAL MUSK AND ORGANIC COMPOUNDS.

Dr. P. H. Van der Weyde—I have first to present for your examination a specimen of artificial musk, which is made of blood, treated in a peculiar manner. At first it could be distinguished from the genuine musk from the absence of the little hairs which musk always contains; but the inventor takes some of the hair and puts it in his artificial musk, and now even the microscope cannot distinguish between the two.

Chemists have frequently transformed one organic substance into another organic substance. Professor Schultz, of Germany, has succeeded in making mellithic acid, which may be changed into benzole, and then we can make the whole series of anilines and all the aniline colors, producing all these substances in the laboratory without the assistance of any organic compound. Whether it will be of any advantage is a question to be decided by experience. It is enough for the present to know how it can be done. Oxalic acid and acetic acid have both been before made artificially. Alcohol has been made artificially from common coal gas. Dextrine also has been made artificially.

The President—It will be remembered that I read an article on mellithic acid a few weeks ago.

STEAM BOILERS.

Professor R. H. Thurston read the report of the judges on steam boilers at the last fair of the American Institute, which will be found in this volume of Transactions, page 66.

After the reading of the report the following debate took place:

Dr. P. H. Van der Weyde — One great point has been brought out by this report, that the Blanchard boiler, which has the largest amount of evaporating surface, was the most economical.

Mr. J. K. Fisher — Could you tell, in these experiments, how much heat went up the chimney?

Professor Thurston—We know the temperature of the gas that went up the chimney, but not the quantity.

Mr. Fisher — The evaporation per foot of surface seems to have been quite small.

Professor Thurston — It is the evaporation with a natural draft, with low chimneys. In the locomotive you have a forced draft, and in the Cornish boiler you have high chimneys, so that their evaporation will be greater.

Mr. Fisher — It appears to me that these boilers did not perform so efficiently as locomotive boilers.

Professor Thurston — You cannot judge of the evaporation of a boiler that has not been tested in this way. A gentleman told me that on testing his boiler he found that it evaporated eighteen pounds of water to the pound of coal. I told him that was twenty per cent more than a perfect boiler would evaporate; so that it was evident that a large amount of water had passed off with the steam. He said that he had held his handkerchief in the steam and it came out dry. He went back and made another trial, and made it fifteen pounds; but on trying the thermometer he found that it indicated a higher temperature than that due to the pressure. Another experiment brought down the apparent evaporation to twelve pounds and a fraction. I have no doubt that in his first experiment he had made the performance at least double what it really was.

Dr. Van der Weyde repeated his suggestion, given in his lecture on heat, that an excellent test is to blow steam into water until we have added a pound to the weight of the water. This requires no apparatus, and enables us to determine, from the rise of the temperature of the water, how much water was discharged mingled with the steam.

Professor Thurston — That would be a very accurate and convenient method for ordinary purposes.

Mr. W. E. Partridge — A further application of this method has been made use of by several engineers in this city, in testing steam pumps. Thermometers are placed in the water that enters the pump, and in the water as it passes away. The radiation is very little, and the results compare favorably with those taken by more expensive methods.

Mr. Geddes — Would the tests made by this committee enable them to advise the Board of Managers as to the form of boilers to be purchased for the fair? Whether it should be one of the forms reported upon or some other form of boiler?

Professor Thurston — All our examinations have been with regard to these five boilers; but we consider them as very good specimens of boilers.

Adjourned.

February 9, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

The meeting was opened by the reading of the following paper by Mr. W. E. Partridge, who also exhibited samples to illustrate the subject treated of.

PROTECTING PLATES OR DESIGN PLATES AS APPLIED TO ENAMELED GLASS.

For want of a better name, this paper might be announced as upon "Stencil Plates, their connection with Stained Glass work, etc.;" but the plates which I shall exhibit to you this evening are not, in any sense of the word, stencil plates. The technical name, though little used, is "formulas." The only resemblance which they have to stencils is in being cut from thin sheets of metal. Webster defines a stencil thus: "A thin plate of metal, leather or other material used in painting, marking, etc. The pattern is cut out of the plate, which is thin, laid flat on the surface to be marked, and the color brushed over it." Now the pattern in these plates is *not cut out*, and the color is *never brushed over* them. To nearly perpetrate a bull, one may say that the *plate* is cut out and the pattern remains, which is exactly the case. In no case is the color ever brushed over the plate.

In the ornamentation of glass by enameling, the first thing to be done is to clean the glass perfectly; and so thoroughly is this done, that when the glass is ready for the color it approximates to what a chemist would call clean. The colors used in glass work are minerals, oxides of the metals, and other substances capable of bearing a great degree of heat.

Indeed, in the majority of cases, the color does not appear until the glass has been heated to redness. The colors are mixed with various proportions of flint glass and other materials termed fluxes. These are then ground exceedingly fine. They are then mixed with gums or oils, so that they can be readily applied to the surface of the glass. The next operation is termed "laying the ground," which consists in giving the glass a perfectly even coating of the enamel over its whole surface. This is done by applying the colors technically called "enamels" to the glass by means of broad soft brushes; and then, as the coating dries, smoothing it by means of blenders—the long-haired brushes used by artists for similar purposes. When thoroughly dry, and, of course, completely covered with the color, the glass is ready to receive the pattern. The protecting plate or design plate now comes in use. It is laid upon the glass, to which it must fit very closely, and the superfluous enamel brushed away through the interstices of the pattern ; a complete inversion of stencil work, where the color is put on through the plate. The glass goes at once to the kiln to be heated or "fixed," so that the enamel, which is a little more fusible than the glass, melts, combining with the glass, so that the pattern becomes as indestructible as the glass itself.

These are the outlines of a process which has had its origin and growth in the glass trade, and, so far as the writer knows, has never been practiced outside of that trade. It becomes a matter of no small importance to consider whether as valuable a process may not be applied to decorative and preservative arts, and have a wider range of use than it has at present.

In the consideration of the topic, it may be well to consider first how these plates are made.

When the sheet brass comes from the manufactory it is rolled up, and when spread out again is very rough and uneven. If made into a plate in that condition it would be utterly useless. It must, therefore, be stretched and rolled until it is perfectly flat. Ordinarily the sheet of metal is then covered with wax, and the lines requiring to be cut through are etched with acid. They cannot be cut as in stencil work, because the action of the punch or tool would so tear and injure the edge of the metal, that it would no longer fit closely upon any surface to which it might be applied. After the acid has cut entirely through the metal, the edges are carefully trimmed with a knife, and the protecting plate is ready for use.

Many of the colors, when applied to the glass, have no resemblance to the intended tint. When heated, however, chemical changes take place and the desired color appears. This piece of glass which I show you now, is covered with what will be black enamel, when it is burnt in; at present it is only a dark olive green. Nitrate of silver produces a brilliant transparent yellow, but when put on to the glass, is a dirty gray color.

The other day, when showing these plates to a gentleman, very wise in his own conceit, he remarked, "oh, yes," he had made such stencils many years before. They were for etching with acid. A remark which he no doubt deemed very wise, but which showed that he knew nothing whatever about enameling glass, and hadn't the faintest conception of the difference between a positive and negative pattern. Another gentleman who seemed to think that he knew a good deal about the relation of things, remarked, "yes, those were very good stencils, they could be made by rolling." It is barely possible that he would like the job of making a pair of rolls that would roll a plate just like that. To make such a plate as this, costs, perhaps, $10 for a die, with which to cut it. They are made double, male and female; and then, perhaps, $5 to make the plate. Total cost from $12 to $15 for the first plate, and $5, or thereabouts, for each succeeding plate. Now, if that gentleman is present, will he be kind enough to just tell us how much it would cost to make a pair of rolls that, would turn out a plate thirty-six inches long by fifteen wide? Then how much would it cost to reduce the plate to a perfect plane, so that when it is laid upon the glass, it would touch at all points? At the same time the plate must not be distorted.

An important application of this process would be to enamel iron for buildings. This cost would be little, for the principal labor can be done by boys. An iron building can be enameled for about thirty-five cents per square foot; and the saving of the expense of painting would pay for that in five or ten years.

Mr. T. D. Stetson—Can it be done upon either cast iron or wrought iron?

Mr. W. E. Partridge—Either. It will be observed that one difficulty in the use of stencil plates is entirely obviated by this process; which is the necessity for breaks in forming letters or other patterns. Here the form is complete with one plate.

A Member—In enameling an iron building, how would you apply the heat?

Mr. W. E. Partridge—The enamel would be applied to the iron as it came from the foundry.

Mr. T. D. Stetson—One word with regard to the enameling of iron, and the construction of iron-clad buildings. A building may be of brick, and yet plated or veneered with iron. There were whole blocks of houses made some years ago in that way, not enameled, but so coated as to make a very perfect imitation of brown stone. The operation was briefly this: to take the same kind of varnish used in japanning, having it preferably of a light color approximating to that of brown stone; put it on thick, by one or more operations, and when the composition is a little sticky, sprinkle upon it some actual brown stone in the form of powder. They will probably endure the weather forever, and make a very durable and substantial surface, at but little more than the expense of brick. But, after all, this was only a scheme; for the iron-clad houses ceased to be built, for the reason that brown stone fell to two-thirds its former price, and that killed the iron-clad houses.

Mr. J. K. Fisher—I think it is a pity that the iron-clads did not also kill the brown stone house; for it is the ugliest color that is used in building.

The President—There is such a difference between the expansion of iron and any sort of enamel, that enameled iron cannot be expected to be very lasting.

Dr. L. Bradley—I recollect that when that very objection was made by Dr. Rich, it was answered by the fact that the specimen had already suffered all the changes of heat from some 200 deg. F. down to zero, and still remained perfect.

Mr. Partridge stated that samples of similar work done by protecting plates in Belgium, bore no comparison, in the perfection of the coating, or in the regularity of the design, with work done from the protecting plates made by the American machine in Newark, specimens of which he exhibited.

Fire Escape.

Mr. Sharp exhibited a new fire escape, consisting of a brass cylinder with a spiral groove around it, the friction of which, upon a rope passing through it, is sufficient to enable a man to descend from the window of an upper story with safety. One end of the rope is fastened to a bedstead or other fixed object near the window, and the person sits in a seat formed of leather straps attached to the brass cylinder. If the descent is too rapid, a slight pull upon the rope below the apparatus will increase the friction to any desired extent. The whole apparatus, including the rope, may be packed in a small box, and weighs but about three pounds, costing about ten dollars.

The President—Would it not be cheaper if made of iron?

Mr. Sharp—Brass is cheaper in this case than iron, because this screw can be finished more easily in brass. In case of a fire, if this apparatus was at hand, a man could remain in a building in flames, saving the property, until the very last minute, and then come down with safety. Even if the flames should reach the rope, he would reach the ground before it would burn.

The President—It would be very easy to make the rope fire proof. The proper way would be to make the fiber fireproof, before made up into rope, and then the outside wear would not affect it. This is a novel and simple invention; and its cheapness will be an important point. We have had many successful fire escapes, but they have cost too much. If this can be furnished cheaply enough to put in a closet in every house where it is needed, or in every room where it is needed, it will be of great utility. The least pressure beneath the brass stops the descent at any point.

Dr. J. V. C. Smith—There is a fire escape much used in England, consisting of a sort of ladder on wheels, which is run up to a window, and women and children are taken down; and I have been struck with the marvelous ease with which they manage that instrument. This apparatus strikes me very favorably. The principle is admirable; but to introduce it rapidly, it must be cheap.

Mr. Sharp — When we go up into an upper story to sleep, we want something that we can depend on ourselves, in order to be relieved from the fear of the danger from a fire. We cannot avoid that fear, if we must wait for that apparatus to be brought to us before we can escape. Another use for this apparatus is for painters. We not unfrequently hear of accidents to painters in consequence of their falling from scaffolds, or the scaffolds giving way, and such accidents are sometimes fatal. Let the painter attach one end of the rope and place himself within these belts, and he may then feel himself safe. In painting ships, the painter may descend by this apparatus and stop at any point, and when he wishes to come up again he can climb up the rope. The apparatus may be adapted to going down into mines or into wells. In fact, there are very many uses to which it can be applied.

A Member — Suppose the person descending loses his presence of mind and forgets to apply the check, would the descent be so rapid as to be dangerous?

Mr. Sharp — Descending two stories it would not; but if it was from the sixth story the descent might be too rapid. Any person on the ground, pulling slightly on the rope, can check the descent just as effectually as the person descending. Usually, in a case of fire, a man wants to come down pretty fast.

A Member — I have seen the apparatus used in London, and which has been spoken of. It is clumsy, awkward and cumbrous. When attached to a building it is exceedingly safe; but I have known of persons being burned to death in East London while the apparatus was finding its way to the fire. One great advantage of this new apparatus is that the individual needs no assistance.

Mr. Sharp — When one man has come down, another can draw up the brass by the rope, attach the other end, and slide down the other way. It works equally well in both directions.

Yeast.

The President — It has been stated that taking a spoonful of yeast three times a day entirely destroys the disease diabetes. Yeast turns ordinary sugar into carbonic acid and alcohol. My theory is that the yeast, operating upon the blood, takes hold of the solid substances that pass off as saccharine matter, and, turning the saccharine matter into carbonic acid and alcohol, the alcohol goes to nourish the system.

Dr. J. V. C. Smith — Some years ago, in a case of diabetes, I recommended the use of yeast. The patient took it faithfully, and for a few days thought it did some service; but he afterward died of diabetes. There may be cases in which the use of yeast may be beneficial; but I do not consider it a specific.

The President — The cause of the disease is in the liver or kidneys — this does not, of course, reach that.

Dr. Van der Weyde — While this disease is there, poisoning the blood, changing the substances by catalytic action, into grape sugar, which is poisonous if allowed to remain in the blood, the kidneys take up this sugar from the blood, and in so doing are overworked, and immense quantities of urine are discharged. In any case the use of yeast will not affect the cause of the disease. The sugar is found. It sounds very plausible; but the yeast can only be a palliative. In order to be acted on at all by this yeast, the sugar must be grape sugar. Now, it is very simple to test the presence of grape sugar in the urine; for it is a property of potassium to produce a salt with copper when grape sugar is present. If a little sulphate of copper and a little potassa are put into the urine, if no grape sugar is present there will be no action; but if grape sugar is present there will be a brown deposit. A few drops of nitric acid will detect the presence of albumen. In health, there is not even a trace of either grape sugar or albumen in the urine.

The President — I knew of a gentleman, seventy years of age, who was attacked with diabetes, and who was cured by the use of yeast, in a short time. It is possible that the yeast, disposing of the sugar, the system was invigorated and brought to its normal action so far that the disease itself was cured. There are particular nerves which cause the liver to produce sugar, and if we can restore them to healthy action we can cure the disease. The yeast sustains the body until its natural powers can repel and eradicate the disease.

Dr. J. W. Richards — There is another new remedy to which I will call attention — skim-milk, which contains a considerable amount of caseine, used as an exclusive diet.

The President — Of course in the diet, the exclusion of everything containing starch, which may be converted into sugar, will be beneficial. I will read upon this subject a portion of an article by Prof. Huxley, showing that the tendency of his mind is in the same direction that this association has been tending toward for the last year, that many contagious diseases, and perhaps all, are the results of minute organisms, animal or vegetable, which get into the system and generate disease.

YEAST.

By Professor T. H. HUXLEY, of London.

It has been known, from time immemorial, that the sweet liquids which may be obtained by expressing the juices of the fruits and stems of various plants, or by steeping malted barley in hot water, or by mixing honey with water, are liable to undergo a series of very singular changes, if freely exposed to the air and left to themselves, in warm weather. However clear and pellucid the liquid may have been when first prepared, however carefully it may have been freed from even the finest visible impurities, by straining and filtration, it will not remain clear. After a time it will become cloudy and turbid; little bubbles will be seen rising to the surface, and their abundance will increase until the liquid hisses as if it were simmering on the fire. By degrees some of the solid particles which produce the turbidity of the liquid collect at its surface into a scum, which is blown up by the emerging air bubbles into a thick, foamy froth. Another moiety sinks to the bottom, and accumulates as a muddy sediment, or "lees."

When this action has continued for a certain time, with more or less violence, it gradually moderates. The evolution of bubbles slackens, and finally comes to an end; scum and lees alike settle at the bottom, and the fluid is once more clear and transparent. But it has acquired properties of which no trace existed in the original liquid. Instead of being a mere sweet fluid, mainly composed of sugar and water, the sugar has more or less completely disappeared, and it has acquired that peculiar smell and taste which we call "spirituous." Instead of being devoid of any obvious effect upon the animal economy, it has become possessed of a very wonderful influence on the nervous system ; so that in small doses it exhilarates, while in larger it stupefies, and may even destroy life.

Moreover, if the original fluid is put into a still and heated for a while, the first and last product of its distillation is simple water; while, when the altered fluid is subjected to the same process, the matter which is first condensed in the receiver is found to be a clear volatile substance, which is lighter than water, has a pungent taste and smell, possesses the intoxicating powers of the fluid in an eminent degree, and takes fire the moment it is brought in contact with a flame. The alchemists called this volatile liquid, which they obtained from wine, "spirits of wine," just as they called hydrochloric acid "spirits of salt," and as we, to this day, call refined turpentine "spirits of turpentine." As the "spiritus," or breath, of a man was thought to be the most refined and subtle part of him, the intelligent essence of man was also conceived as a sort of breath, or spirit; and, by analogy, the most refined essence of any thing was called its "spirit." And then it has come about that we use the same word for the soul of man and for a glass of gin.

At the present day, however, we even more commonly use another name for this peculiar liquid—namely, "alcohol," and its origin is not less singular. The Dutch physician, Van Helmont, lived in the latter part of the sixteenth and the beginning of the seventeenth century—in the transition period between alchemy and chemistry—and was rather more alchemist than chemist. Appended to his "Opera Omnia," published in 1707, there is a very needful "Clavis ad obscuriorum sensum referandum," in which the following passage occurs:

"*Alcohol.*—Chymicis est liquor aut pulvis summe subtilisatus, vocabulo Orientalibus quoque, cum primis Habessinis, familiari, quibus *cohol* speciatum pulverem impalpabilem ex antimonio pro oculis tingendis denotat. * * * Hodie autem, ob analogiam quivis pulvis tenerior, ut pulvis oculorum caneri summe subtilisatus *alcohol* audit, haud aliter ac spiritus rectificatissimi *alcolisati* dicuntur."

Robert Boyle similarly speaks of a fine powder as "alcohol;" and so late as the middle of the last century the English lexicographer, Nathan Bailey, defines "alcohol" as "the pure substance of anything separated from the more gross, a very fine and impalpable powder, or a very pure, well-rectified spirit." But, by the time of the publication of Lavoisier's "Traité Elémentaire de Chimie," in 1789, the term "alcohol," "alkohol," or "alkool" (for it is spelt in all three ways), which Van Helmont had applied primarily to a fine powder, and only secondarily to spirits of wine, had lost its primary meaning altogether; and, from the end of the last century until now, it has, I believe, been used exclusively as the denotation of spirits of wine, and bodies chemically allied to that substance.

The process which gives rise to alcohol in a saccharine fluid is known to us as "fermentation," a term based upon the apparent boiling up or "effervescence" of the fermenting liquid, and of Latin origin.

Our Teutonic cousins call the same process "gähren," or "gäsen," "göschen," and "gischen;" but, oddly enough, we do not seem to have retained their verb or substantive denoting the action itself, though we do use names identical with, or plainly derived from, theirs for the scum and lees. These are called, in Low German, "gäscht" and "gischt;" in Anglo-Saxon, "gest," "gist" and "yst," whence our "yeast." Again, in Low German and in Anglo-Saxon, there is another name for yeast, having the form "barm," or "beorm;" and in the midland counties "barm" is the name by which yeast is still best known. In High German there is a third name for yeast, "hefe," which is not represented in English, so far as I know.

All these words are said by philologers to be derived from roots expressive of the intestine motion of a fermenting substance. Thus "hefe" is derived from "heben," to raise; "barm" from "beren" or "bären," to bear up; "yeast," "yst" and "gist," have all to do with seething and foam, with "yeasty waves," and "gusty" breezes.

The same reference to the swelling up of the fermenting substance is seen in the Gallo-Latin terms "levure" and "leaven."

It is highly creditable to the ingenuity of our ancestors, that the peculiar property of fermented liquids, in virtue of which they "make glad the heart of man," seems to have been known in the remotest periods of which we have any record. All savages take to alcoholic fluids as if they were to the manor born. Our Vedic forefathers intoxicated themselves with the juice of the "soma;" Noah, by a not unnatural reaction against a superfluity of water, appears to have taken the earliest practicable opportunity of qualifying that which he was obliged to drink; and the ghosts of the ancient Egyptians were solaced by pictures of banquets in which the wine-cup passes round, graven on the walls of their tombs. A knowledge of the process of fermentation, therefore, was in all probability possessed by the prehistoric populations of the globe; and it must have become a matter of great interest, even to primæval wine-bibbers, to study the methods by which fermented liquids could be surely manufactured. No doubt, therefore, it was soon discovered that the most certain, as well as the most expeditious, way of making a sweet juice ferment was to add to it a little of the scum, or lees, of another fermenting juice. And it can hardly be questioned that this singular excitation of fermentation in one fluid, by a sort of infection, or inoculation, of a little ferment taken from some other fluid, together with the strange swelling, foaming and hissing of the fermented substance, must have always attracted attention from the more thoughtful. Nevertheless, the commencement of the scientific analysis of the phenomena dates from a period not earlier than the first half of the seventeenth century.

At this time, Van Helmont made a first step, by pointing out that the peculiar hissing and bubbling of a fermented liquid is due, not to the evolution of common air (which he, as the inventor of the term "gas," calls "gas ventosum"), but to that of a peculiar kind of air such as is occasionally met with in caves, mines and wells, and which he calls "gas sylvestre."

But a century elapsed before the nature of this "gas sylvestre," or, as it was afterward called, "fixed air," was clearly determined, and it was found to be identical with that deadly "choke damp" by which the lives of those who descend into old wells, or mines, or brewers' vats, are sometimes suddenly ended; and with the poisonous aeriform fluid which is produced by the combustion of charcoal, and now goes by the name of carbonic acid gas.

During the same time it gradually became clear that the presence of sugar was essential to the production of alcohol and the evolution of carbonic acid gas, which are the two great and conspicuous products of fermention. And finally, in 1787, the Italian chemist, Fabroni, made the capital discovery that the yeast ferment, the presence of which is necessary to fermentation, is what he termed a "vegeto-animal" substance—or is a body which gives off ammoniacal salts when it is burned, and is, in other ways, similar to the gluten of plants and the albumen and casein of animals.

These discoveries prepared the way for the illustrious Frenchman, Lavoisier, who first approached the problem of fermentation with a complete conception of the nature of the work to be done. The words in which he expresses this conception, in the treatise on elementary chemistry, to which reference has already been made, mark the year 1789 as the commencement of a revolution of not less moment in the world of science than that which simultaneously burst over the political world, and soon engulfed Lavoisier himself in one of its mad eddies: "We may lay it down as an incontestible axiom that, in all the operations of art and nature, nothing is created; an equal quantity of matter exists both before and after the experiment. The quality and quantity of the elements remain precisely the same, and nothing takes place beyond changes and modifications in the combinations of these elements. Upon this principle, the whole art of performing chemical experiments depends; we must always suppose an exact equality between the elements of the body examined and those of the product of its analysis. Hence, since from must of grapes we procure alcohol and carbonic acid, I have an undoubted right to suppose that must consists of carbonic acid and alcohol. From these premises we have two modes of ascertaining what passes during vinous fermentation: either by determining the nature of, and the elements which compose, the fermentable substances; or by accurately examining the products resulting from fermentation; and it is evident that the knowledge of either of these must lead to accurate conclusions concerning the nature and composition of the other. From these considerations, it became necessary accurately to determine the constituent elements of the fermentable substances; and, for this purpose, I did not make use of the compound juices of fruits, the rigorous analysis of which is perhaps impossible, but made choice of sugar, which is easily analyzed, and the nature of which I have already explained. This substance is a true vegetable oxide, with two bases, composed of hydrogen and carbon, brought to the state of an oxide by means of a certain proportion of oxygen; and these three elements are combined in such a way that a very slight force is sufficient to destroy the equilibrium of their connection."

After giving the details of his analysis of sugar and of the products of fermentation, Lavoisier continues:

"The effect of the vinous fermentation upon sugar is thus reduced to the mere separation of its elements into two portions; one part is oxygenated at the expense of the other, so as to form carbonic acid; while the other part, being disoxygenated in favor of the latter, is converted into the combustible substance called alcohol; therefore, if it were possible to re-unite alcohol and carbonic acid together, we ought to form sugar."*

Thus Lavoisier thought he had demonstrated that the carbonic acid and the alcohol, which are produced by the process of fermentation, are equal in weight to the sugar which disappears; but the application of the more refined methods of modern chemistry to the investigation

* Elements of Chemistry. By M. Lavoisier. Translated by Robert Kerr. Second edition; 1793 (pp. 186-196).

of the products of fermentation by Pasteur, in 1860, proved that this is not exactly true, and that there is a deficit of from five to seven per cent of the sugar which is not covered by the alcohol and carbonic acid evolved. The greater part of this deficit is accounted for by the discovery of two substances, glycerine and succinic acid, of the existence of which Lavoisier was unaware, in the fermented liquid. But about one and one-half per cent still remains to be made good. According to Pasteur, it has been appropriated by the yeast, but the fact that such appropriation takes place cannot be said to be actually proved.

However this may be, there can be no doubt that the constituent elements of fully ninety-eight per cent of the sugar which has vanished during fermentation have simply undergone rearrangement; like the soldiers of a brigade, who at the word of command divide themselves into the independent regiments to which they belong. The brigade is sugar, the regiments are carbonic acid, succinic acid, alcohol and glycerine.

From the time of Fabroni, onward, it has been admitted that the agent by which this surprising rearrangement of the particles of the sugar is effected is the yeast. But the first thoroughly conclusive evidence of the necessity of yeast for the fermentation of sugar was furnished by Appert, whose method of preserving perishable articles of food excited so much attention in France at the beginning of this century. Gay-Lussac, in his Mémoir sur la Fermentation,* alludes to Appert's method of preserving beer-wort unfermented for an indefinite time, by simply boiling the wort and closing the vessel in which the boiling fluid is contained in such a way as thoroughly to exclude air; and he shows that if a little yeast be introduced into such wort, after it has cooled, the wort at once begins to ferment, even though every precaution be taken to exclude air. And this statement has since received full confirmation from Pasteur.

On the other hand, Schwann, Schroeder and Dusch, and Pasteur, have amply proved that air may be allowed to have free access to beer-wort, without exciting fermentation, if only sufficient precautions are taken to prevent the entry of particles of yeast along with the air.

Thus, the truth that the fermentation of a simple solution of sugar in water depends upon the presence of yeast, rests upon an unassailable foundation; and the inquiry into the exact nature of the substance which possesses such a wonderful chemical influence becomes profoundly interesting.

* Annales de Chimie, 1810.

The first step toward the solution of this problem was made two centuries ago by the patient and painstaking Dutch naturalist, Leeuwenhoek, in the year 1680.*

Leeuwenhoek discovered that yeast consists of globules floating in a fluid; but he thought that they were merely the starchy particles of the grain, from which the wort was made, rearranged. He discovered the fact that yeast has a definite structure, but not the meaning of the fact. A century and a half elapsed, and the investigation of yeast was recommenced almost simultaneously by Cagniard de la Tour, in France, and by Schwann and Kützing, in Germany. The French observer was the first to publish his results; and the subject received at his hands, and at those of his colleague, the botanist Turpin, full and satisfactory investigation.

The main conclusions at which they arrived are these: The globular or oval corpuscles, which float so thickly in the yeast as to make it muddy, though the largest are not more than one-two-thousandth of an inch in diameter, and the smallest may measure less than one-seven-thousandth of an inch, are living organisms. They multiply with great rapidity, by giving off minute buds, which soon attain the size of their parent, and then either become detached or remain united, forming the compound globules of which Leeuwenhoek speaks, though the constancy of their arrangement in sixes existed only in the worthy Dutchman's imagination.

It was very soon made out that these yeast organisms, to which Turpin gave the name of *Torula cerevisiæ*, were more nearly allied to the lower Fungi than to anything else. Indeed Turpin, and, subsequently, Berkeley and Hoffmann, believed that they had traced the development of the *Torula* into the well-known and very common mould — the *Penicillium glaucum*. Other observers have not succeeded in verifying these statements; and my own observations lead me to believe that, while the connection between *Torula* and the moulds is a very close one, it is of a different nature from that which has been supposed. I have never been able to trace the development of *Torula* into a true mould, but it is quite easy to prove that species of true mould, such as *Penicillium*, when sown in an appropriate nidus, such as a solution of tartrate of ammonia and yeast-ash, in water, with or without sugar, give rise to *Torulæ* similar in all respects to *T. cerevisiæ*, except that they are, on the average, smaller. Moreover, Bail has observed the development of

* Leeuwenhoek, Arcana Naturæ Detecta. Ed. Nov., 1721.

a *Torula* larger than *T. cerevisiæ*, from a *Mucor*, a mould allied to *Penicillium*.

It follows, therefore, that the *Torulæ*, or organisms of yeast, are veritable plants; and conclusive experiments have proved that the power which causes the rearrangement of the molecules of the sugar is intimately connected with the life and growth of the plant. In fact, whatever arrests the vital activity of the plant also prevents it from exciting fermentation.

Such being the facts with regard to the nature of yeast, and of the changes which it effects on sugar, how are they to be accounted for? Before modern chemistry had come into existence, Stahl, stumbling with the stride of genius upon the conception which lies at the bottom of all modern views of the process, put forward the notion that the ferment, being in a state of internal motion, communicated that motion to the sugar, and thus caused its resolution into new substances. And Lavoisier, as we have seen, adopts substantially the same view. But Fabroni, full of the then novel conception of acids and bases and double decompositions, propounded the hypothesis that sugar is an oxide with two bases, and the ferment a carbonate with two bases; that the carbon of the ferment unites with the oxygen of the sugar, and gives rise to carbonic acid; while the sugar, uniting with the nitrogen of the ferment, produces a new substance analogous to opium. This is decomposed by distillation, and gives rise to alcohol. Next, in 1803, Thénard propounded a hypothesis which partakes somewhat of the nature of both Stahl's and Fabroni's views. "I do not believe with Lavoisier," he says, "that all the carbonic acid formed proceeds from the sugar. How, in that case, could we conceive the action of the ferment on it? I think that the first portions of the acid are due to a combination of the carbon of the ferment with the oxygen of the sugar, and that it is by carrying off a portion of oxygen from the last, that the ferment causes the fermentation to commence — the equilibrium between the principles of the sugar being disturbed, they combine afresh to form carbonic acid and alcohol."

The three views here before us may be familiarly exemplified by supposing the sugar to be a card-house. According to Stahl, the ferment is somebody who knocks the table, and shakes the card-house down; according to Fabroni, the ferment takes out some cards, but puts others in their places; according to Thénard, the ferment simply takes a card out of the bottom story, the result of which is that all the others fall.

As chemistry advanced, facts came to light which put a new face upon Stahl's hypothesis, and gave it a safer foundation than it previously possessed. The general nature of these phenomena may be thus stated: A body, A, without giving to or taking from another body, B, any material particles, causes B to decompose into other substances, C, D, E, the sum of the weights of which is equal to the weight of B, which decomposes.

Thus, bitter almonds contain two substances, amygdalin and synaptase, which can be extracted, in a separate state, from the bitter almonds. The amygdalin thus obtained, if dissolved in water, undergoes no change; but if a little synaptase is added to the solution, the amygdalin splits up into bitter almond oil, prussic acid and a kind of sugar.

A short time after Cagniard de la Tour discovered the yeast plant, Liebig, struck with the similarity between this and other such processes and the fermentation of sugar, put forward the hypothesis that yeast contains a substance which acts upon sugar, as synaptase acts upon amygdalin; and, as the synaptase is certainly neither organized nor alive, but a mere chemical substance, Liebig treated Cagniard de la Tour's discovery with no small contempt, and, from that time to the present, has steadily repudiated the notion that the decomposition of the sugar is in any sense the result of the vital activity of the *Torula*. But, though the notion that the *Torula* is a creature which eats sugar and excretes carbonic acid and alcohol, which is not unjustly ridiculed in the most surprising paper that ever made its appearance in a grave scientific journal,* may be untenable, the fact that the *Torulæ* are alive, and that yeast does not excite fermentation unless it contains living *Torulæ*, stands fast. Moreover, of late years, the essential participation of living organisms in fermentation other than the alcoholic, has been clearly made out by Pasteur and other chemists.

However, it may be asked, is there any necessary opposition between the so-called "vital" and the strictly physico-chemical views of fermentation? It is quite possible that the living *Torula* may excite

* "Das entrathselte Geheimniss der Geistigen Gahrung (Vorlaufige briefliche Mittheilung)" is the title of an anonymous contribution to Wohler and Liebig's "Annalen der Pharmacie" for 1839, in which a somewhat Rabelaisian imaginary description of the organization of the "yeast animals," and of the manner in which their functions are performed, is given with a circumstantiality worthy of the author of Gulliver's Travels. As a specimen of the writer's humour, his account of what happens when fermentation comes to an end may suffice: "Sobald namlich die Thiere keinen Zucker mehr vorfinden, so fressen sie sich gegenseitig selbst auf, was durch eine eigne Manipulation geschicht; alles wird verdaut bis auf die Eier, welche unveraudert durch den Darmkanal hingehen; man hat zuletzt wieder gahrungs-fahige Hefe, namlich den Saamen der Thiere, der ubrig bleibt."

fermentation in sugar, because it constantly produces, as an essential part of its vital manifestations, some substance which acts upon the sugar, just as the synaptase acts upon the amygdalin. Or it may be that, without the formation of any such special substance, the physical condition of the living tissue of the yeast plant is sufficient to effect that small disturbance of the equilibrium of the particles of the sugar which Lavoisier thought sufficient to effect its decomposition.

Platinum in a very fine state of division — known as platinum black, or *noir de platine* — has the very singular property of causing alcohol to change into acetic acid with great rapidity. The vinegar plant, which is closely allied to the yeast plant, has a similar effect upon dilute alcohol, causing it to absorb the oxygen of the air, and become converted into vinegar; and Liebig's eminent opponent, Pasteur, who has done so much for the theory and the practice of vinegar-making, himself suggests that in this case—

"La cause du phénomène physique qui accompagne la vie de la plante reside dans un état physique propre, analogue à celui du noir de platine. Mais il est essential de remarquer que cet état physique de la plante est étroitement lié avec la vie de cette plante." *

Now, if the vinegar plant gives rise to the oxidation of alcohol, on account of its merely physical constitution, it is at any rate possible that the physical constitution of the yeast plant may exert a decomposing influence on sugar.

But, without presuming to discuss a question which leads us into the very arcana of chemistry, the present state of speculation upon the *modus operandi* of the yeast plant in producing fermentation is represented, on the one hand, by the Stahlian doctrine, supported by Liebig, according to which the atoms of the sugar are shaken into new combinations, either directly by the *Torulæ*, or indirectly by some substance formed by them; and, on the other hand, by the Thénardian doctrine, supported by Pasteur, according to which the yeast plant assimilates part of the sugar, and, in so doing, disturbs the rest, and determines its resolution into the products of fermentation. Perhaps the two views are not so much opposed as they seem at first sight to be.

But the interest which attaches to the influence of the yeast plants upon the medium in which they live and grow does not arise solely from its bearing upon the theory of fermentation. So long ago as 1838, Turpin compared the *Torulæ* to the ultimate elements of the tissues of animals and plants: "Les organes élémentaires de leurs

* Etudes sur les Mycodermes, Comptes-Rendus, liv., 1862.

tissus, comparables aux petits végétaux des levures ordinaires, sont aussi les décompositours des substances qui les environment."

Almost at the same time, and, probably, equally guided by his study of yeast, Schwann was engaged in those remarkable investigations into the form and development of the ultimate structural elements of the tissues of animals, which led him to recognize their fundamental identity with the ultimate structural elements of vegetable organisms.

The yeast plant is a mere sac, or "cell," containing a semi-fluid matter, and Schwann's microscopic analysis resolved all living organisms, in the long run, into an aggregation of such sacs or cells, variously modified; and tending to show that all, whatever their ultimate complication, begin their existence in the condition of such simple cells.

In his famous "Mikroskopische Untersuchungen," Schwann speaks of *Torula* as a "cell," and, in a remarkable note to the passage in which he refers to the yeast plant, Schwann says:

"I have been unable to avoid mentioning fermentation, because it is the most fully and exactly known operation of cells, and represents, in the simplest fashion, the process which is repeated by every cell of the living body."

In other words, Schawnn conceives that every cell of the living body exerts an influence on the matter which surrounds and permeates it, analogous to that which a *Torula* exerts on the saccharine solution by which it is bathed: a wonderfully suggestive thought, opening up views of the nature of the chemical processes of the living body, which have hardly yet received all the development of which they are capable.

Kant defined the special peculiarity of the living body to be that the parts exist for the sake of the whole and the whole for the sake of the parts. But when Turpin and Schwann resolved the living body into an aggregation of quasi-independent cells, each like a *Torula*, leading its own life and having its own laws of growth and development, the aggregation being dominated and kept working toward a definite end only by certain harmony among these units, or by the superaddition of a controlling apparatus, such as a nervous system, this conception ceased to be tenable. The cell lives for its own sake, as well as for the sake of the whole organism; and the cells, which float in the blood, live at its expense, and profoundly modify it, are almost as much independent organisms as the *Torulæ* which float in beer-wort.

Schwann burdened his enunciation of the "cell theory" with two false suppositions; the one, that the structures he called "nucleus" and "cell-wall" are essential to a cell; the other, that cells are usually formed independently of other cells; but, in 1839, it was a vast and clear gain to arrive at the conception, that the vital functions of all the higher animals and plants are the resultant of the forces inherent in the innumerable minute cells of which they are composed, and that each of them is, itself, an equivalent of one of the lowest and simplest of independent living beings—the *Torula.*

From purely morphological investigations, Turpin and Schwann, as we have seen, arrived at the notion of the fundamental unity of structure of living beings. And, before long, the researches of the chemists gradually led up to the conception of the fundamental unity of their composition.

So far back as 1803, Thénard pointed out, in most distinct terms, the important fact that yeast contains a nitrogenous "animal" substance; and that such substance is contained in all ferments. Before him, Fabroni and Fourcroy speak of the "vegeto-animal" matter of yeast. In 1844 Mulder endeavored to demonstrate that a peculiar substance, which he called "protein," was essentially characteristic of living matter.

In 1846, Payen writes:

"Enfin, une loi sans exception me semble apparaître dans les faits nombreux que j'ai observés et conduire à envisager sous un nouveau jour la vie végétale; si je ne m'abuse, tout ce que dans les tissus végétaux la vue directe où amplifiée nous permet de discerner sous la forme de cellules et de vaisseaux, ne représente autre chose que les enveloppes protectrices, les réservoirs et les conduits, à l'aide desquels les corps animés qui les secrètent et les façonnent, se logent, puisent et charrient leurs alimens, déposent et isolent les matières excrétées."

And again:

"Afin de compléter aurjourd'hui l'énoncé du fait général, je rappellerai que les corps, doué des fonctions accomplies dans les tissus des plantes, sont formés des elemens qui constituent, en proportion peu variable, les organismes animaux; qu'ainsi l'on est conduit à reconnaître une immense unité de composition élémentaire dans tous les corps vivants de la nature."*

In the year (1846) in which these remarkable passages were published, the eminent German botanist, Von Mohl, invented the word "protoplasm" as a name for one portion of those nitrogenous con-

* Mem. sur les Developpements des Vegetaux, etc. Mem. Presentees, ix. 1846.

tents of the cells of living plants, the close chemical resemblance of which to the essential constituents of living animals is so strongly indicated by Payen. And through the twenty-five years that have passed, since the matter of life was first called protoplasm, a host of investigators, among whom Cohn, Max Schulze and Kühe, must be named as leaders, have accumulated evidence, morphological, physiological and chemical, in favor of that "immense unité de composition élémentaire dans tous les corps vivants de la nature," into which Payen had, so early, a clear insight.

As far back as 1850, Cohn wrote, apparently without any knowledge of what Payen had said before him:

"The protoplasm of the botanist, and the contractile substance and sarcode of the zoologist must be, if not identical, yet in a high degree analogous substances. Hence, from this point of view, the difference between animals and plants consists in this, that, in the latter, the contractile substance, as a primordial utricle, is inclosed within an inert cellulose membrane, which permits it only to exhibit an internal motion, expressed by the phenomena of rotation and circulation, while in the former it is not so inclosed. The protoplasm in the form of the primordial utricle is, as it were, the animal element in the plant, but which is imprisoned and only becomes free in the animal; or, to strip off the metaphor which obscures the simple thought, the energy of organic vitality which is manifested in movement is especially exhibited by a nitrogenous contractile substance, which in plants is limited and fettered by an inert membrane, in animals not so."*

In 1868, thinking that an untechnical statement of the views current among the leaders of biological science might be interesting to the general public, I gave a lecture embodying them in Edinburgh. Those who have not made the mistake of attempting to approach biology either by the high *à priori* road of mere philosophical speculation, or by the mere low *à posteriori* lane offered by the tube of a microscope, but have taken the trouble to become acquainted with well ascertained facts and with their history, will not need to be told that in what I had to say "as regards protoplasm," in my lecture "On the Physical Basis of Life," there was nothing new; and, as I hope, nothing that the present state of knowledge does not justify us in believing to be true.

As we have seen, the study of yeast has led investigators face to face with problems of immense interest in pure chemistry, and in

* Cohn, Ueber Protococcus pluvialis, in the "Nova Acta for 1850.

animal and vegetable morphology. Its physiology is not less rich in subjects for inquiry. Take, for example, the singular fact that yeast will increase indefinitely when grown in the dark, in water containing only tartrate of ammonia, a small per centage of mineral salts and sugar. Out of these materials the *Torulæ* will manufacture nitrogenous protoplasm, cellulose and fatty matters, in any quantity, although they are wholly deprived of those rays of the sun, the influence of which is essential to the growth of ordinary plants. There has been a great deal of speculation lately, as to how the living organisms buried beneath two or three thousand fathoms of water, and therefore in all probability almost deprived of light, live. If any of them possess the same power as yeast (and the same capacity for living without light is exhibited by some other fungi), there would seem to be no difficulty about the matter.

Of the pathological bearings of the study of yeast and other such organisms, I have spoken elsewhere. It is certain that, in some animals, devastating epidemics are caused by fungi of low order—similar to those of which *Torula* is a sort of offshoot. It is certain that such diseases are propagated by contagion and infection, in just the same way as ordinary contagious and infectious diseases are propagated. Of course, it does not follow from this that all contagious and infectious diseases are caused by organisms of as definite and independent a character as the *Torula;* but, I think, it does follow that it is prudent and wise to satisfy oneself, in each particular case, that the "germ theory" cannot and will not explain the facts, before having recourse to hopotheses which have no equal support from analogy.

Adjourned.

February 16, 1872.

Prof. S. D. Tillman, in the chair; Robert Weir, Esq., Secretary.

Blowing off Steam.

Mr. J. K. Fisher inquired how much water would be blown off with the steam from a field boiler.

Dr. P. H. Van der Weyde—You may blow the boiler empty.

Mr. T. D. Stetson—It is a question of time. If you blow off rapidly, the steam mixed with the water will throw the water out, and that is what takes place in an explosion. If you blow off slowly, you will leave the boiler nearly full.

Mr. J. K. Fisher — If the steam is at 370 degrees, the water itself would contain heat enough to evaporate about one-seventh of the water, when the pressure is removed. But will not some of the water be blown off with the steam in the shape of foam, and how much?

Mr. John B. Root — I have seen it done a number of times, and I have never seen over twenty-five per cent of the water blown off under the best circumstances.

Dr. P. H. Van der Weyde — At 350 degrees you have 138 degrees surplus of heat in the water. Dividing by 966 shows that exactly one-seventh is evaporated.

STEAM BOILER EXPLOSIONS.

Dr. Van der Weyde — I wish to report a curious attempt at a boiler explosion that took place at Williamsburgh, yesterday, at the new gas-house. The workmen were alarmed by a shock in one of the upright tubular boilers, and they at once stopped work and drew the fire. It was a very high boiler, with interior vertical tubes, surmounted by a dome. The water stood around the tubes and the fire passed through them. They found, on examination, that several of the tubes had sunk down, making a depression both at the top and the bottom; but there was no leak. Now, what was the cause of that? I ascribed it to scale, which had formed at the bottom and allowed the iron to become very hot and soft, and, probably, the weight of the water forced it down, drawing down the crown sheet with it.

Mr. J. B. Root — If there was scale deposited upon the bottom of that boiler, allowing the lower part of the bottom plate to be heated fifty to 100 degrees hotter than the upper side, that difference of temperature would cause it to bulge down.

ELLIS'S BI-SULPHIDE OF CARBON ENGINE.

Dr. Van der Weyde — Mr. Ellis, of Boston, has lately constructed a bi-sulphide of carbon engine, using the waste steam from the engine to heat the bi-sulphide of carbon, and work another piston attached to the same engine. There have been two objections made to this, which I wish to answer. One objection is that we might just as well have two steam cylinders, making a compound engine, the steam from a high pressure engine working a low pressure engine. The other objection is, that if we are to use the bi-sulphide of carbon, we do not need the steam, and I will reply to this objection first. Volatile substances require very little heat to convert them into vapor. Water requires a temperature of 212° to vaporize at atmospheric pressure, and 966 units of heat become latent. But ether will vaporize at 96°, and only 165 units of heat are required. That is an amazing saving of fuel. On that idea, some fifteen years ago, an ether engine was built at the Novelty Works in New York. But practical difficulties came up. First, it was difficult to get the joints tight; and when it leaked it took fire, and alarmed every one. Another difficulty was that the latent heat was so much by weight, and the vapor of ether is nearly seven times as heavy as steam. It is a curious property of vapors, that whatever the temperature of vaporization, and whatever amount of heat becomes latent, in units, the amount of latent heat in a cubic foot of vapor is always the same; and as engines are driven, not by the weight of the vapor but by its volume, that takes away all the supposed advantage of volatile fluids with regard to their latent heat.

The first objection was that we might as well use the steam from a high pressure engine to drive a low pressure engine. The simple answer to that is, that all the pressure you get from the waste steam becomes back pressure on the first engine, and you have all the machinery and friction for nothing. But if you pass your waste steam freely through tubes which heat bi-sulphides of carbon, there is no back pressure, and the pressure you obtain from the vaporization of the bi-sulphide of carbon is a clear gain. Fairbank & Dunkin in England founded a method of judging of the performance of steam engines, by measuring the water of condensation, as it was done in the recent trial at the American Institute Fair. In the best steam engine, the water condensation is warmed somewhat, and that amount of heat is lost. Now let us see what is the pressure with different vapors:

Ether.	Bi-Sulphide of Carbon.	Water.	Pressure.
95 degrees.....	110 degrees.....	212 degrees.....	1 atmosphere.
115 degrees.....	130 degrees.....	240 degrees.....	2 "
125 degrees.....	140 degrees.....	265 degrees.....	3 "
133 degrees.....	148 degrees.....	280 degrees.....	4 "

Now, if we take the steam at 212, you see that it will produce a pressure of much more than four atmospheres in the bi-sulphide of carbon. It is asserted that, by this engine, a nearer approach has been made to theoretic perfection, in the power produced, than ever before.

Mr. J. K. Fisher — What is the odor of bi-sulphide of carbon?

Dr. Van der Weyde — It is very offensive, and has a paralyzing effect upon some parts of the system; but it is confined to the condensing engine, and ought not to get out.

The President — Mr. Hughes, formerly of Rochester, undertook to use the heat from waste steam to evaporize the bi-sulphide of carbon, and after a great many trials, made sixteen years ago, came to the conclusion that the same amount of heat applied to water would do just about as much.

Mr. T. D. Stetson — Mercury boils at about 600° Fahr.; sulphuric acid at about 300°; water at 212°; alcohol at 180°; bi-sulphide of carbon at 110°; sulphuric ether at about 90°; the hydrocarbons at different temperatures down to 32° F.; and carbonic acid at 148° below zero. It is impossible in practice to communicate all the heat from one fluid to another, but by passing it through very small tubes and thin vessels we may transfer a large part of it. Now, suppose we make our fire under a boiler to volatilize mercury at 600° and upwards, and exhaust right down to atmospheric pressure. Then we may take the exhaust from the mercury, and obtain a vapor from sulphuric acid, which will give us additional power. Exhaust from that to atmospheric pressure, and it will make steam at 300°, a pressure of four or five atmospheres. The exhaust steam at 212° gives us a pressure of several atmospheres in heating bi-sulphide of carbon; and so we may go on, step by step, down the scale until we reach a point where we shall find a difficulty in condensing; for something will depend upon our supply of cold. Working in the winter, on the banks of the river, with an unlimited supply of ice-cold water, we may go down nearly to 32°, perhaps; but ordinarily we may have to stop at 70 or 80°.

I have carried this out to extremes, to illustrate the principle. The reason why we do not adopt this method of working is that it don't pay. It costs too much for the apparatus, for the wear and tear, and for the attendance. The nearest approach to this bi-sulphide of carbon engine is the Dr. Trombly engine, in which sulphuric ether was used, heated by the exhaust steam. This was introduced in a large steamer running upon the Mediterranean, the water of which was cold enough to condense the ether. It required a good deal of condensing surface, and that is one of the difficulties of this method of working; but he did the work, saved his ether, and used it over and over again, with a considerable increase of power. I presume the difficulty in that case was the same as in all analogous cases, in making it pay.

We must consider the first cost of the apparatus, the interest upon it, the risk of losing it by wreck or blowing up, or by some chance of business; then we must allow for attendance and repairs; then there is the bulk of the fuel and machinery, and their weight, to be taken into account. That, in a steamer, makes a tremendous draw-back in the loss of freight and passengers. If you carry the principle far enough, you will fill your steamer all up, and its whole business will be paddling along. There have been some efforts to make six-day ships for crossing the Atlantic, sacrificing everything to speed; but they put none of these traps into those ships, I assure you. Although we may get economy of fuel, almost without limit, by duplicating the apparatus in this way, it don't pay.

Dr. Van der Weyde—Another point. In heating water from 212° to about 248°, you double the pressure, so that at least 2° are necessary for every pound of additional pressure. But if you heat it to 500°, where the pressure is fifty atmospheres, then 15° will produce fifteen atmospheres more pressure, or a whole atmosphere for every degree. Here we have to keep the water at 500° and upward, but there are other liquids that do not require that temperature. Take the liquified carbonic acid gas, which boils at 148° below zero. Heat it to 100° below zero and you have two atmospheres pressure; an additional atmosphere for about 48°. But heat it to 32° and you have thirty-two atmospheres, and at 50° you have fifty atmospheres, making a whole atmosphere for every degree. It is only necessary, then, to maintain the ordinary atmospheric temperatures, and in the summer all you have to do is to heat with the atmospheric temperature and to cool with ice. Your engine will require no coal. But you will have this drawback, that melting ice only consumes 140 units of heat, whereas the combustion of coal gives out 14,000 units of heat. For every pound of coal, therefore, you will want 100 pounds of ice; and ice is not so easy to keep, especially in summer, as coal. Another difficulty is that the boiler must be strong enough to stand fifty to sixty-five atmospheres of pressure. Of course this whole plan is intensely absurd; but as Cicero said that no theory was so absurd that no man would adopt it, so in mechanics, no plan is so absurd that no one will try to carry it out; and there is a young gentleman now endeavoring to carry out this plan. He will have a back pressure of fifty atmospheres on his piston — a very respectable back pressure.

Mr. Root—It seems to be the opinion both of Dr. Van der Weyde and of Mr. Stetson, that there is really a gain in using two liquids, one boiling at a lower point than the other. To my mind that is not so. I have drawn here two diagrams of cards taken from the Boston engine. The first cylinder cuts off at half stroke. Now, I will agree to take the power thrown away at that first cylinder, and, by carrying the expansion up to its limit, obtain all the power that is obtained from the bi-sulphide of carbon, and at a less expense. The same principle will apply in every step, beginning with mercury, if you please. Here is the mercury diagram, expanding right down to the line. That fills a cylinder of a certain size. Exhaust that into another cylinder, and it will require so much the more area. You can go on indefinitely; but you are merely saving the power you have thrown away. I admit that increasing the pressure, the same difference of temperature produces a greater difference of pressure; but we must take into consideration that if we increase the pressure six times we have only one-sixth the volume, and it requires six times as many units of heat to change the temperature; so that when we come to calculate the power of the engine, the effect is the same in both cases. If you expand steam, under a pressure of sixty pounds, the effect will be the same as expanding it in a cylinder of four times the area under a pressure of fifteen pounds. It seems to me that the whole thing is explained by the principle stated by Dr. Van der Weyde at the outset of his remarks, that whatever the liquid, it takes the same number of units of heat to make the same volume. Consequently there cannot possibly be any economy in using different fluids.

Dr. Van der Weyde—The gentleman mixed up latent heat and temperature. The latent heats are alike, but not the temperatures.

Mr. John B. Root—You leave out of view the fact that you cannot increase the volume; that you cannot make any more volume with the same amount of heat, from bi-sulphide of carbon than from steam; and unless you can make a great volume, you cannot make a greater pressure.

The President—The chair understood Dr. Van der Weyde to take the same ground, with regard to volume, at first.

Dr. Van der Weyde—The latent heat required to change a liquid into vapor is entirely independent of the temperature at which it boils. Steam at 212° coming in contact with bi-sulphide of carbon, which boils at 110°, the bi-sulphide of carbon will flash into vapor. This will condense the steam into water; and 966 units of latent heat will be given out, of which 190 units will be absorbed by every pound of the bi-sulphide of carbon, and produce some four atmospheres pressure in exchange for the waste steam without pressure. The advantage is in favor of the bi-sulphide of carbon at every step.

The President—There was a hot-air engine brought here from Boston some years ago which gained fifty per cent by using the discharged hot air in making steam; and it was suggested that by applying all the heat to water instead of the air they might gain the other fifty per cent. (Laughter.)

Mr. J. K. Fisher—The great difficulty about Dr. Trombly's engine was that they could not prevent leakage, and it interfered with the health of the men.

The President—Ericsson's hot-air ship would not go without a great deal of oil!

Mr. J. K. Fisher—I do not believe you can do any more with ether or bi-sulphide of carbon than with the hot water that comes from the condenser. I do not think there is any gain in using the bi-sulphide of carbon.

A member suggested that the application of the principle that artificial draft produces great economy of fuel, to hot air engines, would extend their usefulness.

Mr. J. B. Root—That principle was admitted here in the former discussion, but I think it is a mistake.

Separating Cockles from Wheat.

Mr. Henry, of Tennessee, described a new apparatus by means of which cockles are separated from wheat. There are two cylindrical rollers, about eight inches in diameter, one of which is of iron and the other of vulcanized rubber. The cockle, being a rough grain, imbeds itself in the rubber, and is carried over and swept off. The cockle is of as large diameter as the wheat, and it has hitherto been difficult to separate it. It poisons hogs and poultry, and no use has been found for it after it is separated from the wheat.

Danks' Puddling Furnace.

Mr. Samuel Danks explained his new puddling furnace, which substitutes steam for man power. He had conceived the idea in 1856, and in 1857 was nearly ready to start when the financial crash stopped his operations. He has recently carried the plan into successful operation. The iron is placed in a hollow cylinder, hung and revolving upon an axis at right angles to its central line, so that the melted metal is thrown from end to end at each half revolution. By this process, five tons can be as readily puddled at once by steam power as 500 pounds could formerly by hand. The result is shown at Chattanooga to be the removal of impurities more perfectly than ordinary puddling. The phosphorus is entirely removed by the new process. The iron may be heated to a higher temperature than it can be worked at in hand puddling. The furnace is lined with the oxide of iron, and instead of losing fifteen to twenty per çent by the process, it is found that there is actually a gain of seven to ten per cent. Ordinarily, we can make two to two and one-half tons before re-lining.

Dr. P. H. Van der Weyde—I was not aware, until to-night, that the oxide of iron was used for the lining. That is a most beautiful method, for the oxide of iron is itself partly reduced, and there is a gain instead of a loss in the charge.

Mr. J. K. Fisher—How large a mass of iron can you make, to roll into a boiler plate, for example?

Mr. Danks—There is scarcely a limit to the size of the puddled ball. It depends upon the apparatus for reducing the lump. The iron is more perfectly puddled than it possibly can be by man power.

Dr. Van der Weyde—I suppose it is as homogeneous as Bessemer steel?

Mr. Danks—A puddled ball is always homogeneous and crystalline. The fiber is due to the elongation of the crystals by rolling and hammering. If you wish to retain a portion of the carbon, you can stop the puddling process at any stage you choose, and then you will have steel; and that will remain steel, without showing fiber, through a great number of workings. Or we can make the finest quality of iron. We can make an iron that will bear a tensile strain of 70,000 pounds, when the same material treated in the ordinary furnace will not bear more than 50,000 pounds, for the simple reason that the puddling is more complete. In the old hand process, the iron was liable to have faults, and it was necessary, therefore, to weld several bars together to make it homogeneous. In this, that is unnecessary.

The President—What is the cost of the puddling, as compared with the hand process?

Mr. Danks—It is about one-half, depending upon the quantity produced. It takes about the same number of men to man the furnace, but the labor is less. It will bring another class of men into the puddling field, for I have not found many of the old puddlers of any use. I have found that a good man from the machine shop would make a better puddler than the old puddlers, for the reason that the latter will stick to the old ideas.

Mr. T. D. Stetson—In making balls of 700 or 800 pounds weight, how much does the whole revolving mass weigh, charge and all?

Mr. Danks—The cylinder is about six feet in diameter on the outside and four and a half feet long. The whole weighs about five tons. We have a pair of engines for each furnace. Several velocities are necessary, and also a reverse. The axis rests upon four rollers, so that the friction is not very great. When we are refining, a slow motion is necessary.

The President—Have you built any in England?

Mr. Danks—The iron and steel manufacturers sent a commission, who brought about sixty tons of material, and have tested the proccss and made a favorable report.

The President read the following paper

On True Musical Intonation.

By Samuel D. Tillman, LL.D.

The pleasing effect of harmony arises from simultaneous impressions made upon the organs of hearing. Air-waves producing such impressions have a definite relation to each other, expressed by ratios which contain no higher prime number than seven. Taking any musical sound as the tonic, we find it is produced by a fixed number of air-waves within a given time, and that the octave or eighth sound above in the diatonic scale is produced by just double the number of waves or pulsations in the same time. These two series of waves whose relation is expressed by 1:2, produce sounds so nearly resembling each other that they form the limits of the diatonic scale. The tonic is the first of a series of seven sounds, and the octave is the first of similar series of seven sounds, each of which is an octave above the corresponding sound in the first series. On comparing six sounds of the septave with the first or fundamental sound, we obtain the following ratios: tonic and dominant or the fifth, 2:3; tonic and subdominant or the fourth, 3:4; tonic and mediant or the third, 4:5; tonic and submediant or the sixth, 3:5; tonic and supertonic or the second, 8:9; tonic and subtonic or the seventh, 8:15.

When heard in their proper order each sound has a relation to the next, which enables us to indicate the seven intervals by the following series:

$$\tfrac{9}{8}\quad \tfrac{10}{9}\quad \tfrac{16}{15}\quad \tfrac{9}{8}\quad \tfrac{10}{9}\quad \tfrac{9}{8}\quad \tfrac{16}{15}.$$

Taking the first three, we find their differences indicated by $\frac{1}{8}$, $\frac{1}{9}$ and $\frac{1}{15}$; these fractions reduced to a common denominator give, $\frac{135}{1080}$, $\frac{135}{1080}$, $\frac{72}{1080}$; dividing the numerators by 3 we obtain as the measure of the first interval (a major-tone), 45; as the measure of the second interval (a minor tone), 40; and as the measure of the third interval (a so-called semitone), 24. Substituting these values in the remainder of the series, we have the septave intervals measured by the following whole numbers, 45, 40, 24, 45, 40, 45, 24; and the sum of these numbers, 263, measures the interval from the tonic to its octave. The interval of the major third is measured by 85; the fourth by 109; the fifth by 154, and the sixth by 194. Each of these sounds harmonizes with the tonic. If C is taken as the tonic, the intervals made by D, E, F, G, A, B, are measured by 45, 40, 24, 45, 40, 45, 24; but these sounds of the natural key cannot all be used when the position of the tonic is changed. In the progress of modulation, the major and minor intervals are subdivided by flats and sharps, and finally other sounds are introduced in place of those indicated by letters. In order to obviate this difficulty, and to use the smallest number of sounds possible in modulations, the true notes are tempered so as to permit the same sound to be used in several keys. By this method, the twelve so-called semitone intervals, made on keyed instruments, fulfill the required conditions. When the temperament is isotonic, these intervals are of the same length. The amount of temperament thus required is shown by the following comparison of the several intervals: True scale 45, 40, 24, 45, 40, 45, 24 = 263. Tempered scale 44, 44, 22, 44, 44, 44, 22 = 264. The fourths and fifths are seen to be nearly correct in every key, while the thirds are very discordant. The temperament of the fifth is one-twelfth of a comma where fifty-three such commas measure the septave, and twelve-fifths measure the same distance as seven octaves, while in the true system, the sum of the intervals being 263, seven octaves are measured by 1841, and twelve fifths by 1848. The same point may be illustrated by the use of the mono-chord. Let a homogeneous musical string be of such diameter and length as to make the sound C designated by the note on the second leger line below the bass staff, two-thirds of its length will give the fifth above, which may be indicated by $\frac{2}{3}$, and one-third an octave above. A series of upward and downward measurements may be made, the sum of which is expressed by $\frac{2^{19}}{3^{12}}$, and a B♮ is thus obtained which is a little higher than the original sound C. If the string were divided to 531, 441 parts, the sound B♮ would be made by 524, 288 of those parts; its acuteness as compared with C would be measured by 7,153 parts. It is evident that the B♮ thus generated is not the B♮ used in the key of C♮

In the division of scale into fifty-three parts or commas, the difference between these notes is measured by two commas.

In order to ascertain the true intervals required in the thirteen keys used, I have prepared a table (portions of this table were presented on the black-board), in which the major tone interval is measured by forty-five, the minor tone by forty, and the so-called semitone interval by twenty-four; and for comparison these intervals are also measured by nine, eight and five respectively.

By this table it is shown that, to make seventeen perfect intervals, with the tonic in thirteen different positions, forty-six different sounds within the octave are required. If the correct intervals, measuring only five tones and two semitones in thirteen keys, are used, twenty-nine different sounds will suffice.

Many attempts have been made to construct musical instruments, played by keys, which would give true intonation with every change of the tonic. Among the organs actually constructed in which this plan has been partially carried out, may be mentioned those devised by the Rev. Henry Liston, of Scotland, in the early part of this century; that of Col. Thompson, of England, and that of Messrs. Alley and Poole, of Newburyport, Mass. Neither of these instruments has met with general approval.

I have devised a plan for bringing into use all the true sounds required for each tonic, by one motion, and so quickly, that the change may be made during the progress of any piece resembling in its movement ordinary church music. It may be applied to the melodeon, by the introduction of extra reeds; to the organ without increasing the number of pipes; and to the ordinary piano. No alteration in the key boards is required, since the change from one tonic to another is effected, by moving a single lever operated by the hand or foot. The mechanism required is somewhat complicated, and differs radically from any hitherto employed.

The pleasure to be derived from the use of such an instrument would be unalloyed, were there not a serious defect in the harmony belonging to one note of the true scale, which, in stringed instruments of violin class and wind instruments like the sliding trumpet and trombone, can be easily remedied; yet it is doubtful whether the remedy does not produce a confusion more to be dreaded than discord. I allude to two of the chords used with the supertonic. It is generally supposed that the fifth to the supertonic, is identical with the submediant; for example, in the natural key of C, the fifth to D is supposed to be A, yet it can be demonstrated that the true D and the true A do not harmonize. The intervals between these sounds are a minor tone, a semitone, a major tone and a minor tone, measured by thirty commas, while the true fifth is measured by thirty-one commas, and contains two major-tone intervals. The other doubtful chord is the supertonic and subdominant, or the sounds D and F of the natural key; this is the only instance in the true diatonic scale where a minor tone and a semitone form a minor third measured by thirteen commas, the other minor thirds being measured by fourteen commas. The effect of this combination is not so displeasing as that of the supertonic and the submediant. Moreover, when the submediant of a major mode becomes the tonic in the relative minor mode, the supertonic of the major key is a comma more acute than the true fourth of the minor mode. This could be remedied by the introduction of a new sound in the scale one comma higher than the submediant in one case, and a comma lower than the supertonic in the other, which would require an additional key or pedal to bring each sound into use; but the query arises, What would be the effect of introducing this A^1 when every other note and chord demands the true A generated from the tonic C? The answer can only come from those who are favored with educated ears highly sensitive to discords. It is for this class more especially that enharmonic instruments will be made. Very few, however, even of those who are not musicians, are unaffected by a "concord of sweet sounds." Pure harmony, unaccompanied by words, has the power of exciting and controlling human emotions. When invention has perfected instruments which will answer the human touch in true intonations, their introduction and general use will only be the work of time.

Dr. Van der Weyde commented on the paper of the President, and, confirmed the position maintained in it by demonstrating mathematically that the interval between the second and the sixth of the diatonic scale, if perfectly tuned, is less than a fifth, and, therefore, not a chord.

Adjourned.

February 23, 1872.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

High Pressure Steam Engines.

The Chairman—Before taking up the paper advertised for this evening, a word or two upon the steam-engine may not be out of place. I think it was to Emerson an Englishman said, some years ago, while advocating an international copyright law: "If you do not give us a copyright on our works, we shall, at any rate, educate your children." They have done it, on one subject at least, for their histories of great inventions and discoveries have been widely circulated in this country. English books are filed with statements which we know are not altogether true with regard to the origin and improvement of the steam-engine. The high pressure steam-engine, which is moved by heat alone, is an American invention. The low pressure or condensing engine is a European invention. It originated with Dr. Denis Papin, a French physician, in the year 1690. He used the pressure of the atmosphere to move the piston of a cylinder, within which was a vacuum resulting from the condensation of steam on the application of cold water to the outside of the cylinder. When the steam condensed, the pressure of the atmosphere brought down the piston. That was the first step in the invention of the condensing steam-engine. Other improvements of Papin were embraced in the first steam and atmospheric pumping engine, made by Newcomen and Savery, which was used in draining mines more than fifty years before Watt's invention. His improvement consisted in keeping the steam cylinder hot, by condensing the steam in another vessel. The rose jet, by which was forced in fine streams into the cylinder, for the purpose of condensing the steam, had been invented long before; so that the second cylinder introduced by Watt contained only the jet and piston, which were old devices. The steam cylinder was thus no longer exposed to the cooling effects of the condensing water. This was, of course, a great advance. Up to this time, 1770, and through nearly the whole of Watt's career, the steam engine had only been used for pumping water. The greatest improvement of the steam-engine in England was the invention of a boy named Humphrey Potter, who in 1715 made the machine self-acting. He was employed to move the valves by hand; finding that this was done when the walking beam reached its highest and lowest points, he simply fastened ropes to the beam which lifted the valves when required. Iron rods were afterwards substituted for ropes, and thus the machine was made automatic. Before Watt took out patents for his double-acting engine, and in fact during our Revolutionary war, Oliver Evans, of Philadelphia, devised an entirely new steam-engine. Many erroneous anecdotes have crept into the biographies of inventors; for example, that of Watt, which is accompanied by a picture of him as a little boy looking intently at the lid of a teapot, which was raised when the steam could not escape at the spout; yet Watt said he never thought of the power of steam until he was a full grown man. So the Marquis of Worcester, who never made a steam-engine, is represented as sitting by an old fashioned fire-place, watching the motions of the cover of a boiling pot. The story of the origin of the high pressure engine is more curious, and yet is not contradicted by any other statement. The brother of Evans and other boys were celebrating Independence day; having no gunpowder, they procured an old gun-barrel, stopped up the touch-hole, poured into the barrel a little water and drove a plug in the end, and placed the barrel in the fire of a blacksmith's forge. The plug was finally driven out with a loud report, and with such force as to go through the wooden side of the shop. From the account of that feat Evans first found out that great force can be obtained from the direct action of steam. He set to work to devise a plan for using this force.

In the year 1779 he perfected his invention of the high-pressure steam engine, and it came from his brain, like Minerva from that of Jove, complete. Evans made the first locomotive, and the first cylindrical boiler which contained a flue. For many years these boilers were made of wooden staves and bound with iron hoops. This invention is now called the Cornish boiler. Although the outside of the boiler was made of wood, it contained a wrought-iron flue in which a fire was made with wood. Some of these boilers have continued in use up to within a comparatively recent period.

The next great improvement of the steam-engine, also made in this country, was the application of the variable cut-off, first used on marine engines by Sickles, and first applied successfully to stationary engines by Corliss. With the cut-off, of which there are now many ingenious varieties, the high pressure engine uses steam just in proportion to the amount of work to be done. Thus the American engine is literally and perfectly automatic in its action, and by means of its own governor it controls itself with a light or heavy load more perfectly, and decides more correctly than any engineer could, the exact amount of steam required to do a given amount of work, even though that amount should be varied every second.

Early in the last century Evans sent to England the plan of his direct pressure steam-engine, which was tried by Trevithick; but the English, for twenty years, scouted the idea of using high pressure steam; and would not probably have used it up to this day, had not high power been required in small space for the locomotive. Many other improvements in the application of steam were first made in this country. For example, the use of two cylinders for applying power continuously by cranks set at right angles to each other, invented by Joseph Dixon, and used in about the year 1823. Perkins, who made improved boilers, and Dr. Church, who made improvements in the valve-gearing for steam carriages, went to England with their improvements, and spent their lives there, in trying to put them in practical operation. While in England the high pressure engine is seldom used, except for locomotives, in this country ninety-nine out of every 100 engines are high pressure; and our engineers are convinced that this will be the engine of the future. It requires less space, costs less, and can be run with equal economy.

A great many improvements have been made in the high pressure engine. Mr. Charles T. Porter has invented a very sensitive governor and other improvements. Of late, Mr. Porter has presented the advantage, although he does not claim to have originated the idea of high speed pistons. That it is economical to run a high pressure engine at a very high speed, he claims is fully demonstrated by the Allen engine. Upon that particular point, and the operation of the Allen engine, President Barnard will now address you.

F. A. P. Barnard, S. T. D., LL.D. (the president of the American Institute), premising that the paper was drawn up in the form of a report to be formally presented to the managers of the fair of the American Institute, for 1870, the investigation having been made at the request of Mr. Porter, one of the exhibitors of the Allen engine in that year, read the following:

HIGH SPEED ENGINES.

Report on the Allen Engine.

To the Managers of the Annual Fair of the American Institute, for 1871:

The undersigned judges in Department V, group 1, in said fair, beg leave to submit the following report supplementary to their report heretofore rendered in regard to the high speed steam engine, called the Allen engine, which was pronounced by them in their report above mentioned, to be first in the order of merit. The opinion of the judges here referred to was founded upon a careful testing of the performance of the engine and an examination of its construction; but it was announced as a simple judgment upon the facts, without any attempt to connect these with the theoretic principles to which, according to the claim of the exhibitors, the excellence of the performance is due.

But it was upon the soundness of these principles chiefly that these gentlemen had been desirous to obtain a verdict. In consequence, therefore, of their solicitations, frequently renewed after the closing of the fair, the investigations, of which the results are presented below, have been recently undertaken; and in compliance with a written request addressed to the undersigned by Mr. Charles T. Porter, one of the exhibitors, under date of February 15, 1872, these results are here embodied in the form of a supplementary report.

It may be remarked of this engine, in the beginning, that the principal object aimed at in its construction is to secure steadiness of action and uniformity of strain upon the crank shaft, while working steam with large expansion; and to accomplish this in such a manner as to make the engine practically its own regulator, and to render it in a great degree (it cannot be entirely) independent of the fly-wheel. It has other noticeable peculiarities; as, for instance, its variable cut-off, operated by the link motion, without which it probably could not be run advantageously with the high velocities which its theory requires; and its admirably balanced valves, in which the effects not only of pressure but of current have been considered, and which give prompt and free admission to the steam even when the cut-off is short; but these are features of secondary importance on which it is not necessary to dwell in this place.

To maintain steady action under very largely varying pressure of steam upon the piston, is, then, the main problem which the constructors of this engine have set themselves to solve. The mechanical solution which they offer is simple, but it is opposed to notions in regard to reciprocating engines which have long been traditionally received, and, therefore, it should be closely criticised.

This solution consists in giving to the reciprocating parts of the engine a very considerable weight, so that, as the pressure of the steam falls off during the latter part of the stroke, their inertia may cause them to act as a driving power instead of it. The living force which these moving parts will embody will be of course maximum at, or very nearly at, the middle of the stroke; since it is in the nature of uniform crank motion that the piston velocity should there be greatest. Supposing that, from this point onward, the pressure on the piston should wholly cease, it would nevertheless be true that all this living force would be expended on the crank during the succeeding quarter-revolution; so that, in case the steam pressure, during the first half-stroke, had been adequate to the production in the same moving mass of twice as much living force, and that one-half of this pressure had gone to the performance of work through the engine, the action upon the crank in the two successive quarter-revolutions would be exactly equal. At first thought it might seem that it should also be symmetrically distributed over these two quadrants; but this we shall find not to be the case.

In order, however, that large force should be thus imparted to the mass of the piston and the moving parts connected with it, it is necessary that these should not only be massive, but that they should move with high velocity. High velocity is therefore a condition as essential to the theory of the Allen engine as large mass in the parts which immediately receive the action of the steam. Now, it has always been held that the reciprocating parts of a steam-engine should be as light as is consistent with strength; the force expended in moving these alternately in opposite directions having been regarded as so much thrown away. And in this view of the subject high velocities are objectionable for precisely the same reason. Nor, supposing steam to be worked with full head, from beginning to end of the stroke, is this view wanting in plausibility; but even in that case it is by no means just. The effect under such circumstances would be, not to occasion waste of force, but irregularity of action; and this irregularity, as will be presently illustrated, would be just the reverse of that resulting from light reciprocating masses and short cut-off. For as, in the latter case, a forward strain on the shaft between the crank and the fly-wheel would occur in the first quarter revolution, and a back strain in the second quarter; so, in the former, it would be in the second quarter revolution that the forward strain would occur, while the backward would take place in the first.

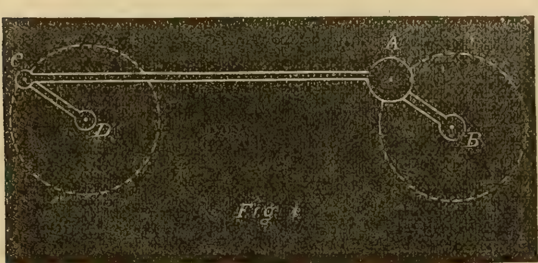
Mr. Porter, the gentleman above referred to, as one of the exhibitors of the engine under consideration, has published* a theory of the

* Engineering and Mining Journal for January 31, 1871; also in Porter's Description of Richards' Steam Engine Indicator, London, 1866.

action of the reciprocating parts of a steam-engine, which, so far as he has pursued the subject, leads him to results not dissimilar to those to which the present inquiry has conducted. Upon certain points, however, he has expressed himself in such a manner as to convey impressions which he probably did not intend; and thus, perhaps, to excite in some minds doubts of his substantially just conclusions. The natural effect has been to create the belief, in which the undersigned to some extent at first participated, that the problem presented in this engine is more obscure than, upon closer examination, it is found to be.

The particular points of Mr. Porter's articles to which reference is here made, are: First. The stress laid by him upon the fact that the strain upon the crank produced by the living force of the piston at the end of the stroke (revolution supposed to be uniform) is equal to the centrifugal force which a mass of equal weight would exert, if revolving with the same velocity at the end of the crank. Secondly. The inference which seems to be drawn from this, that the heavy piston high speed steam-engine is closely analogous in its action to a rotary; or, in Mr. Porter's own words, that "by combining rapid speed and short stroke with considerable weight in these parts (the reciprocating parts) their centrifugal force may be developed to whatever extent we choose; and if it is in excess of the steam, the engine, with the steam turned on, becomes in effect a rotary engine;" and thirdly, the proposition that "the excessively intermittent pressure caused by working steam at a high grade of expansion is transformed (in this engine), as by magic, into a steady and uniform rotative pressure upon the crank."

The second and third of these propositions are hardly borne out by the analysis. To what extent the first is so, will be apparent from considering the diagram here presented:



If a heavy body, A, revolve about the center, B, at the extremity of the arm, A B, it will exert upon this arm an equal centrifugal force at every point of the revolution. If the same body be at the same time connected with the arm, C D, equal to A B, and similarly situated in reference to the center, D, the connecting rod A B and the arm C D being both void of weight, then at C there will be no centrifugal force exerted upon the arm, C D; and yet, should C D offer resistance to revolution, say by friction on the center or otherwise, force would be transmitted from A, through A C, to C; and the living force of the mass A would, in time, be exhausted in performing work at D.

Supposing, also, that when A and C are on the line of the centers B and D, the cohesion of the crank A B should be suddenly destroyed, there is no doubt that the total amount of the centrifugal force of A would be exerted at C, on the arm C D, and in the line of that arm. Also, when the two arms are in the position perpendicular to the line of the centers, there will be no radial stress exerted upon C D, but the whole living force of A will act at C in a direction normal to the arm; so that if the resistance at C should be sufficient, this force might be wholly absorbed, and the motion arrested in a space of time inappreciably small

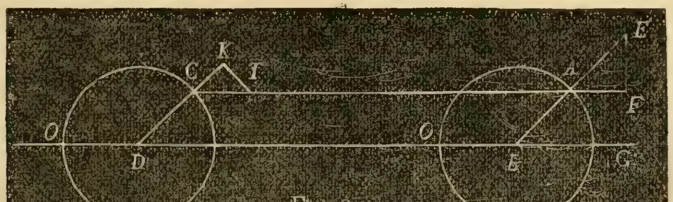


Fig. 2.

At any position later in the revolution, such as is represented in Figure 2, the centrifugal force of the mass A, acting in the direction of the radius B A, acts only partially at C. Taking A E, on the radius B A produced, to represent this force, and resolving into the components A F and F E, it is A F only which acts on C D, and this not altogether radially. Take C I, on the line connecting A and C, equal to A F, and draw I K perpendicular to C D produced. C I represents the component of the centrifugal force of A acting at C; and C K represents the element of this component, which acts in the direction of the radius D C.

If, now, the revolution be supposed to begin from O, and the arc of revolution O A, be represented by φ, then A F will be equal to A E cos φ, and C K will be equal to C F cos φ = A F cos φ = A E cos$^2\varphi$. Hence the radial force exerted upon C D will be, to the centrifugal force of the body revolving at A, as radius is to the square of the cosine of the arc passed over from zero taken at the line joining the centers. The radial force on the arm or crank, C D, is, therefore, never equal to the centrifugal force of the revolving body, except at the moment when cos φ = radius; or when $\varphi = 0°$ or $180°$.

Now, instead of a heavy mass revolving at the extremity of an arm A B, and acting through a connecting rod upon another equal arm C D, let us suppose an equal mass to have a reciprocating motion along the line O B G, but still to be connected with the arm C D, by a rod, which, as well as the arm, is without gravity. This is the case presented in the engine under consideration; and if, for the sake of simplicity, we suppose that the distance of the reciprocating body from C D is so great that the connecting rod may be regarded as remaining sensibly parallel to itself throughout the revolution, it will also be, to all intents and purposes, the case we have just been considering; except that the force acting in the direction O G, will be to that exerted, radially at C, as radius to cosine φ simply, and not to $\cos^2\varphi$. Supposing, therefore, once more, that the angular motion of C D is uniform, the radial strain upon C D (which we may call the crank), as the heavy body or piston approaches the limit of its course, will be, as before, equal to the centrifugal force which the same heavy body would exert if revolving at the extremity, C, of the crank.

But it does not appear that this circumstance has anything to do with the facility with which the crank of the Allen engine passes the line of the centers. The heavy body has no tendency in itself to return upon its path, no matter what may be the law determining its final strain upon the crank. If, indeed, C D should offer no resistance at all, and if its angular movement should not be controlled by a fly-wheel or other regulator, the heavy body being in the meantime acted on by a constant force (say pressure of steam), this body would be regularly accelerated up to the end of its course, and would expend its whole living force upon C D, with a violent concussion in the line of the centers; motion being at the same time totally arrested. The strain of the heavy piston upon the crank at the close of the stroke has, therefore, no influence in facilitating the passage of the centers; and this is not the circumstance which, in the heavy piston engine, to use the words of Mr. Porter, "strips the dead center of its terrors." The Allen engine really owes the advantage which it enjoys in this respect to the introduction, on the side of the shaft opposite to the crank, of what the constructors call a "counterpoise," equal in weight to the piston and the moving parts connected with it, which counterpoise not only exerts a centrifugal force equal to the opposing strain of the piston on the crank, but also, by its powerful movement of rotation, compels the crank to pass the center with an unchecked velocity of angular movement. To this must be added, in further explanation of the important peculiarity of this engine under consideration, that the time during which the effective tangential force exerted upon the crank fails to act near the centers is very small, not only absolutely (in consequence of high velocity), but also relatively to the whole time of revolution; and that, therefore, the center passage imposes no great tax upon the regulators. This matter being disposed of, we may proceed regularly with the problem before us. This problem presents several questions which must be separately considered. These are:

First. Supposing the heavy piston to start from rest at the beginning of its course, and the crank to be maintained in uniform angular motion by some independent regulator, what must be the law of force acting on the piston, so that it may complete the first half stroke without exerting any strain upon the crank, in the way either of acceleration or of retardation?

Second. Supposing the force accelerating the piston to cease to act from mid stroke onward, according to what law will the living force embodied in the piston be imparted to the crank, supposed still to be maintained in uniform angular motion?

Third. Supposing the force on the piston to be constant throughout the stroke, as in working a cylinder steam-engine without a cut-off, according to what law will this force reach the crank; and what will be the relative amount of work done in the first and second quadrants of the revolution?

Fourth. The same questions as proposed in the case last specified, with the additional supposition that a cut-off is used.

Fifth. The point of cut-off, and the pressure of steam in the cylinder before cut off, being given, to determine the conditions which will secure equality of work in the successive quadrants of revolution, and the nearest approach to uniformity of action upon the crank in the direction of rotation.

To proceed with the first case.

Taking, as before, φ to represent the arc of revolution measured from zero at the line of the centers, the differences of the versed-sines of φ for equal successive minute intervals of time will be proportional to the velocities of the piston in such successive intervals. And the differences of these differences will be proportional to the successive accelerating forces required, in order that the uniformity of revolution may be maintained. These conditions may be best expressed in the notation of the differential calculus.

Put therefore:

$\varphi =$ arc of revolution, as above, to radius $= 1$.

s = the space passed over by the piston.
r = the length of the crank.
t = time; v = velocity; f = accelerating force.
F = constant value of f at maximum.
T = constant time of revolution.
V = constant angular velocity of revolution.

$$\text{Then } V = \frac{d\varphi}{dt} = \frac{2\pi}{T}. \quad \frac{d\varphi^2}{dt^2} = \frac{(2\pi)^2}{T^2}.$$

$$ds = r\,d(\text{v. s. }\varphi) = r\,d(-\cos.\varphi) = r\sin\varphi\,d\varphi.$$

$$v = \frac{ds}{dt} = \frac{r\sin\varphi\,d\varphi}{dt}. \quad \frac{dv}{dt} = \frac{r\,d(\sin\varphi\,d\varphi)}{dt^2} = \frac{r\cos.\varphi\,d\varphi^2}{dt^2}$$

$$\text{Substituting for } \frac{d\varphi^2}{dt^2}, \ \frac{dv}{dt} = \frac{(2\pi)^2}{T^2} r\cos.\varphi$$

$$\text{But } \frac{dv}{dt} = f \ \therefore \ f = \frac{(2\pi)^2}{T^2} r\cos.\varphi$$

When $\cos.\varphi = 1$ or -1, $f = +\frac{(2\pi)^2}{T^2} r = +V^2 r$ = centrifugal force of a unit mass of matter revolving in a circle of which r is the radius, the time of revolution being T. The accelerating force f, therefore, varies as $\cos.\varphi$, and is maximum when $\cos.\varphi$ is maximum. Hence:

$$F = \frac{(2\pi)^2}{T^2} r, \text{ and } \frac{F}{g} = \frac{(2\pi)^2 r}{32.166\ T^2} = \frac{\pi^2 r}{8.0416\ T^2}$$

which expresses the ratio of F to gravity.

In order to compare this force with the constant force which would generate the same velocity in the same time, we observe that, by hypothesis, this force acts only during a quarter revolution of the crank, or a half stroke of the piston; and, hence, that the maximum velocity is necessarily equal to the uniform velocity of the extremity of the crank; or, in other words, since

$$v = \frac{r\sin\varphi\,d\varphi}{dt}; \text{ and } \frac{d\varphi}{dt} = \frac{2\pi}{T}; \ \therefore \ v = \sin\varphi\frac{2\pi r}{T}.$$

which is maximum when $\sin\varphi$ is maximum, or when $\varphi = 90°$. Thence, putting V_1 for this maximum velocity.

$$V_1 = \frac{2\pi r}{T}.$$

This velocity is generated on the time $\frac{1}{4}$T. Supposing it generated by a constant force, this force would be represented by the velocity it is capable of generating in one second; or putting F_1 to stand for this constant force.

$$F_1 = \frac{V_1}{\frac{1}{4}T} = \frac{2\pi r}{\frac{1}{4}T^2} = 4\frac{(2\pi r)}{T^2},$$

From this we obtain

$$\frac{F}{F_1} = \frac{(2\pi)^2 r}{4(2\pi r)} = \frac{2\pi}{4} = \tfrac{1}{2}\pi.$$

Also $\frac{F_1}{g} = \frac{4(2\pi r)}{g\,T^2} = \frac{8\pi r}{32.166\ T^2} = \frac{\pi r}{4.0208\ T^2}.$

If we take, for r and T, the values assumed by Mr. Porter in the Engineering and Mining Journal, viz., $r = 1.25$ ft. and $T = \frac{60}{122.3}$ sec., we shall obtain, by substitution,

$F = 205.031$, and $F_1 = 130.527$; whence $\frac{F}{F_1} = 1.57078 = \frac{1}{2}\pi$ as above.

This force F_1, however, is a greater force than would be required to generate the velocity, V_1, in acting constantly through the *space* represented by r, if *time* is left out of the question; for, remembering that the spaces passed through under the influence of constant forces are governed by the law,

$$S = \tfrac{1}{2} f t^2$$

and applying this to the case in hand in which the time to be considered is $\frac{1}{4}$T, we have

$$S = \tfrac{1}{2} F_1 (\tfrac{1}{4}T)^2 = \frac{8\pi r}{T^2} \times \frac{1}{32} T^2 = \tfrac{1}{4}\pi r,$$

which is less than the radius r.

Where different velocities are generated by forces acting through the same space, these forces are proportional to the squares of the velocities generated. And the velocities generated by the same force acting through different spaces, are as the square roots of the spaces.

Thus, gravity will generate, in acting through the space r, the velocity $= g\sqrt{\frac{r}{\frac{1}{2}g}} = g\sqrt{\frac{2r}{g}} = \sqrt{2rg}$

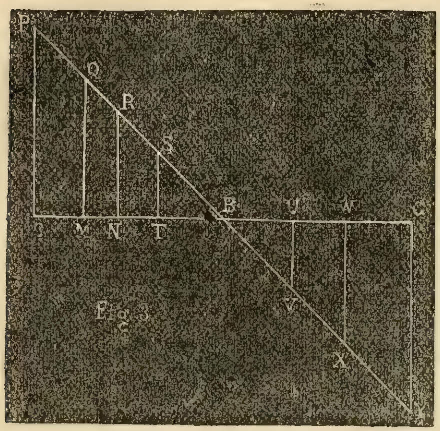
Hence, the force $F_{\prime\prime}$ which, in acting through the same space r, would generate the velocity $\frac{2\pi r}{T}$ will be found by the proportion,

$$\left(\sqrt{2rg}\right)^2 \ : \ \left(\frac{2\pi r}{T}\right)^2 \ :: \ g \ : \ \frac{(2\pi)^2}{2T^2} r.$$

which is one-half the initial accelerating force F.

Hence, the force required to give to the heavy piston the requisite initial acceleration is double that which, by acting constantly through a space equal to the length of the crank, would impart to the piston the same final velocity — a proposition which is, moreover, made self-evident by an inspection of the diagram below.

Since the accelerating force varies as the cosine of the arc of revolution; and since, in the circle described by the crank, if the length of the crank be taken as radius, the cosines will always be equal to the distance of the reciprocating body from the middle point of its course, it follows that if, upon a line, as OBG, representing this course, in which B is the middle point, rectangular ordinates be drawn, each equal to its distance from B, these ordinates will be proportional to the accelerating forces at the points corresponding to them; and the line drawn through their extremities will be a straight line, showing that the force is uniformly diminishing.



2. In order to find the law according to which the force stored up in the piston at mid-stroke is subsequently imparted to the crank, we must first find the expression for this living force and the work it represents, and then take the differential of this stored-up work, which represents its subsequent progressive diminution, on the condition that the crank motion is uniform.

The work done in generating the velocity $\frac{2\pi r}{T}$ during the first half stroke, is found by integrating the expression,

$$dW = Fds = \frac{(2\pi)^2}{T^2} r\cos.\varphi r\sin.\varphi d\varphi,$$

which gives $W = -\frac{(2\pi)^2}{2T^2} r^2\cos.^2\varphi + C$, the mass acted on being regarded as unity: where W represents work in the piston.

Now when $\varphi = 0°$, $W = 0$, and $\cos.\varphi = 1$.

Whence $W = \frac{(2\pi)^2}{2T^2} r^2(1 - \cos.^2\varphi) = \frac{(2\pi)}{2T^2} r^2 \sin.^2\varphi$.

When $\varphi = 90°$, $\sin.\varphi = 1$ and $W = \frac{(2\pi)^2}{2T^2} r^2$.

In the second quadrant this operation is simply reversed, thus:

$dW = \frac{(2\pi)^2}{T^2} r \sin.\varphi r\cos.\varphi d\varphi = Fds = -Fr\sin.\varphi d\varphi$;

and dividing by $r \sin.\varphi d\varphi$.

$$\frac{(2\pi)^2}{T^2} r\cos.\varphi = -F,$$

the negative sign, showing that the direction of the force is now reversed. This negative character belongs implicitly to the first member of the equation, also, since cos. φ is negative in the second quadrant.

The law of retardation in the second half stroke is, therefore, the same as the law of acceleration in the first.

The expression for work found above, viz.:

$$\frac{(2\pi)^2}{2T^2}r^2 \sin.^2\varphi; \text{ or, generally, } \frac{(2\pi)^2}{2T^2}r^2 \sin.^2\varphi \frac{w}{g};$$

(in which w is the weight of the reciprocating body, and g, the force of gravity), represents the amount of work which continues to be stored up at the successive points of the second half stroke at which $s =$ v. s. φ; and, therefore, the amount which will have been, at these successive points, transferred to the crank, will be expressed by

$$W' = \frac{(2\pi)^2}{2T^2}r^2\frac{w}{g}\ (1-\sin.^2\varphi) = \frac{(2\pi)^2}{2T^2}r^2\frac{w}{g} \cos.^2\varphi.$$

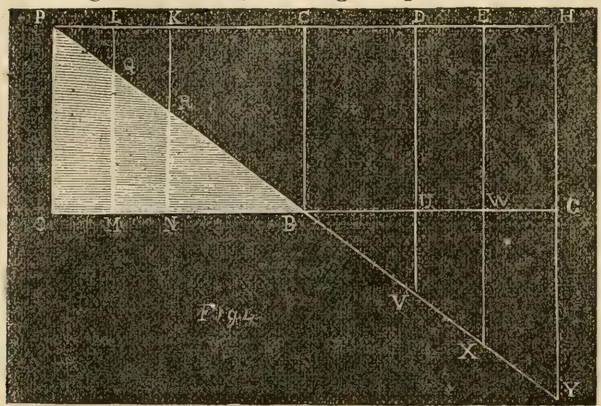
At the end of the stroke, $\varphi = 180°$, sin. $\varphi = 0$, and cos. $\varphi = -1$.

Here $W = 0$ and $W' = \frac{(2\pi)^2}{2T^2}r^2\frac{w}{g}$; or, the living force of the moving mass has been entirely exhausted, and its equivalent of work transferred to the crank.

This case is illustrated in figure three. Producing the line P B to meet G Y, drawn perpendicularly to B G downward, the ordinates U V, W X, parallel to G Y, are proportional to the forces exerted on the crank in a direction parallel to O G at the points U V of the path of the piston; and the triangle B G Y represents the work done by these forces during the last half stroke.

3. The third of the questions above proposed relates to the law according to which the force of the steam reaches the crank during the first half stroke in presence of the heavy piston, on supposition that the pressure in the cylinder is constant. This is substantially answered in the solution already given to the first question. If the reciprocating parts of the engine were wholly without inertia, the diagram of work done would be a rectangle, the ordinates representing the force acting on the crank in a direction parallel to the line of the centers being all equal.

Thus, if P O represents the steam pressure on the piston, and O G the length of stroke, B being the point of mid-stroke, P O G H will,



on this supposition, represent the work done during the stroke, and P O B C the work done during the first half stroke. But if the reciprocating parts of the engine are of such a weight that the whole force P O is only sufficient to give to them the requisite initial acceleration, then, by joining P B, it will be manifest, from what has been already shown, that the entire work represented by the triangle P O B will be absorbed by these moving parts, so that the work done by the engine through the crank will be only that represented by the triangle P B C; and the steam force which reaches the crank at the successive points M, N, etc., will be proportional to the partial ordinates L Q, K R, etc.

In the second quarter revolution, however, the crank will not only be acted upon by the full pressure of the steam, but also by the living force of the reciprocating parts of the engine; and the work done will be represented by the trapezoid C B Y H; the forces at successive points, as V, W, of the stroke being proportional to D V, E X, etc.

It is obvious, therefore, that in working without cut-off, the inertia of the reciprocating parts of the engine has the effect to diminish the amount of work done during the first half stroke, and to increase it during the second; this disturbance of the distribution reaching, in the case here presented, the large irregularity shown in the ratio 1:3.

It has the further bad effect of producing a final strain on the crank double of that which the full pressure of the steam would produce, while the initial strain is reduced to zero.

But this property which makes the heavy piston engine unfit to be worked with a full head of steam throughout the stroke, is precisely the property which is needed in using steam expansively.

Suppose, for instance, the steam is cut off at mid stroke, the diagram of work will be such as is here shown:

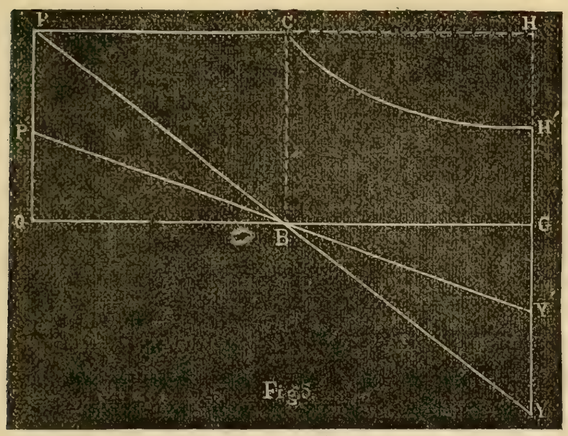


Fig 5

The rectangle corresponding to the work of the second half stroke is reduced by the area C H H′, but the remaining area, C B Y H′, still exceeds the triangle P B C, which represents the work of the first half stroke. Let, now, through the point, B, another line be drawn, as P′ B Y′, and suppose such a weight given the reciprocating parts of the engine that P′ O may suffice to impart to them the necessary initial acceleration, then P P′ B C will be the diagram of work for the first quadrant, and C B Y′ H′ the corresponding diagram for the second quadrant. It is obvious that such a position may be found for P′ Y′ as to make these two diagrams equal.

It is to be noticed, however, that if we wish the engine to perform, when worked with cut-off, the same amount of work which we have supposed it to perform when working with full head of steam (viz.: that represented by the rectangle P O G H), the initial pressure will have to be increased to a degree which is a function of the part of stroke performed before cut-off. And as it is usual to compute roughly the work of expansively working engines by means of hyperbolic logarithms,* we may find the pressure P, which would do

* If it were important to the object of this inquiry that the elastic force of expanding steam, and the work done during exhaustion, should be very exactly stated, it would hardly be proper to depend, in this part of the investigation, upon the hyperbolic theory, or the law of Marriotte. The formula of Poisson for expanding gases, viz.:

$$P' = P\left(\frac{k}{x}\right)^{1,421}$$

though not strictly true of vapors which, like steam, partially condense during exhaustion, would give results nearer the truth. Pambour's formula, now generally accepted, is the formula of Marriotte, with a negative term annexed, increasing with the exhaustion; and may be thrown under this form:

$$P' = P\frac{k}{x} - p\,\frac{x-k}{x};$$

the same amount of work per stroke with the cut-off k, as is done with full head of steam by the smaller pressure P, by means of the formula:

$$Pr\left(1+\text{h l}\frac{2r}{k}\right) = 2\text{P}r$$

$2r$ being the length of the stroke, since r = length of crank.

$$\text{Hence } P = \frac{2\text{P}r}{k\left(1+\text{hl}\frac{2r}{k}\right)}$$

If, for simplicity, we put $r = 1$, we may find the value of P in terms of P for any cut-off, by substituting the proper value for k, remembering that, as $r = 1$ the whole stroke $= 2$; and that if k be taken, as usual, at a fraction of the whole stroke regarded as unity, this fraction must be doubled when introduced into the present formula.

A favorable cut off for the high speed engine would be one-eighth, which would give us

$$P = \frac{2\text{P}}{\frac{1}{4}\ (1 + \text{h. l. } 8)} = \frac{8\text{P}}{3.08} = 2.6\text{P, nearly.}$$

In order, therefore, that a cylinder engine, working with a one-eighth cut-off, may do the same amount of work per stroke which the same engine would do working without cut-off under the given pressure of steam, P, an initial pressure must be employed two and six-tenths as great as P.

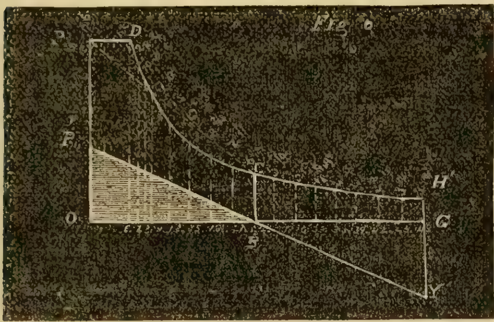
In an engine in which the reciprocating parts are without inertia, the distribution of work upon the different parts of the stroke with this cut-off is very unequal; more than three and a half times as much being done in the first quarter revolution as in the second. But, by the use of a heavy piston, this inequality may be reduced to any extent; and even, as will be obvious from what has gone before, may be entirely reversed.

In fig. 5, we have seen that the line P′ Y may be so drawn as to make the areas P P′ B C, C B Y′ H′ equal to each other. We may easily find the point P′ through which it should be drawn, by considering that P′ O B = B G Y′; and that P P′ B C = P O B C —

in which p is a pressure empirically determined, the values of which, for condensing and for non-condensing engines, are given in his treatise.

To have employed either of these formulas in the expressions used in this paper, would only have increased their complexity without materially affecting the conclusions arrived at.

P′ O B, and C B Y′ H′ = C B G H′ + B G Y′; for all which areas may be found simple numerical expressions.



To make the case more general, let the cut-off be taken nearer to O or P, as in figure 6. Then we need to draw P′ Y′ so as to make P P′ B C′ D = C′ B Y′ H′; or P O B C′ D − P′ O B = C′ B G H′ + B G Y′.

Putting, as before, P O = P; P′O = P′; PD = K; and OB = r, the foregoing equation becomes:

$$Pk\left(1 + \text{h l}\,\frac{r}{k}\right) - \frac{P'r}{2} = Pk\left(1+\text{h l}\,\frac{2r}{k}\right) - Pk\left(1+\text{h l}\,\frac{r}{k}\right) + \frac{P'r}{2}$$

$$\text{Or } P'r = 2Pk\left(1+\text{h l}\,\frac{r}{k}\right) - Pk\left(1+\text{h l}\,\frac{2r}{k}\right)$$

$$= Pk\left(2+\text{h l}\,\frac{r^2}{k^2}\right) - Pk\left(1+\text{h l}\,\frac{2r}{k}\right);$$

$$\text{And } P'r = Pk\left(1+\text{h l}\,\frac{r}{2k}\right).$$

If now we put $r=1$, and $k=\frac{2}{8}=\frac{1}{4}$, as before, we shall find,

$$P' = \tfrac{1}{4}P\left[1+\text{h l}\,2\right] = \frac{1.693}{4} = 0.423P, \text{ nearly.}$$

Now, as P, in this case, viz., $k=\frac{1}{8}$, must be 2.6 times p (the mean pressure, or that which would do the same work without cut-off), hence,

$$P' = 0.423 \times 2.6\text{p} = 1.0998\text{p} = 1.1\text{p, nearly.}$$

Inasmuch as the great advantage to be secured from the heavy-piston high-speed engine is uniformity of distribution of work over the stroke, it is evident that the proportion of the total steam pressure which can be most beneficially employed in generating living force during the first quarter revolution, in order that it may be transferred to the crank during the second, is, for every given value of the cut-off, fixed and definite. The weight, therefore, which should be given to the reciprocating parts of the engine, in order to secure the most beneficial effect, is also equally fixed, when the steam pressure, the area of piston surface, the length of stroke, and the angular velocity of revolution, are given, along with the cut-off.

Thus, if a is the piston area in square inches, and P′ the pressure per square inch, corresponding to P′O in Fig. 5, above (a pressure ascertained by the formula foregoing, from the given values of P =

total pressure, and k), then $P'a$ is the initial pressure employed in accelerating the piston. But the initial force required to produce the proper degree of acceleration is represented by $\frac{(2\pi)^2}{T^2}r$; and the relation of this to gravity is $\frac{(2\pi)^2}{g\,T^2}r$. Hence, if w represent the weight of the piston, the following ought to be true, viz.:

$$\frac{(2\pi)^2}{g\,T^2}r\,w = P'a; \text{ and } w = \frac{g\,T^2\,P'a}{(2\,\pi)^2\,r}.$$

If we wish, with a one-eighth cut-off, to do the work of a full head of steam of 30 pounds pressure per square inch, upon a piston 16 inches in diameter, with a two-foot-stroke, and 120 revolutions to the minute, we shall find P′ to be 33 pounds, and $P'\,a = 6{,}633$ pounds. Also, the initial accelerating force will be nearly five times gravity (4.9), and $w = 1{,}350$ pounds. But if, the other data remaining the same, the length of stroke be increased to 30 inches, the initial accelerating force will be increased to a little over six times gravity (6.1), and w becomes something less than 1,100 pounds (1080).

It may be remarked that, while the weights thus assigned are mathematically the best,* in reference to the equality of distribution of work over the stroke, yet there can be considerable variation from these values without affecting injuriously, to any very marked degree, the performance of the engine.

It having thus been shown what is necessary to the most favorable distribution of work, in the heavy-piston engine, it is proposed now to illustrate by tabular coefficients, and by diagrams, the effective tangential force exerted upon the crank, at every point of the revolution, under several hypotheses in regard to the admission of steam, and to the presence or absence of large inertia in the reciprocating parts of the engine.

1. The first case considered will be that in which the steam pressure is constant throughout the stroke, and the reciprocating parts of the engine are supposed to be without inertia.

Referring to Fig. 2, the pressure on the piston transmitted to the crank by the connecting rod, may be represented by C I, which is resolvable into the rectangular components C K and K I, of which the second only is effective in turning the crank round D. This effective component is, therefore, $= P \sin. \psi$. If it were possible to make P vary so that the turning force might always be equal to the

* This is on supposition of the correctness of the logarithmic theory of pressures. As the actual pressures of expanding steam are considerably less, the values of w found by employing a more exact formula, as for instance that of Pambour, would be greater.

resistance, R, regarded as constant, and reduced to the circumference described by the crank, we should have $P \sin. \psi = R$; or $P = \frac{R}{\sin. \psi} = R \operatorname{cosec}. \psi$. On this supposition the variations of value of P would be very large; the limits being P=R at 90°, and P=∞ at 0°. On the other hand, if P remain constant, the effective force is equally variable, being zero at 0° and =R at 90°.

In the first case, the following are the values which must belong to P at the several angles named.

At 0°, P′=∞.	At 45°, P′= 1.444 R.
1°, P′=57.30 R.	50°, P′= 1.305 R.
5°, P′=11.47 R.	55°, P′= 1.221 R.
10°, P′= 5.76 R.	60°, P′= 1.115 R.
15°, P′= 3.864 R.	65°, P′= 1.104 R.
20°, P′= 2.924 R.	70°, P′= 1.064 R.
25°, P′= 2.366 R.	75°, P′= 1.035 R.
30°, P′= 2.000 R.	80°, P′= 1.016 R.
35°, P′= 1.742 R.	85°, P′= 1.004 R.
40°, P′= 1.556 R.	90°, P′= 1.000 R.

The values for the second quarter revolution are the same, in reversed order.

If P remain constant, the effective force, P, will have values as follows:

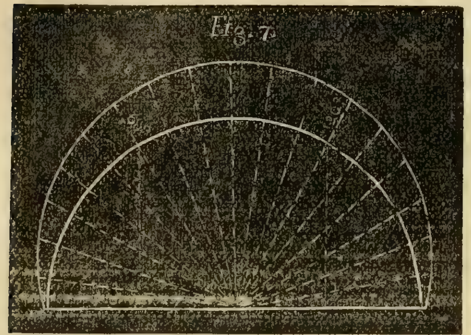
At 0°, P′=0.00.	At 45°, P′=0.7071 P.
1°, P′=0.0175 P.	50°, P′=0.7660 P.
5°, P′=0.0872 P.	55°, P′=0.8192 P.
10°, P′=0.1736 P.	60°, P′=0.8660 P.
15°, P′=0.2588 P.	65°, P′=0.9063 P.
20°, P′=0.3420 P.	70°, P′=0.9397 P.
25°, P′=0.4226 P.	75°, P′=0.9659 P.
30°, P′=0.5000 P.	80°, P′=0.9848 P.
35°, P′=0.5736 P.	85°, P′=0.9962 P.
40°, P′=0.6428 P.	90°, P′=1.0000 P.

And, as before, the values of P in the second quadrant will be the same in reversed order.

It appears from this, that the force exerted on the crank is comparatively ineffective for fifteen or twenty degrees near the beginning of the first, and the end of the second quadrant, and is effective nearly to the extent of the total pressure on the piston for about as many toward the end of the first and the beginning of the second.

For the intermediate degrees, the effective force averages about five-eighths of the total.

The distribution of the effective force upon the crank over the circumference of revolution may be graphically illustrated as follows:



Upon O Q * taken equal to twice the length of the crank, describe the semi-circumference O P Q; and subdivide this into eighteen arcs of ten degrees each. Draw radii through the points of division; and upon these radii produced beyond the circumference, set off, from the circumference outward, the distances *a a'*, *b b'*, etc., proportional to the coefficients of effective pressure for the values $\psi = 10°$, $\psi = 20°$, and so on, taking P P' = 100 parts. The curve drawn through the points thus determined, will be the curve of effective force, in the case in hand.

2. The next case supposes the reciprocating parts to have large inertia, and is that in which the steam pressure exactly suffices to furnish the requisite initial accelerating force. In this case, it is necessary to subtract from the effective force in the first quadrant, all that would be contributed in the absence of the heavy reciprocating parts, by the proportion of the total steam pressure which is required to set those parts in motion, and to add an equivalent amount in the second quadrant.

The accelerating force on the piston is expressed by $\frac{(2\pi)^2}{T^2} r \cos. \varphi$; and the part of this which would be effective, if not consumed in the acceleration, is

$$\frac{(2\,\pi)^2}{T^2} r \cos.\varphi \sin\varphi = \frac{(2\,\pi)^2}{T^2} r \tfrac{1}{2} \sin 2\varphi.$$

The following are the coefficients of the effective force thus absorbed:

φ	$\frac{1}{2}\sin 2\varphi$.	φ	$\frac{1}{2}\sin 2\varphi$.
0°	0.0000.	45°	0.5000.
5°	0.0868.	50°	0.4924.
10°	0.1710.	55°	0.4700.
15°	0.2500.	60°	0.4330.
20°	0.3214.	65°	0.3830.
25°	0.3830.	70°	0.3214.

* The letters have been unfortunately omitted in this figure; but it will be easily understood without them.

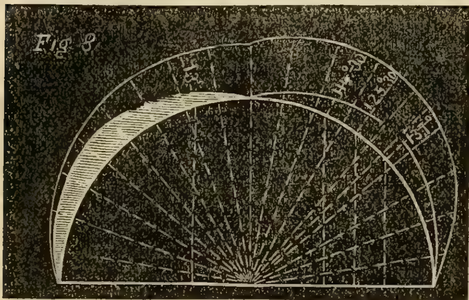
30°	0.4330.	75°	0.2500.
35°	0.4700.	80°	0.1710.
40°	0.4924.	85°	0.0868.
45°	0.5000.	90°	0.0000.

It will be seen from this table that the inertia of the piston draws most heavily upon the force exerted effectively upon the crank, at the end of the first octant; and that the effect diminishes from this point onward by the same law according to which it had previously increased. The coefficients of resultant effective pressure would be, for the first quarter = revolution, equal to $\sin\varphi - \frac{1}{2}\sin 2\varphi$; and for the second, s in $\varphi + \frac{1}{2}\sin 2\varphi$. But they may be obtained by means of a simpler formula, as follows:

Since the force consumed in acceleration is $\frac{(2\pi)^2}{T^2} r \cos.\varphi$, the remaining force not so consumed is $\frac{(2\pi)^2}{T^2} r\,(1 - \cos.\varphi)$. But $1 - \cos\varphi = 2\sin^2\frac{1}{2}\varphi$. Hence this remaining force is $\frac{(2\pi)^2}{T^2} r \times 2\sin^2\frac{1}{2}\varphi$; and the portion of this which is effective on the crank, is $\frac{(2\pi)^2}{T^2} r \times 2 \sin^2\frac{1}{2}\varphi \sin\varphi$. The coefficients will, therefore, be given equally by the formula $\sin\varphi - \frac{1}{2}\sin 2\varphi$ or the equivalent formula, $2\sin\varphi\sin^2\frac{1}{2}\varphi$.

0°	$2\sin.\varphi\sin^2\frac{1}{2}\varphi$	φ	$2\sin.\varphi\sin^2\frac{1}{2}\varphi$
0°	0.0000	95°	1.0850
5°	0.0003	100°	1.1558
10°	0.0026	105°	1.2159
15°	0.0088	110°	1.2611
20°	0.0206	115°	1.2893
25°	0.0396	120°	1.2990
30°	0.0670	125°	1.2892
35°	0.1062	130°	1.2584
40°	0.1504	135°	1.2071
45°	0.2071	140°	1.1352
50°	0.2736	145°	1.0436
55°	0.3493	150°	0.9330
60°	0.4330	155°	0.8096
65°	0.5233	160°	0.6634
70°	0.6813	165°	0.5089
75°	0.7159	170°	0.3446
80°	0.8138	175°	0.1742
85°	0.9094	180°	0.0000
90°	1.0000		

In the following diagrams, the lighter shaded portion of the area of the curve of effective force belongs to that portion of this force which is absorbed by the inertia of the reciprocating parts of the engine:



This diagram illustrates the great disturbance in the symmetry of distribution of effective force acting on the crank, introduced into the reciprocating steam-engine working without cut-off by the use of heavy pistons.

3. The case next presented is that of a similar engine working with short cut-off, the reciprocating parts being supposed to be without inertia. In calculating the coefficients of effective force, the logarithmic theory, or the law of Marriotte, is used, although the pressures of expanding steam thus deduced are somewhat above the truth. If P is the original pressure, k the cut-off expressed in terms of radius or length of crank r, and p the pressure after expansion begins, we shall have

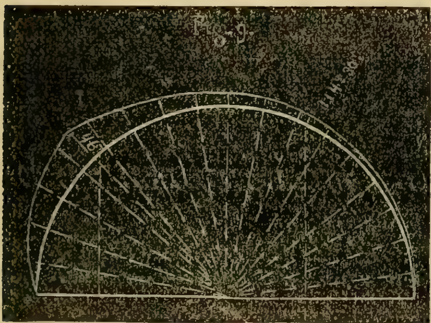
$$p = \mathrm{P}\frac{k}{r \text{ v. s. } \varphi} = \mathrm{P}\frac{k}{r\,(1 - \cos.\,\varphi)} = \mathrm{P}\frac{k}{2\,r \sin.^2 \frac{1}{2}\,\varphi}.$$

Putting, for simplicity, $\frac{k}{2r} = q$, the formula for the coefficient of the pressure will be $\frac{q}{\sin.^2 \frac{1}{2}\,\varphi} = q \operatorname{cosec.}^2 \frac{1}{2}\,\varphi$; and that for the coefficient of effective force exerted on the crank, $= q \operatorname{cosec.}^2 \frac{1}{2}\,\varphi \sin.\,\varphi$. From this formula are deduced the following values, on supposition of a cut-off at one-eighth of the length of the stroke, or $\frac{1}{4}r$; but it is to be observed that, up to the point where $r \text{v. s. } \varphi = k$, the coefficients are those corresponding to case first, in which the coefficient is, simply, $\sin.\,\varphi$. This point is that which $\varphi = 41\frac{1}{2}°$, nearly.

First quarter revolution.		*Second quarter revolution.*	
φ	$\sin.\,\varphi$	q	$q \operatorname{cosec.}^2 \frac{1}{2}\,\varphi \sin.\,\varphi$
0°	0.0000	90°	0.2500
5°	0.0872	95°	0.2291
10°	0.1736	100°	0.2098
15°	0.2589	105°	0.1918
20°	0.3420	111°	0.1750
25°	0.4266	115°	0.1594
30°	0.5000	120°	0.1443
35°	0.5736	125°	0.1301
40°	0.6428	130°	0.1166

φ	q cosec.^{2} $\frac{1}{2}$sin. φ.	135°	0.1035
45°	0.6036	140°	0.0910
50°	0.5360	145°	0.0788
55°	0.4802	150°	0.0670
60°	0.4330	155°	0.0554
65°	0.3924	160°	0.0441
70°	0.3570	165°	0.0329
75°	0.3258	170°	0.0219
80°	0.2980	175°	0.0109
85°	0.2728	180°	0.0000

The distribution of effective force in this case is shown in the following diagram to be even more disadvantageous than in the case preceding; but the work is here principally thrown upon the first quarter revolution, instead of on the second, as in that.



4. We have finally to consider the case of the heavy piston engine, working with short cut-off, and with such weight in the reciprocating parts as is indicated by theory to be that which most equally distributes the work over the circumference described by the crank. The cut-off for which the calculations are made is, as in the case last considered, one-eighth. In computing the coefficients of effective force for this case, it must be borne in mind that the initial steam pressure must be 2.6 times as great as that which would do the same work without cut-off; and the part of this which, according to what has gone before, it is most advantageous to use in overcoming inertia in the reciprocating parts of the engine, is to the total initial pressure, as 1.1 to 2.6, for a one-eighth cut-off. Hence, therefore, the formula for the coefficient will be

$$q\text{cosec.}^2\ \tfrac{1}{2}\varphi\ \sin.\varphi - \frac{1.1}{5.2}\ \sin.2.\varphi$$

The sign connecting the terms is negative; but when φ exceeds 90°, 2φ exceeds 180°, and sin.2φ becomes essentially negative; so that, during the second half stroke, the coefficient is the sum and not the difference of the two terms of the formula. The first form of this formula is only to be used for the values of φ in which r v. s. φ exceeds k. For values less than this, the formula is

$$\sin. - \frac{1.1}{5.2}\sin.2\ .$$

The coefficients found by these formulæ are the following:

$\phi \sin.\phi - \frac{1.1}{5.2} \sin.2\phi$	φ $q$cosec. $^2\frac{1}{2}\phi \sin\phi - \frac{1.1}{5.2} \sin.2\phi$
0°, 0.00000	85°, 0.61380
5°, 0.13124	90°, 0.65000
10°, 0.26326	95°, 0.69114
15°, 0.39814	100°, 0.73359
20°, 0.53566	110°, 0.80854
25°, 0.68786	115°, 0.83574
30°, 0.82370	120°, 0.85148
35°, 0.97436	125°, 0.85526
40°, 1.12964	130° ,0.84480
$q$cosec. $^2\frac{1}{2}\sin.\phi - \frac{1.1}{5.2} \sin.2\phi$	135°, 0.81910
	140°, 0.77824
45°, 1.01910	145°, 0.72118
50°, 0.85196	150°, 0.65050
55°, 0.73152	155°, 0.56534
60°, 0.64950	160°, 0.46820
65°, 0.59894	165°, 0.36054
70°, 0.57466	170°, 0.25504
75°, 0.57208	175°, 0.12382
80°, 0.58644	180°, 0.00000

The curve of effective force corresponding to this case will be seen, in the following diagram, to exhibit a more favorable distribution than has been observed in any of those previously given. The work done in the two successive quarter revolutions of the same stroke is necessarily equal; since that is a result of the mechanical conditions intentionally introduced for the purpose of securing such equality; but it is further true that the work is nearly the same in each of the four successive octants.

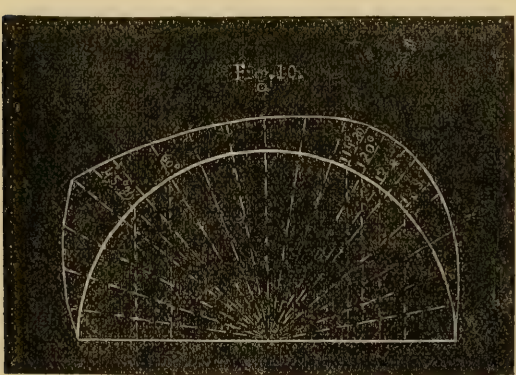


Fig. 10.

In illustration of this statement, it may be observed that the work consumed in accelerating the reciprocating parts of the engine is expressed by the formula, $\frac{(2\pi)^2}{2\,g\,T^2} r^2 \sin.^2\varphi$, and that this is equally divided at the point of the half-stroke at which $\sin^2\varphi = \frac{1}{2}$; which is true when $\varphi = 45°$. Also, that the work performed through the crank during the second half-stroke, by the gradual transformation of this living force of the reciprocating mass into work, is expressed by the analogous formula, $\frac{(2\pi)^2}{2\,g\,T^2}\,r^2 \cos.^2\varphi$. And this is equally divided at the point of the stroke at which $\cos.^2\varphi = \frac{1}{2}$; which is once more true when $\varphi = 90° + 45° = 135°$.

Furthermore, when steam is worked expansively, say with a cut-off of one-eighth, the work done is expressed by the formula,

$$Pk\left(1+\text{h l}\,\frac{r}{k}\right),$$

for the first half stroke; and by the formula,

$$Pk\left[1+\text{h l}\,\frac{2r}{k}\right]-Pk\left[1+\text{h l}\,\frac{r}{k}\right],$$

for the second half stroke.

If we put x to stand for the distance over which the piston must pass in performing one-half the work of the half stroke, we shall have the two equations,

$2Pk\left[1+\text{h l}\,\frac{x}{k}\right]=Pk\left[1+\text{h l}\,\frac{r}{k}\right]$, for the first half stroke; and

$2Pk\left[1+\text{h l}\,\frac{x}{k}\right]=Pk\left[1+\text{h l}\,\frac{2r}{k}\right]-Pk\left[1+\text{h l}\,\frac{r}{k}\right]$, for the second. Whence, in the former case, $1+\text{h l}\,\frac{x^2}{kr}=0$.

If $r=1$, and $k=\frac{1}{4}$, $\text{h l}\,4x^2=-1$; and $\text{h l}\,2x=-\frac{1}{2}$; or

$$\text{h l}\,\frac{1}{2x}=+\tfrac{1}{2}=0.5.$$

And $x=0.30327$, which is the natural versed sine of the angle 45° 50′.

The total work of the steam is thus divided, in the first half stroke, very nearly at the middle point of the quadrant, and the amount of this work which the inertia of the piston absorbs, is divided exactly at that point. Whence the portions of this work which are done in the successive octants are very nearly the same.

In the second case we have immediately,

$$\text{h l}\,\frac{x^2}{k^2}=\text{h l}\,\frac{2r^2}{k^2}, \text{ or } x^2 = 2r^2.$$

Whence $x = r\sqrt{2}$; or putting $r=1$, $x = 1.4142$, which is the natural versed-sine of 114° 30′; say 115°.

The work done by the steam in the second quadrant is equally divided, therefore, at a point not one-third advanced from the beginning, but that which is added by the living force of the reciprocating mass, which is the greater of the two, is equally divided, in this as in the quadrant preceding, exactly at the middle point, where $\varphi = 135°$. The point of equal division of the whole combined will be not far from that in which $\varphi = 126°$.

In working steam without cut-off, the moving parts being supposed to be without inertia, the points of equal division of the work in the successive quadrants are those in which $\varphi = 60°$, and $\varphi = 120°$.

The preceding figure shows these several points. It may be remarked finally in respect to this matter, that, inasmuch as the logarithmic theory, applied to the pressure of steam working expansively, is too favorable to the low pressures in the second half stroke; therefore, in practice, considerably more mass may with propriety be given to the reciprocating parts of the engine than the theoretical determinations here reached would justify; and the effect of such increase of weight will be to advance the point of equal division of the work of the second quadrant still nearer to the middle point where $\varphi = 135°$.

One further particular deserves a moment's attention here: It will be seen, by a careful comparison of the last diagram and the accompanying table, that the effective force exerted tangentially on the crank, for points only 10° from the centers, exceeds one-fourth the mean pressure on the piston, or that which, exerted uniformly, would do the same work per revolution, while the mean tangential effect of such uniform pressure would be about five-eighths; also, that the effective force runs from these points rapidly up. It is only, therefore, for about one-ninth part of the semi-revolution that the driving force falls below, say, two-fifths of the mean; and this, with 120 revolutions to the minute, gives less than the thirty-sixth part of a second to the duration of each interval in which this force is largely deficient. To this fact may be ascribed, in large measure, the facility with which the crank passes the centers, so that this facility is manifestly promoted by running at high speed.

The conclusions to which the foregoing discussion leads, may be summed up briefly thus:

High velocities and considerable weight in the reciprocating parts of cylinder steam-engines, working expansively, are advantageous in the following particulars: First. In distributing the work done with a near approach to uniformity over the circumference described by the crank in its revolution; and, secondly, in greatly reducing the irregularities of strain experienced by the working parts of the engine, especially as it respects the torsion of the shaft.

The advantage derivable from the use of heavy pistons increases with increase of weight only up to a certain point; which point is dependent on the initial pressure of the steam in the cylinder, on the point of the stroke at which cut-off is made, and on the velocity of revolution. A high-speed, heavy-piston engine depends, like every other reciprocating engine, upon the inertia of its fly-wheel or other rotating parts for the facility with which it passes the centers; but it taxes these regulators less than the ordinary reciprocating engine, because of the brevity of the intervals during which the effective force intermits.

There must be, at the beginning of the stroke, a large excess of steam pressure above that which is required to overcome the inertia of the piston and impart to it the necessary acceleration; otherwise the advantages derivable from this construction and mode of working will not be fully secured; and the irregularity of working of the engine may even be exaggerated.

The counterpoise weight, employed to balance the strain exerted toward the close of the stroke by the heavy piston upon the crank, ought not to exceed one-half the weight of the reciprocating mass to which it is opposed: otherwise, immediately after the passage of the centers, the strain on the main shaft in the direction opposite the crank will be excessive, and may be injurious.

F. A. P. BARNARD,
Chairman of Judges, Group 1, *Department V*, 1870.

Mr. C. E. Emery—After so admirable and elaborate a discussion, in so scientific a manner, it seems useless to add anything further. Unfortunately, however, those who build steam-engines do not have the leisure to make such abstruse calculations. Facts of this character must be reached in some simple manner, until the exact results are published, as I hope these will be. I will mention that in most engines, practically, the mean pressure is substantially the same as that given by the parabolic theory. This occurs for two reasons. First, there must be a terminal clearance, which diminishes the pressure somewhat; and, second, most engines use more steam than the theory would give, absorbing heat from the cylinder toward the end of the stroke, to evaporate the water, and make more steam. In ordinary practice, therefore, the rule by the parabolic system is sufficiently accurate.

I suppose Mr. Porter would hardly admit, as this paper intimates, that he put the weight into his piston without calculations on the subject. Those who heard the discussions here a year ago will not consider it probable. I do not suppose he made so elaborate an investigation as has been laid before us to-night; but I think by a little arithmetical calculation, the proper weight to be put in the piston can be obtained without difficulty. For illustration, taking the cylinder sixteen inches in diameter and thirty-two inches stroke, running at 120 revolutions per minute. The diameter of the circle being thirty-two inches, and its circumference eight and one-third feet, the velocity is sixteen two-thirds feet per second, which, for simplicity, we may consider exactly equal to one-half *g*. The velocity varies sensibly as the pressure. A pressure of one pound will give to a mass of one pound a velocity of thirty-two feet in a second; so that half a pound pressure will produce the velocity corresponding with the acceleration in a second. If then we have 1,500 pounds in the moving parts, there ought to be 750 pounds pressure on the piston, supposing the acceleration to take place in one second. But, as we have two revolutions per second, and as the acceleration takes place in one-quarter of a revolution, it takes place in one-eighth of a second. The velocity varies with the pressure, and, in order to get the required acceleration in one-eighth the time, we must have eight times the pressure, or 6,000 pounds; that is, there must be 6,000 pounds acting on that piston, in order to give it the requisite velocity in mid-position. As the piston has an area of about 200 inches, about thirty pounds mean pressure will be transferred from the first part of the stroke to the latter part of the stroke; and, in this manner, it is easy to make the calculation with other cylinders, and with a different velocity.

Mr. C. T. Porter—Eleven or twelve years ago I became interested in the remarkable improvements of Mr. Allen in the valves and valve-gearing of steam-engines. It had long been well settled that the best economy was obtained by working steam expansively, and by variable cut-offs. All the valve-gears adapted to this were some form of the detachable valve-gear of which the Corliss valve-gear is a prominent illustration. There existed no system of working the valves by positive movement. Mr. Allen accomplished this by his adaption of the link motion, and introduced equilibrium valves. At that time I became impressed with the idea that this system of valve-gearing was admirably adapted for the progress of a high-speed engine. I was also impressed with the idea that the day was coming when high speed engines would become a necessity, attaining high speed not merely by making long strokes of nine or ten feet, but combining high speed with a short stroke, giving a rapid rotation; and this problem I undertook to solve.

I went to England, and there I met with the same objections that were raised here. They said I could not work steam expansively by positive motion, because we should close the parts suddenly, and open them gradually, whereas positive motion would give as rapid opening as closing; and the faster the engine is run, the worse would be the effect. I found on conversing with engineers that the idea was universal and traditional that steam must be admitted to an engine very gently indeed. The original engines were all beam engines, and the strain being double the force of the steam, had broken many engines, so that engineers were sore on that subject. That idea I had to combat; and I did it by making the engines, and running them. I found on trial that the difficulty was not aggravated, but, on the contrary, removed to a great extent by a moderately rapid speed. Again, engineers said that high speed would be very good, provided the piston could be kept in motion in one direction all the time; but, unfortunately, it has to be stopped and put in equally rapid motion in the opposite direction. I saw that the only way was to present to their senses the phenomenon that must be accounted for. When I stated, in a paper that I read before the Association of Mechanical Engineers in England, that the accelerating force was greatest precisely on the center, the president of the association interrupted me, and said that I certainly could not mean that, for there the piston was entirely passive, and I could not mean to dispute it. I told him I did mean to dispute it; but he shook his head very wisely, and Mr. Cowper silenced me effectually by showing on the blackboard that the point of greatest acceleration was some distance from the center, and that at the ends and middle of the stroke there was no acceleration. My doctrine was heresy to the gospel according to Tredgold, and they would not receive it.

So I made an engine, and took it to the Paris Exposition. The piston was twelve inches diameter, and it made 200 revolutions per minute. It ran like a wheel, with no sign of a dead center about it, and some of the greatest engineers came there and studied it for hours.

When that engine had run there for months, the proposition was settled.

In using the expression "centrifugal force" in relation to the reciprocating parts of a steam-engine, I have always meant the centrifugal force upon the dead centers, and at no other point. Dr. Barnard's conclusion that the proper weight of the piston is that which will be sufficient to absorb about half the initial pressure of the steam is one that I arrived at as a practical result long ago; and the larger engines which I have built have been constructed upon that principle. I am unspeakably gratified that the investigation by the calculus, of which I am ignorant, brings investigators to the same results.

It is undoubtedly possible to have the counterbalancing weight too large. Without any counterbalancing weight, the engine would be unsteady. The recoil of the cylinder, in expelling the piston, being precisely the same as that of a gun expelling the shot, must be neutralized. In our larger engine, we have found that one half the weight of the reciprocating parts is sufficient to keep the engine steady; but in the smaller size we have had to make the counterbalance equal in weight to the whole reciprocating parts; for otherwise they would not run with perfect steadiness.

Mr. J. K. Fisher—My impression is that we are beginning to understand this subject more clearly. The utility of high speed engines, and of counter-weights, on locomotives, is recognized; and it is understood that in cutting off short, the strain is not at the beginning of the stroke, but at the end of the stroke. The men who build engines are not generally highly educated mathematicians, and we need to have mathematicians calculate the distribution of the power, and the strain upon the materials. All our formulæ for strains are false until the time of Rankin. When Watt began to work with his steam-engine without a cut-off, he found that his piston came down with a bang, and by experiments he found that he could do the work, cutting off at one-quarter of the stroke, without increasing the pressure of the steam. The use of the steam expansively has saved an enormous amount of fuel, and prevented great waste of power. I am very glad to see professional mathematicians co-operating with practical men, for they are needed as writers.

On motion of Mr. C. E. Emery, the thanks of the Association were unanimously tendered to Dr. Barnard for his very able paper presented this evening.

Mr. Hamilton E. Towle—It is usual in theaters, after a heavy tragedy to have a little farce; and, if it is not inappropriate, I will give the mathematicians present the benefit of a new symbol which met with some approval the first time it came before an audience.

It has been remarked that the formulæ of science do not provide for all that we have to contend with in practice. By way of illustration, I will suppose a wall pressed on two sides by different heads of water H′ and H′, as in the case of a lock-gate. I will not trouble you with differentiation or integration; but there are formulæ which determine that under such circumstances the thickness must be exactly so much to stand. The difficulty is that the formulæ do not provide for the contingencies in practice. For instance, a block of wood catches in the bottom of the gate; and there is no formulæ under heaven that provides for that case. Again, this wall is built of the exact thickness required by the books; but a bad navigator comes along, perhaps a little tight, and runs his boat against it, and the whole affair goes to the dogs. Now, we must have something to add to our formulæ to take into account the skill or want of skill of the engineer, and all the circumstances not included in the calculations. Every man's experience differs. Let any man take Dr. Barnard's formulæ, apply them universally, and they will almost universally fail. We see that in bridges, in dams, and in all sorts of things. The professor said he had not taken into account clearance, but clearance will play the dickens with it if it is not taken into account. What shall we do then? I suggested to the Institution of Engineers in London the idea of using a character which should represent a co-efficient in every formulæ, which you may call the personal equation if you like, to take into account the block of wood, the carelessness of the boatman, clearance, everything, according to the notions of the man that applies it. I would prefix that co-efficient in every formulæ, and call it the co-efficient of common sense; and the engineer must use that co-efficient of common sense all the time if he wants reliable results.

Dr. Barnard—One remark upon the relation that exists between pure abstract theory and practice. It is impossible in a purely abstract theory to present formula which will exactly meet practical cases. But it does not follow that these mathematical formula do not express the absolute truth. The formula expresses the absolute truth in its simplest form. In practice there are conditions which modify the result, but the formula shows for itself what conditions are included, and all others are left for subsequent ascertainment, by experiment or by a more extended formula. If we can make the necessary corrections for the omitted conditions, our results will agree with practice; or if there are no modifying conditions, the formula is absolutely true.

Mr. Towle—I hope the gentleman did not understand me as questioning the formula. I would look to them first, and then take in other things besides.

Dr. Barnard—I wanted to explain that mathematics are not to be undervalued because they do not tell all the truth. They do tell all the truth with regard to the prescribed conditions. if there are certain other conditions that cannot be defined, they cannot be put in a mathematical formula, and must be considered separately, and superadded. It is necessary to have experiments in many branches of practical mechanics, in order to have theory; but without theory what would be the value of observations? You can grope your way by experiment to some valuable results; but you cannot make a system, or form a safe conclusion, without theory. Mathematics does not tell you everything, but what it tells you is true. The formula do not tell you everything about the steam-engine, but they tell you what conditions they assume, and the results of these conditions, and tell you to look for and investigate the other conditions independently, to see how they will modify the practical results. They are not a sole guide, but they are a valuable aid; and without the aid of absolute abstract science, you cannot have any practical science that is good for anything. (Applause.)

Mr. Emery—Every successful engineer depends on theories as a basis; but it is often necessary to make large allowances. In steam-boilers, for instance, we make enormous allowances, and yet make much less allowance for accident than in many other cases. In building a bridge we give it six times as much strength as is required by calculation; but nine-tenths of the boilers that are made allow only about three and a half times. With an agent capable of causing so much destruction, we tamely submit to be blown up occasionally, from neglecting the precaution that we take in the beams of a house, or in the construction of a bridge. If in doubling the size of an engine, every part were to be doubled in size, we should make some parts too heavy, and others too weak. We must observe scientific principles to make the proportions correct.

For the want of true scientific knowledge we often see in steam-boilers one part capable of sustaining 500 pounds, another 200 pounds while the shell itself will bear perhaps but 100 pouuds. These subjects require investigation; and there is need of mathematics as the foundation. The question before us to-night is one of pure mathematics. It is a matter where there are no allowances to be made. The proper weights for pistons are to be ascertained by pure mathematics. It has been said that the formulæ before Rankin are incorrect. It is usually the case that it is only the constants in these formulæ that are in error; so that by substituting the proper coefficients they may be made accurate. In many cases it is only to multiply the result by a constant quantity. In that way the old formulæ are used every day.

Adjourned.

March 1, 1872.

Prof. S. D. Tillman, in the chair; Robert Weir, Esq., Secretary.

Cutting Irregular Forms.

Dr. Virgil W. Blanchard, of Bridport, Vermont, explained his machine for cutting irregular forms automatically in wood, iron or stone, and exhibited a sample of the work in stone. The principle is essentially the same as that of the Blanchard lathe. The difficulty in cutting in stone hitherto has been two-fold. First, to produce a pattern that the tracing-bar will run upon rapidly; and, second, to preserve the sharpness of the cutting point. This machine produces, from the model, a pattern which is almost a plane surface, and then transposing the tracing and the cutting points, from that pattern a perfect facsimile of the model may be produced. He read the following description of the machine, written by J. E. Emerson, the inventor of the movable tooth-saw:

For the past fifty years many attempts have been made to devise mechanism to automatically produce the irregular forms found in carving, sculpture, bronze, etc., but which have till now signally failed. This lathe, or engine, to which any amount of motive power may be applied that may be requisite that will automatically produce any of the irregular forms found in carving, sculpture, bronze work and engraving—that will produce every line and feature with mathematical precision and certainty—that will work equally well upon wood, stone or metal, that is simple in construction and easy to manipulate, has long been wanted to meet a great and growing demand in the field of the fine arts.

Every want seems to be fully realized in this invention to which reference is made. The difficulties in the mechanical problem solved by this invention are five-fold in character.

First, to devise a pattern of such a character so near a plane that an anti-friction ball will roll rapidly upon its surface, and yet have *such* a pattern produce the irregular form desired.

Second, to have the cutting point so sensitive to the motions of the tracing ball upon the pattern as to produce with mathematical certainty and precision every line and feature found upon the surface of the pattern, in the material wrought, and yet, in the presence of all this delicacy and sensitiveness in action, to be able to apply any desired amount of force or motive power to the cutting point.

Third, to be able to transfer the design of the same pattern to any variety of form in the material wrought, whether an oval, cylindrical or plane surface, or any other that may be desired.

Fourth, to adapt the mechanism of the machine to the production of the pattern from the original work of art.

Fifth, to combine the solution of the above four mathematical problems in a simple, durable, practicable form, the machine as a whole being perfectly *automatic* in its action.

In the practical operation of this invention, the work of art, whatever it may be, whether a bust, or sculptured vase, or an ordinary piece of carving, is placed in the machine; a piece of wood of the requisite size is at the same time placed in the proper position in the machine from which the pattern for future use is to be cut.

The machine, on being put in motion from the work of art, whatever it may be, will produce a pattern in the wood from which a duplicate of the work of art may be produced. A metal cast of the pattern, after being produced in the manner described, on an almost plain surface, is then taken—filling, in this invention, the place of the stereotype plate in the art of printing.

The metal cast of the pattern being put into a proper position in the machine, and a suitable form of wood, stone or metal being placed in the position occupied by the work of art during the process of cutting the pattern, as above described, the machine, with a suitable cutting point and requisite amount of motive power, will *automatically* produce the work of art, whatever it may be, with a rapidity in proportion to motive power applied.

The principles involved in this invention and in their application are entirely novel in the field of mechanical art. As a combination of intricate and delicate action, with the great strain resulting from the application of a large amount of motive power, yet with all the delicacy and sensitiveness preserved and applied in the midst of high velocities and ponderous effect, with a mathematical precision that is beyond criticism, this invention is truly a crowning, and as yet the grandest, triumph in applied dynamic science.

As illustrative of this point, we would observe that to the cutting point, where a delicacy and sensitiveness in action is required that will produce the most delicate lines and features found in an elaborate piece of statuary, in the machine which I recently saw in operation, from one to four horse-power as a motive agency could be applied.

As a piece of automatic machinery, in simplicity and general adaptation to the end desired, competent judges pronounce this invention to be unrivaled.

On visiting the doctor's pleasant house, there, on the mantel-shelf in his parlor, sat a bust of Webster, just as it came from the machine, every feature perfect, and the life-like expression of the lion face never excelled by any artist. Surely will mechanism compel the sculptor to lay down his chisel.

Dr. B. proceeded to explain the cutting point. It has been hitherto supposed that a slow motion is required. On the contrary, it is found that, when revolving forty or fifty revolutions per second, its cutting property will be destroyed; but revolving from seventy to eighty revolutions per second, it will last indefinitely. Fine steel may be made to retain its sharpness in the presence of quartz.

The President—The principle involved is the same as in the Tilghman Sand-blast, that a soft substance in rapid motion will cut a much harder substance. Some years ago a wooden steamboat, the Swallow, ran directly through one of our city piers, which was filled in with stone; and I learn from Dr. Blanchard, to whom I stated this to-day, that it was one of the facts which led him to make his discovery.

Dr. Blanchard—It was the great fact.

The President—On the same principle a disk of copper may be revolved so rapidly as to cut the hardest steel. The essential improvements in this machine, over the lathe of Thomas Blanchard (of whom the Dr. is a distant relative), is that the tool has a rapid rotation.

Dr. P. H. Van der Weyde—If the pier had been in motion and the vessel still, the result would have been the same. When the disc of copper cuts the steel, it is not by its velocity, but because a great many particles of copper come to act upon the same point. But in the case of the vessel coming in contact with the pier, motion and rest being only relative, it makes no difference which was in motion.

The President—It is said, you can shoot a tallow candle through a pine board.

Dr. Van der Weyde—For the same reason that a great many particles follow each other to increase the effect produced by the first.

Mr. Reuben Bull described a similar machine which he had constructed in 1866. The tool revolved 8,000 times per minute. All the works revolved on steel points; there being thirty-two steel points, connected with two sets of parallel levers. It required to be guided by the thumb and finger in tracing, and was used for cutting medallions, eight inches in diameter.

Dr. Van der Weyde stated that a similar machine was used for making wood type, cutting the forms of the letters, but not producing relief, as in other machines.

Dr. Blanchard—My machine does not require skilled labor; it is automatic. Ten or twelve cutting points can be applied at once. With two points it will cut in marble ten superficial feet, two inches deep, in ten hours, using four-horse power. A cylindrical surface may be cut with equal facility.

Mr. Kelly stated that the work done with Mr. Bull's machine was more delicate than the sample produced.

Dr. Blanchard explained that the sample was cut in a very soft stone, and was not intended to show the capability of the machine in cutting a fine stone.

Mr. Charles T. Porter added the explanation that the pattern itself, in this case, was of wood, and not delicately finished.

Mr. J. K. Foster suggested that the principle of giving drills a high speed might be applied to great advantage in tunneling.

Dr. J. W. Richards suggested the use of this machine for forming spectacle lenses.

Mr. Raynor stated that in slitting the iridium points of gold pens, 18,000 revolutions per minute are required.

Dr. Blanchard (in reply to Mr. Fisher) stated that his machine would either enlarge or diminish the size, if desired.

The President remarked that this was peculiarly an American invention, and narrated the manner in which the original Blanchard lathe came to be invented.

The same inventor presented the following papers:

ROOFING.

By V. W. BLANCHARD, M. D.

In this invention I do not claim any new form or mode of constructing a roof. I only claim a cheap, durable, fire-proof roofing material. In this invention, the soft, cheap varieties of wood, such as poplar, sapling pine, whitewood and other varieties of a similar character, whose loose, soft fiber unfits them for ordinary shingle, are first cut into the form of the ordinary taper shingle or slate. These are then passed between two toothed rollers, in a bath of coal tar heated to about 300 degrees F. These rollers are so arranged that their teeth may be made to penetrate or perforate the wood to any desirable depth. They are also arranged in the alternate or quin quick order, so as to cut as much of the grain of the wood as possible. By this means, the wood treated in the manner described may be saturated to any desirable degree by the coal tar. The shingles are then placed in a dry-house and the volatile and inflammable elements of the coal tar evaporated therefrom. They are then surfaced or "veneered" with a coat of coal tar pitch from which the volatile and inflammable elements have been entirely removed by distillation. If desirable, in the process of surfacing or "veneering" the shingle with coal tar pitch, a stone finish may be applied at a very slight cost. By the process of saturating the wood with coal tar and then evaporating its volatile and inflammable elements, we have actually a diffusion of coal tar pitch, which is one of the most uninflammable, tenacious cements known, diffused through the grain of the wood. As a result of this we have a fire and water-proof shingle, much stronger than the ordinary wood one, that can be afforded at a much less price. Good pine shingles are now selling all over the country at from five and one-half to seven dollars per thousand. The first cost of this improved form of shingle, prepared in the manner described, is from one and one-half to two dollars per thousand. The company manufacturing the article (like the sample) deliver the same at the depot of shipment for four dollars per thousand. In more favorable localities they could be afforded for three, and sold in the retail trade at a cost not exceeding four dollars per thousand.

Manufacture of Steel and Malleable Iron

By Virgil W. Blanchard, M. D.

I do not claim the introduction of any new principle in the process of the reduction of cast-iron to malleable iron and steel.

I do, however, claim to have simplified the "air blast," or pneumatic principle, so as, first, to be able to produce a homogeneous product. Second, to remove any per centum of carbon from the metal that may be desirable, and therein to have so simplified and cheapened the process as to put it within the reach of every manufacturing interest in the country. In the practical application of this invention, a stream of molten iron direct from the blast furnace is carried to the converting vessel. By means of a gauge the stream is rendered uniform in size.

The converting vessel is simply a cylindrical vessel, lined with fire-brick and provided with an aperture for the entrance of the stream of molten metal, and another just beneath it for the entrance of the hot-air blast.

These two apertures enter the vessel about two feet above its bottom, the vessel being about ten feet in height. At the lowest point, at the bottom of the vessel is another aperture, which, during the reducing process, should be plugged with fire-clay, for drawing off the metal after reduction has taken place. It should be borne in mind that the hot-air blast enters the reducing vessel just beneath the aperture through which the stream of molten metal enters. A projection or ledge is formed in the inner side of the vessel, from the edge of which the molten metal is allowed to flow downward in a thin, uniform stream. Beneath the ledge or projection the blast is applied, at an obtuse angle, upward against the thin flowing stream of molten metal. The result is that the stream of molten is dashed to atoms by the impinging blast. The blast is so directed from below, upward, that the flying particles of molten metal strike the side of the converting vessel about four feet above the spot where the metal enters. By this means every particle of molten metal is brought into contact with the free oxygen contained in the blast.

By this arrangement of working on a thin stream of molten metal only, a small amount of force per square inch in the reducing blast is required. By this means of working on a uniform stream of molten metal by a uniform blast, a homogeneous product is produced. So, with a given stream of molten metal, by increasing or diminishing the force and volume of the blast, a greater or less per cent of carbon may be eliminated from the same. If desirable, a number of these converting vessels may be arranged one below another; the metal passing from one to another in the process of reduction. In this method malleable iron or steel may be very cheaply manufactured from cast-iron. By this method an intermediate metal may be produced at a very slight cost, that will become invaluable in the arts. By removing about one-half of the carbon from ordinary cast-iron a product having nearly the malleability of ordinary malleable iron, yet retaining the rigidity of cast-iron, is the result. Tests have determined that it possesses nearly double the tensile strength of ordinary cast-iron without its liability to fracture. This metal, heated to a dull cherry red, will draw considerably under the hammer. Its susceptibility to take a "chill," as compared with ordinary cast-iron, is increased rather than diminished. A chilled surface of this metal, if the metal contains at the same time a proper proportion of tiltanium and clorine acid, nearly or quite equals the ordinary black diamond as a material for cutting purposes.

By the use of this metal, gearing of all kinds and a great variety of machinery could be lessened in weight, while its strength and durability would be increased.

I would here remark that the air-blast, as found in the ordinary machine shops of our country, is sufficient, if properly applied, in the production of steel and malleable iron from cast-iron according to this process.

This process is equally effective, applied to the process of puddling. The cast-iron can be reduced to pure malleable iron by simply continuing the process to the requisite extent.

The President—One peculiarity of this process is that you can graduate the amount of air so as to produce pure steel or any gradation. Bessemer has to use about twenty pounds pressure to the square inch in his blast. The result is that the air passes up through in channels, and only a very small part of the oxygen is utilized. In this process nearly all the oxygen is utilized. Another peculiarity is that this apparatus can be applied readily to any ordinary furnace. Its utility, however, can only be ascertained by many experiments.

Mr. J. B. Root—What will be the additional expense of the casting?

Dr. Blanchard—Merely the loss of two and one-half per cent of carbon.

The President—The oxygen of the air unites not only with the carbon, but with the iron; and there is the great point to be settled with regard to the economy of this process: how much iron is burned up and reduced to oxide? In the Bessemer process, about ten per cent of the iron is supposed to be consumed.

Dr. Blanchard further stated that the air-blast has a pressure of four pounds to the square inch, and is heated to about 600 degrees. He proposed hereafter to try the effect of chlorine gas in the blast, to eliminate the phosphorus.

THE IMPROVEMENT OF THE STEAM-ENGINE AND THE EDUCATION OF ENGINEERS.

By PROF. R. H. THURSTON.

Having rapidly sketched the history of the steam-engine, and of some of its most important applications, we may now take up the question: What is the problem, stated precisely and in its most general form, that engineers have been here attempting to solve?

After stating the problem, we will examine the record with a view to determine what direction the path of improvement has taken hitherto; and, so far as we may judge the future by the past, by inference, to ascertain what appears to be the proper course for the present and for the immediate future.

Still further, we will inquire, what are the conditions, physical and intellectual, which best aid our progress in perfecting the steam-engine.

This most important problem may be stated in its most general, yet definite, form as follows:

To construct a machine which shall, in the most perfect manner possible, convert the kinetic energy of heat into mechanical power, the heat being derived from the combustion of fuel, and steam being the receiver and the conveyer of that heat.

The problem embodies two distinct and equally important inquiries.

The first: What are the scientific principles involved in the problem as stated?

The second: How shall a machine be constructed that shall most efficiently embody, and accord with, not only those scientific principles, but also all of those principles of engineering practice that so vitally affect the economical value of every machine?

The one question is addressed to the man of science, the other to the engineer. They can be satisfactorily answered, even so far as our knowledge at present permits, after studying with care the scientific principles involved in the theory of the steam-engine under the best light that science can afford us, and by a careful study of the various steps of improvement that have taken place, and of accompanying variations of structure, analyzing the effect of each change, and tracing the reasons therefor.

The theory of the steam-engine is too important and too extensive a subject to be treated here in even the most concise possible manner.

I can only attempt a plain statement of the course which seems to be pointed out by science as the proper one to pursue in the endeavor to increase the economical efficiency of steam-engines.

The teaching of science indicates that success in economically deriving mechanical power from the energy of heat motion, will, in all cases, be the greater as we work between more widely separated limits of temperature, and as we more perfectly provide against losses by dissipation or heat in directions in which it is unavailable for the production of power.

Scientific research has proved that, in all known varieties of heat engine, a large loss of effect is unavoidable from the fact that we cannot reduce the lower limit of temperature, in working, below a point which is far above the absolute zero of temperature; far above that point at which bodies have no heat motion; the point corresponding to the mean temperature of the surface of the earth is the lower limit.

The higher the temperature of the steam when it enters the steam cylinder, and the lower that at which it arrives before the exhaust occurs, the greater, science tells us, will be our success, provided we at the same time avoid waste of heat and power.

Now, looking back over the history of the steam-engine, let us rapidly note the prominent improvements and the most striking changes of form, and thus endeavor to obtain some idea of the general direction in which we are to look for further advance.

Beginning with the machine of Porta, at which point we may first take up an unbroken thread, it will be remembered that we there found a single vessel performing the functions of all the parts of a modern pumping engine; it was, at once, boiler, steam-cylinder and condenser, as well as both a lifting and a forcing pump.

The Marquis of Worcester divided the engine into two parts using, a separate boiler.

Savery duplicated that part of the engine of Worcester which performed the several parts of pump, steam-cylinder and condenser, and added the use of water to effect rapid condensation.

Newcomen and Cowley next separated the pump from the steam-engine proper, and in their engine, as in Savery's, we noticed the use of surface condensation first, and subsequently that of the jet, thrown into the midst of the steam to be condensed.

Watt finally effected the crowning improvements, and completed the movement of "differentiation" by separating the condenser from the steam-cylinder. Here this movement ceased, the several important processes of the steam-engine now being conducted, each in a separate vessel. The boiler furnished the steam, the cylinder derived from it mechanical power, and it was finally condensed in a separate vessel, while the power which has been obtained from it in the steam-cylinder was transmitted, through still other parts, to the pumps, or wherever work was to be done.

Watt, also, took the initiative in another direction. He continually increased the efficiency of the machine by improving the proportions of its parts and the character of its workmanship, thus making it possible to render available many of those improvements in detail, upon which effectiveness is so greatly dependent, and which are only useful when made by a skillful workman.

Watt and his cotemporaries also commenced that movement toward higher pressure of steam and greater expansion, which has been the most striking feature noticed in the progress of steam-engineering since his time.

Newcomen used steam of barely more than atmospheric pressure, and raised 105,000 pounds of water one foot high with a pound of coal consumed. Smeaton raised the pressure somewhat, and increased the duty considerably; Watt started with a duty double that of Newcomen and raised it to 320,000 foot-pounds per pound of coal, with steam at ten pounds pressure.

To-day, Cornish engines of the same general plan as those of Watt, but worked with forty to sixty pounds of steam and expanding three or four times, do a duty probably averaging, with the better class of engines, 600,000 foot-pounds per pound of coal. The compound pumping engine runs the figure up to about 1,000,000.

The increase in steam pressure and in expansion since Watt's time have been accompanied by a very great improvement in workmanship; a consequence, very largely, of the rapid increase in perfection, and in the wide range of adaptation of machine tools, by higher skill and intelligence in designing engines and boilers, by increased piston speed, greater care in obtaining dry steam, and in keeping it dry, until thrown out of the cylinder, either by steam jacketing or by superheating, or both combined; and it has further been accompanied by greater attention to the important matter of providing carefully against losses by radiation and conduction of heat.

The use, finally, of the compound or double-cylinder engine, for the purpose of saving some of the heat usually lost in consequence of condensation from great expansion, has already been alluded to when treating of the marine engine.

It is evident that, although there is a limit, tolerably well defined, in the scale of temperature, below which we cannot expect to pass, a degree gained in approaching this lower limit is more remunerative than a degree gained in the range of temperature available by increasing temperatures.*

Hence, the attempt made by the French inventor, Dr. Trembly, twenty-five years ago, and by other inventors since, to utilize a larger proportion of heat by approaching more closely the lower limit, was in accordance with known scientific principles. The form of engine

* The fact here referred to is easily seen, if it is supposed that an engine is supplied with steam at a temperature of four hundred degrees above absolute zero, and works it, without waste, down to a temperature of two hundred degrees. Suppose one inventor to adapt the engine to the use of steam of a range from five hundred down to two hundred degrees, while another works his engine, with equally effective provision against losses, between the limits of four hundred and one hundred degrees—an equal range with a lower mean. The first case gives an efficiency of one-half, the second three-fifths, and the third three-fourths, the latter giving the highest effect.

here referred to is known among engineers as the Binary vapor engine. In it the heat of the water from the condenser of the steam engine is made to evaporate some very volatile liquid, as ether or carbon-di-sulphide, which, in turn, by the expansion of its vapor, develops additional mechanical power. Mechanical difficulties have hitherto prevented the success of this form of engine, but it cannot be pronounced unlikely that coming inventors may make the system commercially valuable.

We may now summarize the result of our examination of the growth of the steam-engine thus:

First. The process of improvement has been one, primarily, of "differentiation;" † the number of parts has been continually increased; while the work of each part has been simplified, a separate organ being appropriated to each process in the cycle of operations.

† This term, though perhaps not familiar to engineers, expresses the idea perfectly.

Secondly. A kind of secondary process of differentiation has, to some extent, followed the completion to the primary one, in which secondary process one operation is conducted partly in one and partly in another portion of the machine. This is illustrated by the two cylinders of the compound engine and by the duplication noticed in the Binary engine.

Thirdly. The direction of improvement has been marked by a continual increase of steam pressure, greater expansion, provision for obtaining dry steam, high piston speed, careful protection against loss of heat by conduction or radiation, and, in marine engines, by surface condensation.

The direction which improvement seems now to be taking, and the proper direction, as indicated by an examination of the principles of science, as well as by our review of the steps already taken, would seem to be:

Working between the widest attainable Limits of Temperature.

Steam must enter the machine at the highest possible temperature, must be protected from waste, and must retain, at the moment before exhaust, the least possible amount of heat. He whose inventive genius, or mechanical skill, contributes to effect either the use of higher steam with safety and without waste, or the reduction of the temperature of discharge, confers a boon upon mankind.

In detail: In the engine the tendency is, and may probably be expected to continue, in the near future at least, toward higher steam pressure, greater expansion in more than one cylinder, steam jacketing, superheating, a careful use of non-conducting protectors against waste, and the adoption of higher piston speeds.

In the boiler: more complete combustion without excess of air passing through the furnace, and more thorough absorption of heat from the furnace gases.

The latter, I am inclined to suppose, will be ultimately effected by the use of a mechanically produced draught, in place of the far more wasteful method of obtaining it by the expenditure of heat in the chimney.

In construction we may anticipate the use of better materials, and more careful workmanship, especially in the boiler, and much improvement in forms and proportions of details.

In management there is a wide field for improvement, which improvement we may feel assured will rapidly take place, as it has now become well understood that great care, skill and intelligence are important essentials to the economical management of the steam-engine, and that they repay, liberally, all of the expense in time and money that are requisite to secure them.

In attempting improvements in the directions that I have indicated, it would be the height of folly to assume that we have reached a limit in any one of them, or even that we have approached a limit.

If further progress seems checked by inadequate returns for efforts made, in any case, to advance beyond present practice, it becomes the duty of the engineer to detect the cause of such hindrance, and, having found it, to remove it.

A few years ago, the movement toward the expansive working of high steam was checked by experiments, seeming to prove positive disadvantage to follow advance beyond a certain point.

A careful revisal of results, however, showed that this was true only with engines built, as was then common, in utter disregard of all the principles involved in such a use of steam, and of the precautions necessary to be taken to insure the gain which science taught us should follow. The hindrances are mechanical, and it is for the engineer to remove them.

We have seen that the most important problem offered the engineer for solution is a double one, and that it requires the aid of both the scientist and the mechanist in its solution. But it is sufficiently evident that, before the engineer can determine what form of machine will best yield to him the control of these forces of nature, he must have sufficient knowledge of science to be able to understand what scientific principles are to be rendered available, and what phenomena of nature are operating in the production of the power which he is to seize upon and usefully to apply. Otherwise he will grope in the dark, and will only learn, by the bitter experience of costly failures, to make slow progress toward perfection.

We have seen that the greatest improvements effected in the steam-engine were due to the united engineering skill and experience, and to the scientific attainments of James Watt.

We saw that his improvements followed a long course of intelligent and scientific research, and that, directed by the results of this investigation, the engineering talent and the mechanical knowledge of the great inventor accomplished more in a single lifetime than had been previously accomplished in the whole period embraced in the history of civilization.

This great example confirms what we should infer from the nature of the problem itself, that he who would accomplish most in the profession of the mechanical engineer, must best combine scientific attainments, especially experimental knowledge, with mechanical tastes and ability and engineering experience.

As one of our oldest engineers * tells him, he must "cultivate a knowledge of physical laws, without which eminence in the profession can never be securely attained." He must become familiar not only with science and the arts, but he must train himself to make the one assist the other; he must learn just how to make use of scientific principles in planning his work, and how to do his work most thoroughly, efficiently and economically when he has determined his general design. He must be able to determine how far standard designs are in accordance with correct principles, to detect their defects and to provide a remedy correct in principle and mechanically efficient. Science and art must always work hand in hand.

But how is the rising generation of engineers to acquire this proficiency in both branches of knowledge? How are they to be made mentally and manually accomplished? How fitted for the great work which is before them?

The time has gone by when, in any art, the ignorant and merely dextrous workman can compete with even a less skillful shopmate, in the race for preferment, where the latter possesses and uses brains as well as hands, and knows how to make the one direct and aid the other. We to-day find him occupying a decided vantage ground who

* Charles Haswell.

is at the same time familiar with the schools and at home in the workshop.

Whatever department in the arts a youth may be designed for, he must, to insure success in the future, be taught, not "in the school *or* the workshop," the alternative formerly offered him, but in the school *and* the workshop.

Here then arises the necessity of technical and industrial schools, in which, if properly conducted, knowledge is imparted so as not only to train the mind to habits of thought and study, to give it capacity for logical deduction, but in such a manner as shall, at the same time, make the student familiar with the principles of the art which he is to practice, and prepare him to learn the lessons taught in the workshop and manufactory rapidly and well.

It is the tardy recognition of this great want, this vital necessity, that has placed a great nation, which has been far in advance of all others in manufactures and the useful arts, in a position, relatively to her neighbors, that is causing the greatest uneasiness in the minds of the more intelligent of her people and her statesmen. They see other nations, who were formerly far behind, now rapidly overtaking her, if not already taking the lead, in consequence of the earlier adoption of a system of technical education for their people.

Two hundred years ago Edward Somerset, the second Marquis of Worcester, the inventor whose work has become familiar to us, informed his fellow-countrymen of the growing necessity for such a system of education for the people, and urged the establishment of technical schools.

For this he deserves higher honor than for anything he did for the steam-engine.

But the system first took a definite form upon the continent of Europe, and, for more than a quarter of a century, it has grown with the growth and strengthened with the strength of the western European nations, until it has, to-day, become a most important element of their national power.

In our own country this great need has been long recognized, but the policy of our government does not permit it to institute systems of teaching, as has been done by those of Europe, and it has remained, to a great degree, unprovided for.

Such education cannot be provided at the small cost that the average citizen can well afford to pay, and, even if that were possible, it is quite doubtful whether the vital necessity of such an education, to the people rather than to the individual, and to the coming rather than to the present generation, would be sufficiently well understood to induce the payment of its actual cost, far below the real value, as it may be.

It becomes, therefore, the privilege and the duty of the wealthy among our citizens to provide this great want of our country, and to aid, thus most effectively, in giving her that pre-eminence among nations that every patriotic citizen aspires to see her attain.

I have referred, in another paper, to the services rendered by John Stevens, of Hoboken, New Jersey, and his sons in the introduction of the locomotive and the steamboat, but no single achievement of theirs, nor all combined, has conferred so great a benefit upon the country and upon the world as did the bequest by which one of those sons, Edwin A. Stevens, founded a technical school, where the youth of the present and of succeeding generations are to be taught the principles upon which is based the profession which he and his father and brothers practiced with such splendid results.

In St. Paul's Cathedral is a Latin inscription, which informs the visitor that a memorial is erected to its great architect, Sir Christopher Wren, but that his most appropriate monument is the great cathedral.

So it is here; we see no memorial erected to the founder of this first school of mechanical engineering, but "*si monumentum quaeris circumspice.*"

The President—I wish again to call attention to the fact, which I stated last week, that Watt had nothing whatever to do with the invention of the American steam-engine, which is the high-pressure engine, an engine producing power by heat, and not by heat and cold. Watt made important improvements in the condensing steam-pump. The double-acting engine is, however, essentially the double-acting pump, invented by Delahire many years before Watt's time. The governor was an old invention, first applied to regulate a supply of water, and applied by Watt to steam. The indicator was invented by a clerk in the employ of Watt; the crank and fly-wheel by one who would not allow Watt to use it. Playfair says Watt's greatest invention was "the parallel motion." This we know is very defective, and is not used on American engines. Leopold's high-pressure engine is a myth. He made a drawing of one, which, it is plain to be seen, would not operate.

The English books are full of accounts of English engineering, with little relating to America; and yet all the English engineering projects together do not equal those in the State of New York alone. Along the line of the Erie canal, there are greater wonders of engineering than in all Europe. Foreign engineers know we have had more experience in hydraulic engineering. Perhaps for this reason the government of Austria has recently selected Mr. McAlpine, who is recognized as one of the first engineers of the world, to examine the river Danube and make it navigable. But American skill is not yet recognized in the books. I am willing to give to Europeans all the credit they deserve; but as Americans, we should not forget that Oliver Evans, solitary and alone, invented the high-pressure steam-engine.

Prof. R. H. Thurston—I am afraid that your remarks put me in the position of having forgotten to give credit to our own country; but in my first lecture at the Stevens Institute I had fully described the work of Oliver Evans; in the lecture of which I have read a part to-night, I merely summarized the inventions to show that the steam-engine is not one invention, but a growth or accretion of inventions.

The President—Every flouring mill and elevator in our country is a monument to the genius of Oliver Evans; and yet, in Dr. Hawkes' "American Biography," his life is summed up in one line.

Mr. J. K. Fisher—The high pressure engine was appreciated by Watt, but his workmen could not make boilers steam tight. It was the want of good workmanship that kept back the steam-engine. In 1820 even, it was very difficult to get a tight boiler. If we have adopted the high pressure principle earlier than England, it is because we are more fool-hardy. We were led into it probably from the fact that we began our engineering about the time when boilers could be made to bear a high pressure without leaking.

The President—This apology for the non-introduction of the high-pressure engine does not seem to have much force, when we call to mind the fact that Evans used his high-pressure engines from the year 1802 right onward; and that for years many of his engines were supplied with steam generated in a cylindrical wooden boiler bound with iron hoops, and having a wrought-iron cylindrical flue within, in which a fire was kept by means of wood.

Adjourned.

March 8, 1872.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

Danish Steam Navigation.

By Prof. J. A. Whitney.

The two steamers, Rolf and Thorvaldsen, are the first iron vessels built in Denmark that have visited this country. I passed about two hours on the Thorvaldsen, and found her a staunch, well-built steamer, registering 884 tons. The dimensions are 228 feet long, thirty feet beam, and seventeen feet draft, when laden. The motive power comprises two inverted vertical compound engines, each of sixty horse-power, nominal, and connecting direct to the propeller shaft; the propeller has a diameter of thirteen feet. The boilers, which are two in number, and worked at an average pressure of fifty-five pounds per square inch, are of the tubular return type, and are claimed to give a notable economy of fuel, from two and one-half to three pounds per indicated horse-power per hour. Some features of the boilers are worthy of general imitation, all the rivet holes being drilled instead of punched, and the fire-boxes, or furnaces, being turned to fit their places in the boiler shells, to which, by riveting, they are secured by angle irons. Surface condensers are, of course, employed, but instead of using the water fresh, as it comes from the condensers, care is taken to add about seven ounces of salt water to the gallon, which causes a scale, about the thickness of ordinary paper, to form on the tubes and interior of the shells, and this prevents the corrosion which would destroy the surfaces, if unprotected from the copper salts dissolved by the water from the copper tubes of the condenser, the pipes, etc. The steam, before reaching the cylinders, is carried through a super-heater, situated in the uptake, and heated by the escaping gases from the furnaces. The workmanship seems to be very good throughout, and creditable to the makers, whose establishment in Copenhagen gives employment to about 1,100 operatives.

I was informed by the engineer on board the Thorvaldsen that Denmark is now building quite a number of iron steamers, some registering 1,000 tons, which, considering that this branch of industry was commenced in that country only some fifteen years ago, with boats of fifty tons for the Baltic trade, is a decided proof of progress. One iron vessel, smaller than the Thorvaldsen, but with engines of the same style and power, makes fourteen knots an hour, running between Copenhagen and Stettin. Another, the Dania, runs the distance, 104 miles, between Copenhagen and one of the towns in Jutland, in eight hours. She has paddle-wheels, and oscillating compound engines, the high-pressure cylinder working within the low-pressure cylinder, and both fitted with suitable slide valves.

The Chairman read the following paper:

ATOMS AND MOLECULES.

By SAMUEL D. TILLMAN, LL.D.

The atomic composition of ponderable matter is a fundamental postulate in the theory of chemical equivalency. By an application of the principles of experimental research, and by methods essentially modern, resulting in the discovery of many elementary bodies and their modes of combination, a conception of very great antiquity has been rendered more distinct and worthy of credence. When this conception took definite form is not known. Indeed, it is one of the many speculations naturally elicited in discussing those subtle questions pertaining to the existence of matter and its relations to mind or spirit, the solution of which has always baffled, and will continue to baffle, the most profound thinkers. In attempting to unfold the mysteries of nature by the deductive process, the ancient teachers of cosmogony were brought into direct conflict of opinion regarding the ultimate condition of matter. That it is composed of indestructible atoms which admit of no division, seems to have been the notion of some Oriental sages. Under the genius of the Greek philosophy this notion assumed the form and consistency of a theory.

Among those who held the doctrine, while immatured, were Ecphantus, Leucippus and Democritus. Subsequently Epicurus introduced such modifications and improvements as were essential to its complete development.* The Latin poet Lucretius, in his De Rerum Naturâ, has given a full exposition of the Epicurean philosophy; from this, as well as from the writings of Plutarch, it will be seen that the most prominent atomic tenets did not differ essentially from the opinions entertained by eminent scientists of modern times.†

*Plutarch's Morals, edited by Prof. Goodwin, of Harvard University (Little, Brown & Co., Boston, Mass.), vol. viii., pp. 111–112; vol. v., 345.

† A full exposition of the ancient atomic philosophy would be foreign to the purpose of this paper. Many of the prevailing erroneous impressions concerning it would, however, be corrected by an examination of the third chapter of Dr. Good's Book of Nature, in which Epicurus is ably defended against the charge of atheism. Evidently the Epicureans were opposed to mythology; but while ignoring the power of its gods, they were naturally led to the recognition of a higher Power, an Intelligent Cause, Self-existent and Supreme. This deduction was reached by the earnest believers in the atomic doctrine. According to Stobæus, Ecphantus supposed the

Newton admitted the creation of primitive particles, extremely minute, but permanent. Descartes, on the other hand, held with Aristotle, Plato and Pythagoras, that the division of matter has no assignable limit. Leibnitz attempted to reconcile the conflicting opinions of metaphysicians and mathematicians, by supposing that matter, in its ultimate condition, consists of unextended points which he denominated monads, a term borrowed from Pythagoras. At a later day, Boscovich published his celebrated dynamic theory, in which centers of force are substituted for monads. Neither of these ingenious theories, however, reaches the real points of perplexity.

It is obvious that the science which treats of the ultimate composition of bodies would lead to more correct conceptions regarding minute combinations of ponderable matter. Analysis has shown that nearly all the bodies formed in the great laboratory of nature are compounds. Thus far, sixty-three different kinds of matter have resisted every effort to resolve them into simpler constituents. These substances, distinguished as chemical elements, unite in exceedingly minute quantities according to the well-known laws of Stoichiometry. In the year 1789, Higgins, a professor in the University of Dublin, advanced the idea that certain compounds are formed by the combination of ultimate particles or atoms of different elements. Dalton, in 1803, independently arrived at a similar conclusion, which he generalized, to explain the composition of all compounds, and made it the basis of his "New System of Chemical Philosophy," published five years later. The doctrine of Dalton has undergone, since his day, such modifications as render it more acceptable; but that part of it which ascribes the union of indestructible atoms to chemical affinity may be regarded as the first successful attempt to explain that primordial action which the ancient atomists could not account for, and which this Latin poet, above named, describes as irregular and fortuitous.*

material world to consist of atoms, but yet to be ordered and governed by a Divine providence. *Ἔκφαντος ἐκ μὲν τῶν ἀτόμων συνεστάναι τόν κοσμόν, διοικεῖσθαι δὲ ἀπὸ προνοίας.* Eclog. Physic., lib. i., cap. xxv. And as evidence of the belief prevalent among wise men several centuries later, Berzelius, in his paper on Proportions Determinate, quotes from Philo, who, in his collection of the choicest philosophical ideas of his time (Libri Sapientiæ, cap. xi. v. 22), says: *Πάντα Θεὸς μέτρῳ καὶ στάθμῳ διέταξε* ("God made all things by measure, number and weight"). This remarkable statement—ascribed to Solomon in the Apochrypha—as far as it relates to things terrestrial, modern chemical investigations have fully confirmed.

* Omnimodis coire, atque omnia pertentare,
Quæcunque inter se possint congressa creare.
[Lucret., lib. v., ver. 191.

Chemists of the atomic school happily avoid the vexed question concerning the indivisibility of matter, by defining an atom as the smallest quantity of an element which can enter into the composition of a ponderable molecule; and the molecule, whether made up of one, two or more elements, as the smallest quantity which can exist in a free state. However, a certain individuality must be assigned to the single atom, for a chemical decomposition requiring its transfer from one molecule to another involves its isolation *in transitu*. The absolute weight of the sixty-three different atoms cannot be ascertained; nevertheless, their relative weights have been determined with great care.

It is difficult to arrive at any clear notion concerning the size of an object so minute as to be forever invisible under the most powerful magnifier. As an example of the conclusions regarding molecules, founded on microscopic scrutiny, that of the celebrated Ehrenberg may be cited.* Without attempting to make a close approximation toward its actual dimensions, his researches led him to infer that the diameter of an atom (the molecule of the chemist) was considerably less than six millionths of a line. Quite recently Sir W. Thomson, in a paper on "The Size of Atoms,"† presented four lines of argument founded on experiments of physicists, which all lead to substantially the same estimate of the dimensions of molecular structure. He says:

"Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent, solid, or seeming opaque solid, the mean distance between the centers of contiguous molecules is less than the hundred-millionth and greater than the two thousand-millionth of a centimetre. To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a rain-drop, or a globe of glass as large as a pea, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be coarser-grained than a heap of small shot, but probably less coarse-grained than a heap of cricket-balls."

From these deductions of Thomson some idea may be formed of minute molecular grouping; and I venture the suggestion that, in regard to size, the smallest bullet would probably stand about midway between the *glomeramen minimum* and "the great globe itself."

Beyond this point of extreme tenuity, where matter first exhibits that property which is revealed in visible forms, we are forced to con-

* Pogg. Annalen., xxiv., 35.

† Nature, No. 22, vol. i, p. 551.

sider it in a still more expanded state, as the universally diffused medium of light, heat and actinism; consequently this conception of the minute ponderable globule does not bring us very near the *minima naturæ*, for a difference in size cannot be less marked between ponderable atoms and those infinitesimal particles forming the luminiferous ether or æth which fills the interstellar spaces, and which, in a more condensed state, probably forms the interatomic medium. Assuming that all forces generating wave motions in elastic fluids follow the same law of propagation, I endeavored some years ago to estimate the density of this inconceivably attenuated substance.*

In that calculation the density of air is the unit of measure. If instead hydrogen be taken as the unit, the density of luminiferous ether is expressed by the decimal .00000000001653. Whatever may be its actual density, its reality must be admitted, until the positions established by the investigations of Huyghens, Young, Fresnel, Foucault and Fizeau are shown to be untenable. A very able American metaphysician, in meeting an objection brought by Huxley against the views of Comte, has strongly expressed his unqualified dissent.† Nevertheless, the hypothesis that light, heat and actinism are propagated by the undulations of a subtle, all-pervading fluid, is the only one which satisfactorily accounts for a certain class of phenomena, and it is accepted by all the prominent experimental physicists of the present day.

The vast difference in density indicated cannot be apprehended, because numerical comparisons utterly fail to raise in the mind any clear conception regarding a fluid so attenuated; yet it naturally suggests the idea that there must be many intervening conditions of

* Sound would be propagated, with exactly the velocity of light through a fluid, under the standard pressure, 874,094,104,900 times rarer than air. Therefore, if the density of air be one, the density of æth is represented by the decimal .000,000,000,-001,144+.

It will not be inferred from this view that the aim has been to reach

"The first of things, quintessence pure,"

for the elastic quality of æth involves the hypothesis of a still more subtle fluid. We have raised one curtain only to find another to be raised. As the unfathomed vaults of heaven recede before the sweep of a more powerful refractor, and nebulæ resolved reveal nebulæ beyond, so the most diminutive germ that springs from the Creator's touch discloses, through the lens of higher power, new signs of more wonderful mechanism within. Each nucleus has its nuclei! Each entoblast is but the boundary of a microcosm! Each particle a galaxy of atoms revolving in the all-pervading æth! Thus, before every far-reaching human advance, *Circumference* and *Center* will forever retreat. [Transactions of the American Institute, 1864, p. 539. "Clydonics," No. 1.

† Eleventh Harvard lecture, by Prof. John Fiske, Cambridge, Mass., 1869.

matter in which it exists in successive degrees of increasing density; and that these conditions form the connecting links, so to speak, between its apparently imponderable and its ponderable states. Something like this opinion seems to have been maintained in a curious work published, in England, many years ago.* The reverend author, viewing the universe as a systematic manifestation of the Divine Will, assumes that the medium of light is the mother element from which, by progressive steps, the chemical elements have been evolved. Proceeding from the first lines of morphology, he arrives at the primitive form which cannot be isolated; then, by an exceedingly ingenious synthetic process, he represents by diagrams his ideal structure of different kinds of atoms, all of which are duplications of the tetrahedron. Thus he claims to reveal the unit, by multiples of which the atomic weight of all chemical elements may be expressed, and so arrives at a result which will be recognized as simply a modification of the so-called law of Prout. This, and other remarkable surmises by Macvicar are, for reasons which need not here be adduced, quite untenable, nevertheless, he seems to have led the way to an assumption which has recently met with some favor, namely, that the chemical atom, although indivisible, is a collection of smaller particles. However, in following this author toward the infinitesimal, we only realize more fully the truth that above and below the narrow zone of the visible are objects too far off and too fine for human scrutiny. Although the *seeming all* is rounded by intimations of other and brighter regions, science can never compass them by any extension of her domain! In those unsounded depths which form the boundary and background of the known, thought, grown dizzy, finds no support; and even the positivist turns back, bewildered, when mensuration fails, and computations end in surds!

On examining the numerous works on chemistry published within the last twenty years, one cannot fail to notice a gradual change in the expressions employed in describing reactions. The word "equivalent" seems to have lost the meaning originally assigned to it by Wollaston, and the terms "combining weight" and "combining proportion" are now used less frequently than "atomic weight" and "atom." This abandonment of old forms of expression, doubtless, indicates a gradual change of opinion among leading chemists, a change which may be ascribed partly to an accumulation of facts tending to confirm the atomic theory, and partly to the promptings

*Elements of the Economy of Nature. By J. G. Macvicar, D. D. London: Chapman and Hall. 1856.

of that mysterious intuition which, overleaping the limits of logic, often arrives at correct conclusions, even before their truth has been demonstrated.

During all the discussions on "atomicity," hardly a doubt has been raised as to the actual existence of the atom. It was not, therefore, surprising that the chemical world received a sensible shock at the stand made by Brodie in 1868.* However, a careful examination of his paper is likely to lead to the conclusion that the objections to the atomic theory therein enumerated are not more formidable than those which can be urged against his own ingenious, but complicated, method of chemical operations. Precision in signs and definitions leads to exact results in the abstract; nevertheless a mathematical formula often requires modification to meet the varying conditions found in actual practice, and even then it only gives a near approximation to the truth.

Renewed attention to this subject was doubtless the means of drawing, from the then president of the London Chemical Society, a paper "On the Atomic Theory," which is generally regarded as the best exposition and defense of the doctrine yet made, and which may be consulted with profit by those desiring to obtain a clear statement of the principal results of chemical research adduced for its confirmation.†

A vigorous attack on the atomic theory has since been made by Mills, the real tendency of which is to raise doubts concerning the existence of matter itself.‡ He quotes, with evident satisfaction, from a work by Digby, "On the Nature of Bodies," printed in 1645, wherein *quantity* is defined "as but one whole that may, indeed, be cut into so many several parts; but those parts are really not there till by division they are parceled out; and then the whole (out of which they are made) ceaseth to be any longer, and the parts succeed in lieu of it, and are every one of them a new whole." From this statement proceeds a train of geometrical reasoning concerning extension and division, which leads to the old dilemma regarding finite and infinite indivisibles.

Fortunately a new science, unknown to Digby, has demonstrated that matter has other than mere physical properties, which are so clear

* The Calculus of Chemical Operations. By Prof. B. C. Brodie. Journal of the Chemical Society, London, vol. xxi, p. 367.

† On the Atomic Theory. By Prof. A. W. Williamson. Jour. Chem. Soc. London, vol. xxii, p. 328.

‡ On the Atomic Theory. By Edmund J. Mills, D. Sc. Philosophical Magazine, vol. xlii, No. 278, p. 112.

and well defined as to enable its votaries to determine the ultimate composition of all bodies. The chemist affirms that, however inclined we may be to regard a body as a whole, it is in fact composed of minute parts which may be separated, and that in the great majority of bodies, which are compounds, nature has herself made divisions, by incorporating unlike parts which may be replaced by other unlike parts. On questions relating to the actual size of these parts, their form, their structure, etc., he makes no issue; he simply asserts that all these ultimate parts are permanent, and that those composed of the same kind of matter are identical in size and structure. The limits proposed for this paper will permit elucidation of this point alone.

The clearest conception of molecules and atoms will be arrived at by examining the principal phenomena attending the mechanical mixture and final chemical union of the lightest and the heaviest of the simple gases. The electro-positive element, hydrogen, is a permanently elastic gas, having a relative density expressed by 1. Its properties are in marked contrast with those of chlorine, a yellowish green gas, which may be condensed into a liquid, by a pressure of about four atmospheres. The density of this strong electro-negative element is 35.5. If two vessels of equal capacity, filled with these gases respectively, be placed in the dark, one over the other, and a communication be opened between them, a mutual diffusion of the gases will commence, the relative velocity being inversely as the square root of their densities. The action continues, untraversed by the force of gravitation, until minute portions of hydrogen and chlorine are equally diffused throughout both receptacles. This phenomenon cannot be accounted for, excepting on the supposition that minute parts of each gas have undergone complete isolation. If diffusion were effected only through a single stratum or extremely thin layer, it would be possible for two gaseous elements to retain their continuity by passing each other in intertwining streams, thus forming, like threads, a warp and woof; but when diffusion is in every direction, it is obvious that these elements must positively separate each other, and thus be divided into extremely diminutive bodies each of the same dimensions. Let l represent the lighter gas, d the denser, and e the dimensions or size of each isolated portion, then el and ed will denote the dissimilar parts of which the whole gaseous matter is composed. As the phenomenon of diffusion occurs under the conditions mentioned, whatever may be the quantity of gases employed, it follows that el and ed are individual volumes or molecules, invariably of the same dimensions. This diffusion of gases may, therefore, be defined as the uniform intermingling of dissimilar molecules.

If the molecules *el* and *ed* thus commingled while in the dark, be exposed to direct sunlight, an instantaneous and complete chemical combination occurs with explosive violence, but without condensation; or if exposed to diffused daylight, the union of elements will be gradual and without explosion; the resulting compound in each case being hydrochloric acid gas.

The affinity or force of chemism is generated by the action of light on the colored gas chlorine, which, by absorbing all the rays and transmitting only the yellowish green, acquires a power which seems to be expended by the union of that element with hydrogen. Early in the present century, M. Benard announced that the new properties acquired by chlorine on exposure to light were derived from the violet ray. In 1843 Draper proved by experiment the relative power of each ray in producing this change, the actinic rays being altogether the most effective.* Mr. E. Budde has recently described a remarkable experiment in this direction. He found that a differential thermometer filled with chlorine expanded about seven times more in the violet than in the red ray of the solar spectrum; when the same thermometer was filled with CO_2 no action was noticed.†

As the combination of hydrogen and chlorine is effected without change of volume, it is obvious that the molecule *el* does not unite with the molecule *ed*, forming a compound molecule *el-ed*. The conclusion is, therefore, unavoidable, that each molecule has been divided into two equal parts, and that by affinity, like parts have been separated, and unlike parts have been united. These parts are the smallest quantities that can be isolated, and are, in fact, the atoms recognized by the chemist. If this smallest combining proportion or atom be designated by *a*, the actual composition of the hydrogen molecule *el*, weighing 2, may be clearly represented by *al-al* (weight 1+1), and the chlorine molecule *ed* weighing 72, by *ad-ad* (weight 35·5+35·5). As the attraction of *al* to *al*, and of *ad* to *ad* is, after exposure to light, less than of *al* to *ad*, there is an instantaneous chemical change by which one molecule of hydrogen and one molecule of chlorine are transformed into two molecules of hydrochloric acid gas. This reaction is clearly indicated by the following equation:

$$al\text{-}al + ad\text{-}ad = alad + alad = 2\ alad.$$

* A Treatise on the Forces which produce the Organization of Plants. By Prof. John William Draper. New York: Harper and Brothers. 1843.

† Pogg. Annalen, for 1871, No. 10.

The symbols here used are intended to convey to the mind an idea of the relative size of combining parts, which is not so apparent when expressed as follows:

$$H_2 + Cl_2 = HCl + HCl = 2\ HCl.$$

From the simplest of molecular types we might proceed to the most complex; and, throughout, if we consider the combining proportion of each simple constituent as either a unit or a multiple of a unit, the composition of each molecule may be expressed by whole numbers. Thus, having as many different kinds of units as there are elements, any true chemical combination may be symbolized by a combination of arithmetical ratios. This method, under the light of the atomic theory, clearly reveals the harmonic relations of molecular constituents, which, seen from the stand-point of per centage composition, appear unconnected and discordant.

It must be admitted that well known bodies have not yet been determined quantitatively; yet, were they made out, we should not be able to demonstrate, by experiment, the truth of the atomic doctrine. It still remains a theory, in favor of which there are many facts and phenomena that collectively form an argument not easily to be outweighed. This evidence may be brifly summarized as follows:

1. *Atomic Weights.* Elements combine in extremely minute parts, according to the law of definite and multiple proportions. The atomic weight of an element is either its equivalent weight or a multiple of it; as such multiple cannot be divided by reactions, its weight must conform with the atomic number. Whatever changes of position the combining weight of an element may undergo in a series of molecular metamorphoses, that is to say, however many times it may be displaced and replaced in chemical combinations, it invariably retains its characteristic weight. This invariability of weight is an essential property of the atom.

2. *Atomic Volume.* Gases unite in equal volumes or multiple volumes. If hydrogen be taken as unity, the density of each elementary gas is identical with the weight of its atom. The atomic volume, determined by dividing the atomic weight of a body by its specific gravity, has been the means of revealing many interesting relations among compounds of similar structure, and among many containing different components and of unlike structure.

3. *Atomic Heat.* It has been shown by experiment that quantities of each element, conforming with its atomic number, have the same capacity for heat, excepting only carbon, boron and silicon. These, it is believed, will yet be found to conform to the law that the spe-

cific heats of atoms are the same. The law is regarded as a direct confirmation of atomic weights.

4. *Molecularity.* According to the atomic theory, chemical forces are brought in equilibrium when atoms combine and form a molecule. Every gas and every vapor, undecomposed, has a density proportional to its molecular weight. All known molecular combinations and combining proportions are in accordance with the atomic doctrine. Decomposition by electrolysis affords some evidence that the constituent parts of a molecule, which are simultaneously separated, are proportionate to atomic weights. Moreover, the molecule is supposed to possess polarity, which, under the attraction of cohesion, determines its position in the process of crystalline accretion. Thus, symmetrical solids result from the perfect likeness of their integrant parts.

5. *Atomic Combining Capacity.* The modern doctrine of types and substitutions is solely based on the individuality of the atom, without which the whole fabric of typical structures must fall.

6. *Isomerism.* The fact that bodies containing the same elements, and in precisely the same proportions, exhibit different properties, has been thus far accounted for only on the supposition that atoms are differently arranged in each body. These differences in arrangement depend not only on the relative position of atoms, but also on the order, as to time, in which they combine; for two or more atoms having such precedence over others as to combine first, may, by that means, form a radical of such permanence as to play the part of an atom. Apart from the question of radicals, we may ascertain the number of different bodies which can be formed from the same number of different atoms, by an application of the mathematical law of permutations.

7. *Homogeneity.* The uniformity of structure and appearance of any element or chemical combination of elements furnishes the most palpable proof of the identity in size and shape of those definite parts which we designate as molecules. This homogencity is retained under different degrees of pressure, thus making it apparent that molecules are not only identical in structure, but that they approach and recede in precisely the same manner under the same conditions.

Finally: The foregoing statement regarding the existence of atoms, which are indivisible and indestructible under the present order of things, does not preclude the supposition that the atom may be a cluster of smaller particles held together by a powerful affinity, which, when counteracted, would leave them free to move within a given sphere. On this assumption, it is highly probable that the relative position of such particles may modify the combining capacity of the atom. Moreover, the normal motion of such particles may determine not only the peculiarities of elemental spectra, but produce other effects not dependent on the velocity or the amplitude of atomic oscillations, thus favoring the inference that the atom itself is a receptacle of force.

Dr. J. V. C. Smith, after expressing his high appreciation of the paper read by the president, alluded to what the speaker had said concerning the views of ancient philosophers concerning the atomic doctrine, and said it was only one of the many instances of similarity between modern theories and those taught 3,000 years ago.

Prof. James A. Whitney—My friend, Dr. Smith, is never so much himself as when doing justice to the merits of other people. I, too, must express my appreciation of the paper just read by our chairman, and of the value which always attaches to the latest phases of thought in those branches of scientific research, which, while capable of being traced back to the writings of philosophers in remote ages, are, even now, constantly growing in interest and importance, thanks to the acute intellects of our own time.

SELF-LOCKING SCREW.

Mr. Freeland exhibited a screw, intended especially for railroad purposes, and similar positions, where the perpetual jar has a tendency to loosen the nut. The screw has a longitudinal recess, in which is placed a brass wire bent at the end by a small apparatus; and the nut has a cavity with a ratchet upon its exterior, the end of the brass wire taken in the teeth as a pawl. On tightening the screw, the brass wire holds the nut in position. The screw may at any time be tightened, and the wire will hold it in its new position. If the nut is to be loosened, sufficient force must be applied to the wrench to break the wire; and a new wire inserted on again putting on the nut.

Mr. J. B. Root—The only objection would be the cost of making it; and that when the nut binds close to the bolt, there is less tendency to lateral motion. There might possibly be some difficulty from water getting into the slot and rusting the thread.

ROAD STEAMER IN GREECE.

Mr. J. K. Fisher said: The Engineer of February 16 has a letter from Patras from Mr. Blakevay, engineer to the Hellenic Road Steamer Company, from which I extract the following: "On the 26th of January we tried our first road steamer, with omnibus attached, carrying seventy to eighty passengers. The steepest grade was one in seventeen, up which the engine took its way steadily at three miles per hour. The road had been recently covered with loose soil, but that did not cause the rubber tires to slip. On the levels the average speed was eight miles per hour. The trial was, on the whole, satisfactory; and when it is considered that the engine and omnibus do the work of twenty ordinary carriages, forty horses and twenty men, at a fifth of the cost, the system may be expected to prove advantageous."

Steller Motion Illustrated.

Mr. Robert Weir read the following notice of Prof. Mayer's lecture at New Haven from the College Courant:

Acoustic illustration of the method by which stellar motions are determined with the spectroscope.

The fourth of the series of lectures known as the Mechanics' Course, was delivered on Thursday evening last, in the large hall of the Sheffield Scientific School, upon the above subject, the lecturer being Prof. A. M. Mayer, of the Stevens' Institute of Technology.

Prof. Mayer began by calling the attention of his audience to the character of vibrations, instancing the pendulum as one of the best examples of visible mass-vibration, and saying that the curve representing its motion was that representing all other vibratory motions of whatever kind. The curve he had obtained experimentally by means of an ingenious apparatus which he described. Besides these, there are molecular vibrations due to elasticity, the action of which was very clearly illustrated upon the blackboard. A water-wave is a mass-vibration, as is shown admirably by Prof. Lyman's wave-apparatus. The progressive character of a wave was then exhibited by means of a long wire coil, along which an impulse was transmitted as a visible undulation or wave. As an example of a molecular vibration due to elasticity, the vibration of a Brown & Sharp's straightedge, fastened firmly at one end, was given; and a series of beautiful curves drawn upon smoked glass by a wire attached to such a vibrating rod, were thrown on the screen.

The lecturer then passed to the theories of light, describing the emission theory and the undulatory theory. Certain phenomena, such as reflection, refraction and dispersion, could be equally well accounted for by either; but certain others, such as those of interference, could be explained only by a wave or undulatory theory. This latter theory supposes a trembling of the particles, either of air or of the matter filling space, which trembling, so far as interference goes, may be lateral or longitudinal. But the phenomena of the polarization of light show that these vibrations take place transversely to the direction of propagation of the ray. In sound, the vibration is longitudinal; in heat and light, lateral. Hence, sound-waves may interfere and produce silence, light-waves may interfere and produce darkness, heat-waves may interfere and produce cold. The ear is so constituted that it takes cognizance only of the longitudinal vibrations of the air, though the air vibrates in all directions; the eye takes notice only of lateral ether vibrations, though the ether vibrates in all directions. Interference was then described and illustrated on the board, and the phenomena of fringes shown to result from the overlapping of waves in unequal phases, which could be a consequence only of undulations. The practical use of such knowledge as this was illustrated by a description of Newton's rings, and the method by means of which these rings may be made to indicate a distance as small as a millionth of an inch. Another instance of the practical application of these facts is Arago's Differential Refractometer, which will show a difference of density in the air of one eight-thousandth part, and by which the refraction of the air has been measured and tables constructed, by whose use the mariner may find the true altitude of the sun.

The president remarked that the change of pitch of the whistle of a locomotive approaching, passing and receding, is very perceptible.

Adjourned.

March 15, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

The president read the following notes of scientific progress:

I. BESSEMER'S GUN.

In the improved plan for heavy ordnance by Mr. Bessemer, the initial pressure is reduced by having a series of smaller charges ignited successively as the shot travels along the bore of the gun. This is, however, the essential feature of the American gun patented by Mr. A. S. Lyman. In order to secure the greatest benefit from this method of applying force, Mr. Bessemer proposes to increase the length of the gun to fifty feet. It is to be made of wrought iron tubes, connected by flanges and strengthened by steel rings. Rotation is to be given to an elongated shot, not by rifling the bore of the gun, but by the reaction of powder gas issuing in small jets through tangential orifices at the circumference of the shot. The shot is to be made hollow, and contain the charges of powder required to rotate it. The objections to Mr. Bessemer's "improvements" are so grave that it may be doubted whether he will carry them into practice.

Mr. T. D. Stetson — The objection to the use of long guns consists in the impression of the air ahead of the ball. When the gun is short the air can get away laterally without much resistance, but when the tube is long there is a point beyond which the resistance will become considerable. Experiments have shown that shortening the barrel of an ordinary gun from six feet to five will increase the force of the charge. When you fire with steam you can have a longer gun, but with powder you can get all the velocity from ten or fifteen feet that you can ever get.

The President — The principle of Mr. Lyman's gun is simply this, not to give the ball at first its full velocity. It is the same principle that is applied to the bow and arrow. The bow being upon the principle of the toggle joint, the swiftest motion is at the end of the motion of the string, so that the velocity is increased all the time until the arrow leaves the bow. Mr. Lyman found that if the full power was applied at first there was danger of the gun exploding. He, therefore, fired a small charge at first, and afterward successive charges, propelling the ball faster and faster until it left the gun. In theory this is very beautiful. A gun made by Mr. Lyman is said to have carried a ball eight miles, which is much farther than was ever before attained; but Lyman's gun has never been brought into use, although it was invented before our rebellion.

Dr. P. H. Van der Weyde — Different explosive powers differ chiefly in the time it takes them to burn. Take an explosive powder that is slow in burning and we may use a long gun; but if it ignites very quickly we must have a short gun. That is the danger of bursting a gun in using fulminating powders. It is the virtue of ordinary gunpowder that it burns slowly. If you want long guns you must make the powder burn more slowly. I do not see the necessity of having successive charges.

The President — It is almost impossible to get powder that will burn slowly enough.

Dr. Van der Weyde — We may make it burn as slowly as a fuse. We make a pound of powder burn in a tenth of a second, or a twentieth, or a hundredth, or a thousandth; but in that case it would be equivalent to a fulminating powder. It is only the rapidity of the burning which gives the power to dynamite and nitro-glycerine. It is the difference between a push and a sharp blow of the hammer. Some fifteen years ago I advised Prof. Maillefert to use fulminating powders in surface blasting at Hellgate; but he said gunpowder was dangerous enough, and he was afraid to use anything stronger. Now the stronger materials are found much more economical, and are almost universally used. Gunpowder will only blast out near the bottom of the hole which is charged, but dynamite or nitro-glycerine will crush the rock many inches beyond the bore. Prof. Doremus has made gunpowder in a solid mass weighing ten or twenty pounds to fit the bore of the gun. I do not know what was its practical success.

Mr. R. Weir represented upon the blackboard the Lyman gun and the Bessemer gun. He said the Bessemer gun never was made, never would be made, and never would work if it was made. The powder made by Prof. Doremus was not really solid, but was of a honeycomb structure.

Mr. J. K. Fisher—There is a superstition that it is dangerous to fire a gun when the ball is not rammed home. I think it is worth while to try whether leaving a sufficient place, so that there would not be pressure enough to burst the gun, would not produce good results. Gun-cotton, for instance, might be used with an air space.

Mr. Green—That is out of the question. It upsets the shot and deranges the particles of metal in the gun. If you should have a large chamber of air, there is no material that could resist the blow. Many guns have been burst in that way.

Dr. P. H. Van der Weyde—What Mr. Fisher proposes cannot but be injurious. When the powder commences to ignite it finds the ball at rest, and should immediately act upon it, and commence to set it in motion; but if the ball is at a little distance a considerable part of the powder ignites before its effect reaches the ball, and then it acts with a blow.

Mr. J. K. Fisher—I do not see why there should be a blow when there is a cushion of air there to prevent it.

Mr. Raynor—It is the experience of gunsmiths that when double-barreled sporting guns are sent for repair, in a large proportion of cases the left-hand barrel is burst. The reason appears to be this: It is most natural to discharge the right-hand barrel. The jar starts the bullet in the left-hand barrel and produces a little space behind it. The right-hand barrel is loaded and fired several times, each time increasing the effect. At last the left-hand barrel is fired and an explosion takes place.

Mr. R. Weir—If the shot is next the charge the first pressure upon it is, perhaps, thirty pounds to the square inch; if it is placed off further, the first pressure may be two or three times as great.

II. Gunpowder Gauge.

The principle suggested by Tresca's experiments on the flow of solid bodies, has been applied by M. le Commandant de Reffye to the determination of the pressure in the bore of large guns. A cylindrical hole, bored into the gun, is filled by a block of lead, supported behind by a steel block, through which is a small cylindrical hole. When pressure acts on the lead, a portion of it is forced into the hole in the steel block. The volume of lead found in the cylindrical cavity after the gun has been fired is the measure of the pressure in the bore of the gun.

III. Effect of Fasting.

Prof. Seegan has communicated to the Viennese Academy of Science the results of investigations upon the metamorphosis of tissue during fasting. The subject of his experiments was a young girl, who, in consequence of a stricture of the esophagus, was only able to consume very small quantities of nourishment. During a whole month her daily food was but thirty-five grammes of milk, and about twenty cubic centimeters of water. A teaspoonful of this mixture was taken every hour. After lasting four weeks the difficulty of swallowing gradually disappeared, and the quantity of milk taken daily rose to 210 grammes. The author gives a full account of many interesting results obtained, only one of which need be here stated, namely: that the metamorphosis of the albuminates, which was principally supplied from the muscles, so far as measured by the excretion of urea, during fasting, bears the proportion to the normal metamorphosis of 1:4 or 1:5.

IV. The Flow of Liquids.

Prof. Colding gives, in the Copenhagen Transactions, his investigations of the law of the motion of water in pipes and conduits, and has also applied his results to ocean currents. His method is to determine the motion of liquid threads, that motion varying with the depth when water flows over a plane surface. The formulæ now generally used are founded on the assumption that water moves in plane layers at uniform velocity. These formulæ are known to be defective.

V. MANNA.

Boussingault has given to the Paris Academy of Sciences an account of his observations on a manna obtained from the leaves taken from near the top of an old linden in the Vosges. Other trees of the same kind in the vicinity yielded no manna. The composition of this manna was found to be about fifty-five per cent of cane sugar, twenty-six of glucose and twenty of dextrin. The manna from Mount Sinai, examined by Ehrenberg and Bertholet, had nearly the same composition, and was supposed to be an exudation caused by the puncture of an insect.

ARTIFICIAL LEATHER.

Dr. P. H. Van der Weyde exhibited a specimen of leather made from waste leather scraps, which are treated in a way similar to the manner in which glue is extracted, but not going far enough to change the leather into gelatine. A small quantity of caustic soda and lime is placed in a steam boiler with the scraps, and they are heated to about a pressure of an atmosphere and a half. This makes a pulp, which is treated like paper, made into sheets or into any required form. It cannot stand wear and tear like common leather, but for insoles, and for many other purposes, is just as good.

The President remarked that this would be inferior to leather where the pores are useful to carry off the perspiration, and should not be used where this is important.

Dr. J. W. Richards—There is about the same relation between this leather and the real skin leather, as there is between paper and linen cloth. Paper is used extensively for insoles, and this is better and cheaper to the wearer. It would make excellent packing.

Dr. W. A. Wetherbee suggested its use as a substitute for papier-maché.

Dr. J. V. C. Smith said that it would certainly be better even for the soles of boots and shoes than birch bark, which is sometimes put into brogans intended for the southern market.

Dr. J. W. Richards stated that in manufacturing towns leather scraps are sometimes used for fuel.

Dr. P. H. Van der Weyde stated that nitrogen compounds are made from them, as Prussian blue; and that they are also used for manure.

Mr. Ball—They make a valuable charcoal.

Relief of Fourth Avenue.

Mr. J. V. Henry Nott exhibited a model of a proposed iron avenue to be erected over the Fourth avenue, to be approached by inclined planes of iron from the side streets. The expense would be more than repaid by the increased value of the adjoining property. The level of the new avenue would be that of Park avenue. It would cost about six millions for the whole length of four miles. The buildings which might be erected upon the new avenue would yield a revenue paying a fair per centage upon the cost.

Dr. J. W. Richards considered it a great mistake to place the new depot at Forty-third street. It should have been placed on the North river, affording convenient communication with the railroads terminating in Jersey city.

Mr. Nott—As soon as this avenue is finished we have more than half the distance finished for a fast railroad. It would only be necessary to complete the track down to the Battery.

The President stated that when the subject of rapid transit was discussed in the Polytechnic Association, two years ago, the plan most approved was the elevated railway, passing over the cross streets and between the blocks. The objection to the railway over the streets is the danger of frightening horses.

Dr. P. H. Van der Weyde said the horses were already becoming accustomed to it. He considered the best project to be the Barlow plan.

Drain Pipe.

By Thomas D. Stetson.

Drain pipes do not require much strength, but they require strength enough to resist the strain of handling, and from the settling of the earth upon them after they have been placed in position. One of the simplest forms of drain pipe would be a box. As to materials now in use, there are three general styles of pipe—baked earthenware, lime or mortar, or cement pipe, and pipe of cheap materials, moulded with heat—and it is of this latter class that I shall mostly speak to-night. Economy is the main requisite. For water pipes, we regard healthfulness, or ought to, above all other considerations. We therefore employ tin pipe, or tin-lined pipe, to prevent poisoning the water that we are to drink. But as for the water that passes through drain pipes we don't care what happens to it. But we must have pipes that will stand water, and that will also resist the action of acids and alkalies. The material passing through them is very multifarious in its character; but, as a general thing, the discharge from sinks will be alkaline, and the discharge from privies and water-closets will be acid.

One of the objections to cement pipes is that it is difficult to make them endure acids and alkalies. It is almost impossible to glaze them well, and it takes a long time for them to set, which, of course, increases their expense. Without the glazing they can be made very rapidly. Taking a mould of the right form, and leaving an annular space, we put in a fat mixture of water and lime, which will set rapidly, and ram it tightly, condensing it very firm and solid, and we thus make a very good lime pipe. But it is liable to be destroyed by acids. Yet I regard that as one of the hopeful lines of improvement.

Among the different kinds of pipe now in the market, baked pipes, vitrified or coated, the imported "Scotch vitrified," and those made here, stand among the best. *Here* is a pipe, made in Brooklyn, of clay found in New Jersey, moulded by machinery, very strong and tough. It requires evidently a good deal of expense first to mould them, and then to dry and bake them uniformly. They must be stacked in such a way as to be kept apart, and a good many will be imperfectly baked or broken, which must be rejected. These are very good pipes; the only objection to them is their cost. They cost, for a nine-inch pipe, about fifty-five cents per running foot.

The Manhattan Compost Pipe Company have now built in Greenpoint a large manufactory, just about starting, which proposes to make a pipe adapted to resist all destructive influences, very strong, with sufficient elasticity to withstand ordinary shocks, to bear freezing up and thawing out again, which excels the best of our Scotch or American baked pipe, at a cost, for nine-inch pipe, of about five cents per foot. It is composed of sand cemented together with rosin, and toughened. They take about seventy-five per cent of sharp, clean sand, and five to seven per cent of pine rosin, about one-half per cent of sulphur, which has a vulcanizing effect, and the rest is kaolin, fine clay possessing considerable iron. This composition seems to set before it gets cold, so that it is necessary to melt it and dispose of it very rapidly. Instead of going through the ordinary process of moulding, they adopt a process by which, an hour after it is moulded, it is ready to be laid in the ground. The materials must all be at hand, and they are put together by machinery, carrying them by railway tracks.

One difficulty to be overcome was the shrinking of the material.

It was necessary to make the core in such a way as to contract as the material shrinks.

It is made of a tube, disconnected at the side, and with the edges overlapping, so that as the material contracts it may lap over more. The vertical contraction must be provided for by following down the material with pressure, as it sinks, so as to keep it reasonably dense. After it is once set, there is no agency that will affect it except heat. One of these pipes has been frozen up solid and thawed out several times this winter, without injury, so that cold does not affect it; and it will take a temperature of nearly 500 Fahrenheit to affect it. I cannot imagine any change that will come to these materials from hot water, acids, alkalies, or any substances that will pass through them, or from time.

It is the idea of the inventor that the sulphur will exert a vulcanizing influence upon the rosin, and toughen it, and strengthen the adhesion. I do not know whether it will or will not; but I believe it will. We know that sulphur itself acts as a cement in uniting stone. The effect of the sulphur will be not only to make the united materials stronger, but to enable them to stand a still higher heat.

Mr. Middleton (the manufacturer) stated that the common Staten Island beach sand is used in making this pipe. The nine inch pipe, one inch thick, will stand a pressure of 125 pounds per square inch. (The best Scotch vitrified pipe will not stand more than seventy-five pounds.) The pipes are made from six inches to six feet in diameter. They are not glazed; the action of the zinc mould on the sulphur giving it the appearance of being glazed. The tensile strain that it bears is 780 pounds. We have tested it with all acids, and found nothing to affect it. Gas will not leak through it. We can make the pipe for less than the duty on Scotch pipe.

Mr. Robert Weir — This seems to be a very important discovery in the making of pipes. We have had great trouble in this city in getting a good quality of drainage pipe. The pipes we have largely used have come from Scotland, and, of course, have been procured at an excessive cost, ranging from two dollars for twelve-inch pipe to three or four dollars for fifteen to eighteen inch pipe. But that pipe has never given satisfaction, because it is so brittle. You can seldom get a good foundation for a pipe, and if it is brittle, it is apt to break. I think this pipe would avoid that defect from its partial elasticity. If it proves to be unaffected by acids, I think it will be a much more useful pipe than we now have in the market.

Adjourned.

March 22, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

The Chairman introduced to the audience John A. Parker, Esq., president of the Great Western (Marine) Insurance Company, who read the following paper:

NO PROJECTILE FORCE IN NATURE.

I propose to say a few words on the non-existence of projectile forces, and to give some practical proofs of the theory advanced.

It will be seen at once that if the universality of precession is the cause of the continuance of motion in the heavenly bodies, it constitutes the first established truth, which confirms a doubt of the existence of a *projectile* force. Nature never wastes her powers by supplying two forces where only one is necessary, and if we once admit the existence of magnetic attraction (gravitation), to produce motion, and the universal law of precession to make it continuous, we have then accumulated all the powers that are necessary, and why should anything more be required?

The idea of a projectile force has its origin, no doubt, in our knowledge of the fact that our own earth, in her orbit round the sun, passes over an amount of space many times greater than her revolutions on her axis would measure, and at first sight a projectile movement appears to be an inevitable necessity, and to account for it rationally has exercised the science, ingenuity, skill and judgment of the best minds which the world has afforded, in centuries past. I shall not attempt to repeat what has been said or written on the subject; it is sufficient for our present reasoning to know that by no ingenuity of skill have the believers in an active projectile force (and that belief has, I think, been universal) ever been able to bring their theory within the operation of any natural law known to exist. It is reasonable to suppose that the laws of nature, seen in our own world, are the laws of the universe, and we have no right to assume the existence anywhere of laws which are contrary to nature here. But then comes the certain truth, that the earth does move through space, both positively and relatively to other bodies, faster than her diurnal revolution on her axis would carry her, and how shall it be accounted for?

The result which all who have reasoned on the subject have finally come to is, in substance, like this: They represent the Deity as occupying some limited space, sitting on a vast throne, high and lifted up, engaged in his work, as a man would work with his hands, creating worlds, which he throws off to the right or the left, giving them an impetus which, for some unknown reason, is to last forever, and to be their guide through illimitable space.

They thus, in fact, malign the Deity, by likening him to man, and to His own created things. They forget that right and left are only relative terms to a stationary being of limited power and presence, and that neither height or depth has any existence in the infinity of space. But the question comes back again, how else can they account for the vast movements of the earth and the planets, which we know exist and see daily performed.

The way is then open for imagination to conceive a method by which these movements can be accounted for, but it must be a method consistent with the natural forces known to exist, consistent with the known movements of the heavenly bodies, and contradictory of no known truth whatever.

Imagination is one of the greatest, if not the greatest, power of the mind which God has given us; we identify it with thought, but it is superior to thought, and always leads it; it is creative as well as suggestive in its power; it presents to us the images of things as perfect as the realities, and no matter from what distance they may come, her flight to bring them is instantaneous as the lightning. Although wayward at times, she is always the willing handmaid of reason, and under that guidance *imagination is always the pathway to discovery.* We must invoke her help, then, in our present dilemma, and go wandering for a while in the realms of space, with reason and imagination alone for companionship.

I think I can best lead your minds along with me in this wandering by relating a story of fact. I was sitting on the piazza on the west side of my country house, to witness the splendors of a summer sunset. The air was cool and refreshing, and I sat till twilight had deepened into night, when imagination assumed the reins of thought, and all that here follows is of her suggestion:

"What mean these glittering worlds in view, that downward slope their west'ring wheels?" They are all apparently moving. By what means, for what purpose and to what end? But astronomers say it is we that move, not they, and astronomers must be right, else how could such journeys be accomplished? But there is no appearance of our moving; the air is still around us; it is even moving gently in the same direction with us. If we were in such rapid motion as is supposed, the air would rush by us in the opposite direction with a force that would annihilate us. The atmosphere must, then, move with us. Astronomers say it does, and astronomers must be right.

How high is our atmosphere? Philosophers tell us that it is only forty miles! What is next to it? Where is the dividing line? There must be great friction on that line if the same order of nature is obeyed there as here. Philosophers have again told us that there is nothing next to our atmosphere, and that is the reason of a continuance of the projectile motion, because there is nothing to stop it. Are we then moving through space on the same principle as through an exhausted tube? In that case we should not move in an orbit, but in a straight line, until we should go crash against some other planet, shattering ourselves or them. And these same philosophers have, in their imaginations, gravely provided this mode of destruction for us. But this is not in harmony with nature, or our own motion, and besides "nature abhors a vacuum." It cannot be, therefore, that we are projected thus through space.

There is the moon above us shining brightly. She is moving in the same direction that we are, and she moves faster through space than we do. She accompanies the earth in her orbit round the sun, and at the same time she goes completely round the earth, relatively to the sun, every twenty-nine and a half days. She has kept the same relative position to our earth in all her vast journeys of thousands of years. By what principle are they thus held together? Have we any evidence of the existence, between the earth and the moon, of any medium but the common atmosphere, in whatever rarefied state that may be? Must we not suppose, then, that such atmospheres fill the whole space between them? Are not the earth and the moon, then, a complete system by themselves, revolving together from the beginning of time as one, yet forming a part of another and higher system, and that again still higher, forever upward and onward, till it shall reach the Throne of God? It appears to me, therefore, that the earth and the moon form a separate and independent system in themselves, though tributary to one higher. Can there be any dividing line between the moon's atmosphere and ours? Is it not more probable that they are united and move together in mingling, flowing currents, like the ocean currents of this globe, which by their motion and mingling are made to assist in preserving the world's balance.

In that case the earth would then be the center, and the moon's path the circumference of one inseparable moving orb. By the laws which regulate motion and magnitude, the earth would then move through her orbit, not by attraction to the concrete earth alone, but to the great luminous orb which should include the moon's path, and all between that and the earth, and this, perhaps, a sun to other worlds; then it would follow that the earth's orbit round the sun should be measured by the revolutions of the moon's orbit round the earth. This is a new idea, it is a grand one,—it is startling. I must look to it and see if it is true.

Imagination has now done her work,—she has led our thoughts, she has created a figure and presented the moving image to our mind of the earth revolving around the sun and measuring the distance performed by the value of the circumference of the moon's orbit, and, having no more to do, imagination now bids us to prove our intelligence.

I retire immediately to my room, and, not to make my story too long, after a variety of defective and erroneous calculations I at length arrived at these results:

The sun, as ascertained by my quadrature, is distant from our earth 92,285,568, of those parts of which the diameter of the earth is 7,912. We call them miles. The diameter of the earth's orbit is then 184,591,146 of such miles. Its circumference is therefore 579,847,623+ of the same miles. In passing round the sun the earth revolves on her axis 365.24225 times. In so doing she gains one revolution=1. In the same period the moon revolves about the earth 12.36826. In doing so she gains one revolution of the earth. Total of revolutions, 379.61151+.

These revolutions are all of them solar days, each one of which is greater than the revolution of a circle in space in the proportion of 5184 to 5153, and therefore, as 5153 : 5184 : 379.61151=381.895, and the circumference of the earth's orbit being 579,847,623+÷381.895, gives 1,518,343 miles for the circumference of the moon's orbit, and the diameter of 1,518,243+is 483,303+half equals 241,651, which is the moon's distance from us. Now observe that this distance is of such parts as compose the earth's diameter, reckoned at 7,912 miles, and, if there is any error in that diameter of the earth, then there is an equal proportional error in this distance. And in my opinion the diameter of the earth should be considered as 7,853 + miles, and in that case the moon's distance will be 239,838 and the sun's distance will be 91,597,392 miles. The reasons for all these conditions will be apparent to any one who will take the trouble to examine them.

In the problem to determine the sun's distance, I have taken the diameter of the earth at 7,912 miles, because that is the sum set down in the books as ascertained by the measurement of a degree on the equator. But because in the problem to determine the sun's distance

I have taken the earth as "unit," I am of the opinion that the diameter should be taken as .7853+ or one quarter the circumference of one diameter, and particularly this should be so, as the calculations are all made in reference to motion. This gives a difference in the diameter of the earth of between fifty-eight and fifty-nine miles, and I think the last named sum (7853+) is the most accurate.

Astronomers say that the moon's distance from us is a fraction less than 239,000 miles, but theirs is only an approximation, and they admit a liability to error equal to one or two thousand miles. And again their measurement is from the center of the earth to the center of the moon, and it is self-evident that our measurement as first given includes the moon's whole diameter, and her atmosphere which moves with her, and this being considered it will increase their distance or diminish ours ten or twelve hundred miles, and astronomers admit a possible error greater than that difference would show. But if we admit an error in the diameter of the earth equal to that above stated, we shall then approximate to the latest estimate of the moon's distance by astronomers almost exactly. Now, which shall we accept for the moon's distance; the measurement of astronomers with its liability to error of a couple thousand miles or so, or my hypothesis, which, if true, gives the exact distance to a mile? I think the evidence is all in favor of the hypothesis, which makes the earth to revolve about the sun on the value of the circumference of the moon's orbit, this result being produced by the natural laws of motion, and the attraction of magnetism (or gravitation, if you please to call it such) with the universal law of precession to make motion continuous, and not by any imaginary projectile force which does violence to nature.

The sun's distance from the earth was formerly considered to be 95,000,000 miles, some have said 96,000,000; here again astronomers admitted a possible error of 1,000,000 or 2,000,000 of miles. La Place thought it was within $\frac{1}{87}$ of the truth. Of late, however, they have come to the conclusion that the distance is much less, and, as deduced from the angle of parallax, it has, by some, been stated a fraction under 92,000,000, and I hear that much anxiety is felt to ascertain the fact by observing the transit of Venus to happen in 1874.

I determined the sun's distance by my Quadrature, published in 1851, to be 92,285,568 miles, such as compose the earth's diameter reckoned at 7,912 miles, and I wait the result of the coming observations of the transit without fear of contradiction. It was not until a dozen years after the publication of my Quadrature that the change was made in the estimate of the sun's distance, and then without credit to my earlier demonstration.

But we need not wait for the transit to learn the truth. The mechanical properties of numbers, which Archimedes threw away, and which all astronomers now throw away as useless, will help us out of the difficulty. If we admit the hypothesis that the earth revolves about the sun on the value of the circumference of the moon's orbit (and I do not see how we can help admitting it, unless we first deny the unity of the earth and the moon as constituting a perfect and distinct system, and unless we deny also the well established truth that the heavenly bodies are goverened by laws that regulate their distance and motion relative to each other precisely according to their relative magnitudes, density, etc.), then it will follow, from the mechanical properties of numbers, that knowing how many revolutions of the earth and moon are performed (381,895) in the passage over the earth's orbit, if we divide that number into the sun's distance (which is the radius of the earth's orbit), the product will be the radius of the moon's orbit.

If, then, we want to know whether the sun is 95,000,000 of miles distant from us, we will divide 95,000,000 by 381,895, the number of revolutions of the earth and the moon, and that will give 248,759 miles as the moon's distance; and we know from observation, aside from our own theory, that it is not 248,759, miles and that it does not differ much from 240,000, and by the same means we then know, also, that the sun is not 95,000,000 of miles from us. Again, knowing approximately the moon's distance to be about from 240,000 miles, if we take that as radius, and multiply it by the number of revolutions which the earth and the moon perform (381,895) in passing over the earth's entire orbit, the product will be the sun's distance, or the radius of the earth's orbit. And here again we see that the sun is not 95,000,000 of miles from us, and, moreover, that its distance is not greater than the sum we have given it, viz., 92,285,568 of those parts of which the earth's diameter is 7,912, which we call miles. Again, knowing the moon's distance, we can calculate the circumference of her orbit, and, multiplying that by the number of revolutions; will give us the earth's orbit round the sun.

These truths are all so perfectly simple as scarcely to need a diagram to illustrate them, but as all may not see the truth quite clearly, I have prepared here a diagram to illustrate the power of numbers as applicable to our theory.

Let us consider the larger circle as the earth's orbit, with the sun in the center, the lesser circle is the moon's orbit, with the earth in the center. Now let us suppose that the diameter of the lesser circle is one and the diameter of the greater circle is twelve, then the lesser, revolving about the greater, will make twelve revolutions. Then divide the number of revolutions, twelve, into six, the radius of the earth's orbit, the result is five, which is the radius of the moon's orbit. Again, if you know the moon's distance, and multiply it by the number of revolutions required to pass round the sun, it will give you the sun's distance or the radius of the earth's orbit. And if you know the moon's distance, you can calculate the circumference of her orbit, and, multiplying that by the number of revolutions required to pass round the sun, it will give you the earth's orbit. If you know the moon's distance, and divide it into the radius of the earth's orbit, it will give you the number of revolutions of the moon in her orbit required to pass round the sun, and these are just the things which the earth and the moon together perform every year in the fulfillment of their respective journeys round the sun.

Hence, it will be seen, accepting these premises to be true, it will result that the earth's daily progress in her orbit round the sun is exactly equal to the circumference of the moon's orbit round the earth, viz., it is exactly 1,518,343 miles, such as compose the earth's diameter reckoned at 7,912 miles. Reduced to time, the daily motion is as follows: Revolution of the earth on her axis, twenty-four hours; in the meantime the moon has advanced, in her orbit round the earth, 52′ 30″ +, sidereal time, to which you must add the difference between a solar day and the revolution of a circle in space, 8′ 36″ +.

If it is objected that neither the earth nor the moon revolve in a circle, and therefore these things cannot be true, the answer is, that if we suppose either the earth or the moon to revolve in a circle, the area of which is equal to the area of the ellipse in which they do actually revolve, then the radius of the circle is exactly the mean distance of either the earth or the moon from the center around which they revolve; and it is precisely the same thing whether they revolve in a circle by an equal motion, or in an ellipse by an unequal motion; in either case they fulfill the law of passing over equal areas in equal times.

Divested of the lumber which science has given these questions, it looks too simple to be believed, but you may alter your proportions and carry your numbers and diameters to hundreds of millions, as you please, and still you will find numbers true to those mechanical properties.

Admit the hypothesis, then, as in fact we have already proved it, that the earth revolves round the sun on the value of the circumference of the moon's orbit, and we then know the sun's distance, without waiting till 1874 to learn the confused results of the vast outlay for observing the transit of Venus; and what is of much greater importance, we have learned by this examination that because our earth revolves about the sun, on the value of the circumference of the moon's orbit, the earth being in the center, the earth, therefore, moves evenly through space, as the center of that revolving orb, put in motion by the attraction of magnetism (gravitation), and kept in motion by the universal law of the sun's precession, and, therefore, there is no such thing in nature as a projectile force, and especially there is none in the motion of our earth round the sun.

The President—What do you mean by the term "precession;" do you mean the precession of the equinoxes?

Mr. Parker—I mean the precession of the sun. In consequence of the revolution of the sun in space, the earth is about twenty-three hours and fifty-six minutes in revolving from star to star; while it is twenty-four hours in revolving from sun to sun. I hold that the sun, in that case, *goes before* and takes the lesser tributary orbs along with it, and that is the precession I refer to.

The President—The precession of the equinoxes is only the result of the earth's being an oblate spheroid. It would not exist, were the earth a sphere; and it has nothing to do with keeping the earth in motion.

Dr. J. W. Richards—It is evident that he does not mean the precession of the equinoxes, but I am at a loss to understand the term as it is used in this paper.

Mr. Parker—I consider the sun's advance, every day, as the sun's precession or going before. We revolve opposite a fixed star in four minutes less time than the sun. Does not that prove the sun is in motion? That is the precession I mean.

Dr. P. H. Van der Weyde—That is what is called the acceleration of the stars. The sun lags behind, as it were; is that the precession you mean; that is, supposed to be the cause of keeping the earth in motion in its orbit?

Mr. Parker—Yes.

Dr. Van der Weyde—I should call it the result of the earth's motion in its orbit. The earth must necessarily make one revolution more with regard to the stars than with regard to the sun. That produces the difference between sidereal and solar time.

The President—The idea is presented by Mr. Parker, that the revolution of the earth around the sun is exactly measured by the revolution of the moon around the earth. It is now generally admitted that the celestial space is filled by an ether, which does not revolve in connection with the earth and moon. The earth and moon do not revolve in the same plane. The number of days in the year is now thought to be attributable to a very different cause. Prof. Kirkwood, of Indiana, a number of years ago, announced the law, dependent upon the nebular hypothesis, that the square of the number of days in any planet's year is in proportion to the cube of the attracting sphere of that planet.

Dr. P. H. Van der Weyde—I wish Mr. Parker would apply his rule to the moons of other planets. Fighting against the idea of a primitive impulse, is only fighting against a windmill. Nobody believes in that theory now. I consider the agreement merely accidental, except so far as the figures or the mode of calculation are changed to make the results agree. I see that Mr. Parker adds together the 365 revolutions of the earth on its axis, and the twelve revolutions of the moon around the earth. He might just as well add six trees and three dollars. It makes nine what? Neither trees nor dollars. As to what he calls precession, it is merely the acceleration of the stars; and no one pretends that it has anything to do with keeping the earth in motion.

Dr. J. V. C. Smith—I am inclined to think that this subject has been treated in too curt a manner. The gentleman has read to us a paper which is profound. He has bestowed great thought upon it. He has made a demonstration by figures of what he has stated. I like the idea that the sun is going before and dragging this great train with it. If the gentleman is wrong in his ideas, I think a paper ought to be written to refute them.

Mr. Parker—As to the agreement being a mere accident, I wish to say that you may alter the proportions, and the same principle will hold true.

Dr. L. Bradley—Which of the satellites of Saturn will the principle apply to? It cannot apply to them all.

Mr. Parker—That is not a subject I have treated of. My whole time is devoted to business; but I believe that when any one discovers anything which is an addition to the knowledge of the world, it is his duty to make it known.

The President—I will give Mr. Parker credit for one thing. He announced in 1851, that the distance of the earth from the sun, instead of being 95,000,000 of miles, as was then supposed, was only about 92,000,000. Now it turns out from the most recent and reliable investigations—those of Prof. Newcomb, of Washington—that the distance of the earth from the sun is but little more than 92,000,000 of miles. Here is a coincidence which is certainly worthy of remark.

Mr. Parker—I arrived at that result as a strictly mathematical problem; and it is contained in my book, on the Quadrature of the Circle, in which I claim that I have demonstrated the exact quadrature of the circle.

Dr. Van der Weyde—In answer to Dr. Smith, I am willing to give credit to the paper which has been read, for its ability; but it is not true. That is the trouble.

Dr. L. Bradley—If there is a rule of multiple proportion applying to the earth and moon, it ought to apply to the other planets; but it cannot apply to any planet having more than one moon. It cannot apply to the moons of Jupiter, Saturn or Uranus.

The President—Perhaps Mr. Parker would say that it might apply to the mean motion of all the moons.

Dr. L. Bradley—I am willing to concede that the imagination of the gentleman has been very profound; but my imagination and reflection led me in an opposite direction. Every body, every molecule, is in motion. There can be no motion without something to cause it. Matter is as universal as space; and wherever there is matter there is motion. Whatever is in motion, I think, is moved by a projectile force.

Dr. J. W. Richards—I understand that it is all attraction and no projection.

Dr. L. Bradley—It is true that gravitation has originated all the projectile force in the earth or the planets. The revolution of the earth on its axis, or in its orbit, the revolution of the moon in its orbit, all the motions of worlds as well as of molecules, are caused by gravitation.

A Chinese Puzzle.

Prof. J. V. C. Smith exhibited a puzzle, consisting of several pieces of wood connecting colored threads, which changed in number and color as the central pieces were moved.

Dr. Van der Weyde explained the construction; the threads were passed through variously arranged diagonal holes in each piece of wood.

The Chairman introduced Dr. Ott, who read the following:

PORTLAND CEMENT AND PORTLAND CEMENT STONE.

By DR. ADOLPH OTT.

Nothing, perhaps, has prevented the extensive use of Portland cement in this country more than the circumstance that most parties engaged in the manufacture of stone, or in the laying of floors and sidewalks, endeavor either to conceal what they are using, or try to make the public believe that the strength of the solidified material is not so much dependent upon the cement as upon some ingredient, generally harmless, which they are using in combination with it. Hence, instead of calling their products simply cement stone, or Portland cement stone, if made of artificial cement, they are termed "artificial stone." The public, being well aware of the frequent failures following the attempt to introduce an artificial building stone, which, in most cases, has been gotten up by ignorant parties, now evinces a want of confidence in Portland cement stone, because it is offered as "artificial stone." I am far from asserting that no substitute may be found for good Portland cement; but I hold the opinion, and I think with good reason, that all attempts to find such a one have thus far failed. I am also far from maintaining that probably no further improvements will be made in the application of this cement. On the contrary, by adding other ingredients to it, its strength and durability may be increased, or some other desirable quality may be imparted, and that without proportionally increasing its cost. I am glad to say that such improvements have, in fact, already been made; but I will not dwell upon them now.

In the last paper which I read before this association, I endeavored to give you a history of hydraulic cements in general, and to specify the uses to which they have been and may be applied. As my present paper is devoted to only one kind of hydraulic mortar, I can now be more exhaustive, and I shall be able to impart more practical information. I will first define what Portland cement is; then describe its properties, the process of induration as now established, the properties of the indurated cement or mixtures of cement and inert materials; and I will then conclude with a review of the uses to which it may be applied. Should I be able to remove some of the prejudices which exist among many of our builders and architects with regard to this cement, and thus lead them to a more extensive application of it for building purposes, I shall feel amply repaid for my labor.

Portland cements are those artificial hydraulic mortars which have been exposed to a temperature sufficiently high to produce softening, and which, in this condition, contain no free lime, and have a specific gravity above three. The name originated with Joseph Aspdin, in Leeds, in 1824, who first succeeded in producing cement superior to any before made. The solidified cement being in appearance and quality equal to the Portland stone, of which the finest edifices of the English metropolis are built, he gave to his product the name of Portland cement. When we remember that this stone is classed among the most valuable building materials of England, the above designation may be considered too assuming; but it will be shown that its qualities were not overrated; that, in fact, the name must be considered as very appropriate.

Portland Cement, Physically and Chemically considered.

Portland cement appears as a sharp, crystalline powder, of a color varying from light to dark gray, and having a bluish or greenish tint. Its specific gravity is, for the most part, above 3.1. Chemically considered, it is essentially a combination of lime, silica, alumina and oxide of iron.

Michaëlis gives the following analysis, showing its average composition:

Lime	=	60.05	per cent.
Magnesia	=	1.17	"
Alumina	=	7.50	"
Oxide of iron	=	3.34	"
Potash	=	0.80	"
Soda	=	0.74	"
Gypsum	=	1.82	"
Silica	=	24.31	"

After this cement has been exposed to a heat of 3,500° Fahr., there is no doubt that a thorough chemical action must have taken place, and that no part of it has remained intact. In fact, the calcined cement consists chiefly of a silicate and aluminate of lime, of which the significance of the latter has only been lately recognized. In properly calcined cement, the oxide of iron is always combined with oxide of calcium; provided that, in consequence of too high a temperature, the acid nature of the silica has not been called into play, in which case it is converted into a protoxide which will then unite with silica. If completely melted, Portland cement becomes a glass, tinged with silicate of protoxide of iron.

Whether the above-named combinations exist singly by themselves, or as double compounds, has not been determined; but it appears to be established that there is no free lime in Portland cement.

The Setting or Induration Process.

The slow induration of Portland cement, as Dr. Bleibtreu has shown, consists in the formation of a real mineral, or of a crystalline rock species, which appears to be perfectly analogous to natural zeolites. Dr. Bleibtreu owes the discovery of this induration to the circumstance that, in the loading of some cement in Bonn, a barrel of it rolled into the Rhine. When, after the lapse of about six weeks, at a low level of the water in the river, the same was taken out, it was found to be completely solidified. Upon knocking off a piece and holding it in the sunlight, a peculiar kind of glimmering was observed; and, when it was examined with a magnifying glass, the whole mass was found to exhibit a distinct crystalline structure. This fact was still further confirmed by microscopic examination. On this account, says Becker, we are led to the conclusion that the greater part of the set cement consists of translucent, and, to some extent, even of transparent crystalline particles. By measuring the angles of the crystals, their form is easily ascertained. It appears that rhombic columns, octahedrons and laminæ are prevalent. There are also many needle-like crystals, either of a star-like form or of a form presenting an appearance somewhat resembling a net, exactly like those of the zeolites of nature. This structure has since been noted by Dr. Bleibtreu in different descriptions of slowly set Portland cement.

If, however, a rapid induration ensues, it is evident that there can be no perfect crystallization. The cement will rather form an amorphous mass, often penetrated by cracks and fissures, so frequently seen in constructions composed of cement. How very important it is to the solidity and hardness of hydraulic mortars that the various elements have time to group themselves together, is evident from the diversified columnar structure of slowly set cement. Whether it takes a little longer or not for a cement to set, is, after all, of no great consequence. The mass should not become at once hard and rigid; it should rather, for a few weeks, possess a certain flexibility, so that the crystals which slowly form themselves may penetrate in every direction, and thus form an intimate and compact structure.

Induration in Fresh Water.

If Portland cement is mixed with water to the consistency of a stiff paste, it turns darker in consequence of the displacement of the air by the water, and sets more or less rapidly, according to its composition and the temperature to which it has been exposed. From the moment of setting, it hardens gradually in air, as well as in water, but more rapidly in the former medium. If finely divided cement is exposed to the action of a large quantity of water, it will be completely decomposed. Lime and a small quantity of silica are dissolved, while the hydrates of silica, alumina and oxide of iron remain behind.

If the action of the water went in to such an extent, the cement could not be used in water; it is, however, protected from decomposition by its great density on the one hand, and by the action of carbonic acid on the other. Whenever this gas comes in contact with hydrate of lime or with silicate of lime, and at the same time comes in contact with a silicate of an alkali, a corresponding carbonate is formed, while silicic acid is separated. This latter, as Fuchs has shown, possesses strong binding qualities.

But, however, since the atmospheric air affords a greater amount of carbonic acid than water does, and since water acts to some extent as a solvent, it is easy to see why the hardening of cements takes place sooner and in a more perfect manner in the air than in the water. As to the interior, it hardens equally as well in the air as in the water. One may readily convince himself of this fact by making the tests with samples, one set in the air, the other in the water. No difference will be found, no matter after what length of time they have been tested. The lesser the degree of density of a mortar, the more it will be decomposed by water and carbonic acid. But, as there is no hydraulic mortar having a greater density than Portland cement, there is, therefore, none that is capable of resisting that decomposing action better than this.

Induration in Salt Water.

Experience shows that the setting of hydraulic mortars takes place more slowly in the sea than in fresh water. The principal substances in sea-water are, as is well known, chloride of sodium, chloride of magnesium, and sulphate of magnesia; of these, the two last act the most as decomposing agents. Aside from these salts, sea-water contains other agents which act on the mortar, carbonic acid (either in a free state or as a bicarbonate), and sulphuretted hydrogen, which is, however, local in its occurence. From the moment the mortar is exposed to the sea-water, carbonate of lime will be formed wherever lime, be it free or combined, comes in contact with this agent. As to the salts of magnesia, they will convert free lime or its carbonate into a sulphate or chloride of calcium. With regard to silicate or aluminate of lime, the magnesia probably takes the place of the lime without changing the properties of the respective compounds. As lime is dissolved by all these reactions, the cement becomes porous; and, if a formation of sulphate of lime in crystals takes place, the solidity of the cement is endangered. From what has been said, it is evident that protection is afforded only by the physical properties of the mortar. If it is fine and of a high specific gravity, a layer of carbonate of lime will be formed on the exterior, and thus the sea-water will be prevented from penetrating further. Exposed to the sea immediately after setting, the induration takes place quite slowly; but, if once completed, the permanency of the cement, in so far as air and water are concerned, is secured for ever. The cement stone should, therefore, be allowed to harden well before it is immersed in the sea. Moreover, we have in soluble glass the most simple and effective means of securing and increasing the durability of hydraulic cement, as far as these qualities result from its being rendered inaccessible to water and carbonic acid. The effect of soluble glass is here two-fold; silicate of lime is formed, and silica deposited; and, if the former should again become decomposed by carbonic acid, it will only help to form a layer on the exterior, upon which air and water have hardly any effect.

On the Effect of Frost During Induration.

So long as only the lesser portion of the water that was used to mix with the cement has entered into chemical combination, the work executed would necessarily be endangered by a frost. After the lapse of a week or so, only one-third or one-fourth of the water remains free; while, after four weeks' time, the whole amount used is found combined. Although this amount of time is very small, and though the cement greatly surpasses ordinary lime mortar on account of the solidity it attains, builders are often quite unreasonable in regard to the matter. How often, for instance, are extensive works executed in cement, when a frost may occur every night! And how often, too, is even plastering done at such times! But what are the consequences? Even before the winter has passed, the prematurely undertaken construction falls to pieces on the ground; or, at the least, numerous cracks and fissures prove that great strength and durability were not, under the circumstances, to be expected.

With regard to plastering, a high temperature is equally disadvantageous, in causing a too rapid evaporation. The best season is the spring. Thus, a building which has been completed in the autumn can be provided with a coating of cement the following spring. For common plastering, the summer and the fall are, as is well known, preferred.

The Properties of Cement Stone.

Cement stone possesses an agreeable bright gray stone-color; it is capable of being polished; attains in its best quality a hardness and power of resistance equal to that of the most valued limestones, even to those of the oldest formations. To these properties it owes the name Portland cement. Joseph Aspdin intended to intimate, by the use of this name, that this product equaled the Portland stone in appearance and quality. If this important member of the Upper Oolite, and of that local fresh-water formation, the Wealden, are left out of consideration, the final member of the English cretaceous formation includes the most excellent building stones.

The most splendid edifices of the metropolis, the most beautiful and the grandest buildings of England, are made of this stone, and the extensive quarries of Purbeck are widely known on account of their beautiful and homogeneous material. Like this stone, the solidified Portland cement is of a fine-grained texture, and, offering no cleavage whatever, it yields evenly to the chisel. But this property can be easily dispensed with in the case of cement, on account of the fact that while soft it can be adapted to any form. Herein lies the great value of this artificial product. It is true that Portland cement shares that deportment with other materials like plaster of Paris, but when we consider its degree of hardness, strength and binding qualities, we find that the cement surpasses all similar materials, and what is of the greatest importance, that it will fill a given space without contracting or expanding. If we conclude that Portland cement stone contains on an average sixteen per cent of water in chemical combination, and that the burned cement has an average specific gravity of 3.2, the specific gravity of solidified Portland cement, calculated as follows,

$$\frac{(3.2 \times 84) + 16}{100}, = 2.704,$$

while direct determinations give the figures 2.676.

Strength.

Portland cement, and in fact all mixtures of this cement and sand, according to Major-General Gillmore, acquire, during the first two years, fully nine-tenths of the strength and hardness which, in course of time, they finally attain. Both the tensile and crushing strength vary, of course, according to the quality of the cement; but they are generally the greater the denser the mortar. The tensile strength per square inch of blocks seven days old was found by Mr. Grant to be 236 pounds for English cement powder weighing 103 pounds per United States bushel, while it was 406 pounds for cement weighing 226 pounds, showing a difference of 170 pounds per square inch. The strength of Boulogne cement, for blocks fifteen months old, was found by General Gillmore to be 496 pounds. At the end of one month, according to this authority, the tensile strength of neat Portland cement is equal to about two-thirds of what it attains during the first two years. With regard to its crushing weight, it does not reach its maximum limit within a period of less than two, or perhaps three, years. The crushing weight of English Portland cement was found by Mr. Grant to be 3,806 pounds per square inch for blocks three months old; 5,388 pounds at the end of six, and 5,973 pounds at the end of nine months. The tensile strength of the best Portland cement, when seven days old, is about six times as great as that of the best natural American cements. This holds true whether it is mixed with a little or a good deal of water. The crushing weight of the Portland cement, after the lapse of seven days, is, even when made plastic like mortar, nearly twenty times as great as that of Rosendale cement.

Neat cement finds but a very limited application, firstly because it would be too expensive, and secondly from the fact that even if mixed with sandy materials it is yet sufficiently strong for most practical purposes. Portland cement, mixed with three times its quantity of sand, becomes, in a few months, superior to ordinary mortar more than a hundred years old, while the cost of the material is in no small degree lessened.

With an admixture of from two to four volumes of sand, the cost of the material is considerably lessened; but above that figure, as held by Michaëlis, a decided disproportion between price and solidity ensues. With regard to the tensile strength and crushing weight of various mixtures of sand and cement, reference is made to Plate I, of the Practical Treatise on Coignet Béton and other artificial stone, by Major-General Gillmore. For foundations, flooring, houses, constructions in the sea, etc., chips or small stones, gravel, broken bricks, burned clay, cinders, etc., are generally used in combination with sand. Such a mixture is then termed béton or concrete. The substitution of common lime for a portion of the cement, however, results always in a sacrifice of strength in proportion to the extent of the adulteration. When mixed with a small quantity of lime milk, it loses proportionally but little of its solidity, while it can be worked much better and more safely, as the setting is greatly retarded by such an admixture. In the following table are given the results of Professor Rankine's experiments as to the crushing strength of bricks and natural stone:—

Materials.	Crushing weight per square inch in pounds.
Brick, weak red	550— 800
Brick, strong red	1,100
Brick, first quality hard	2,000— 4,368
Brick, fire	1,700
Chalk	330
Granite, Patapsco	5,340
Granite, Quincy	15,300
Marble, Montgomery county, Penn.	8,950
Limestone, granular	4,000— 4,500
Limestone, marble	5,500
Sandstone, strong	5,500
Sandstone, ordinary	3,300— 4,400
Sandstone, Connecticut	3,319
Caen stone	1,088

Durability; Healthfulness.

European experience, extending over a period of more than forty years, has established the fact that constructions of Portland cement or béton will resist the influences and changes of climate equally as well as the very best building stones. Portland cement stone, if properly made, is almost impervious to water, while this cannot be said of brick and sandstone. Since warmth and moisture are peculiarly favorable to vegetable growth, these latter building materials are more liable to disintegration than others with less absorptive power. The resistance to frost is absolute, even in structures the roofs of which are terraced with this material. With regard to the absorption of moisture by brick, Mr. Edwin Chadwick, who was appointed to report on improved dwellings at the Paris Exhibition, says:

"There is another great source of evil attaching to walls of the common brick and common soft stone construction—the absorbency and retentiveness of water or damp. In England, the common bricks absorb as much as a pint (or a pound) of water. Supposing the external walls of an ordinary cottage to be one brick thick, and to consist of 12,000 bricks, they will be capable of holding 1,500 gallons, or six and a half tons, of water. To evaporate this amount of water would require three tons of coal, well applied. The softer and more workable stones are of various degrees of absorbency, and appear to be more retentive of moisture than common brick."

The chilling sensation experienced on entering an unwarmed brick house in winter is not suprising, when we consider that the walls must be one mass of ice, making the air within the house still colder than without. When it is further considered that Portland cement stone is non-absorbent of moisture, it will not appear strange that houses built of it are from eight to ten degrees warmer in winter than houses built of brick.

Resistance against Fire.

To any one acquainted with the chemical composition of cement stone, it must at once become evident that, with regard to its resistance against fire, it ought to supersede most building stones. That this is really the case, we learn from several reports before us, given on the "Frear stone," which was used in the construction of several buildings in Chicago, and which is essentially a cement stone. Merrill Ladd, Esq., president of the Mutual Life Insurance Company of Chicago, writes as follows:

"In passing through the '*great fire*,' no signs of flaking, splitting, or disintegration were perceptible, as was the case with all natural stone (even granite) which was used in this city. I will say, in conclusion, that I believe it to be the best material that can be used for building, where strength, solidity and protection against fire are desired."

Also Professor McChesney, the geologist, says:

"I examined its condition just after our great fire, where it had been exposed to as severe tests as any building material in this city; it was neither cracked nor scaled off by the great heat so badly as the real stone used in this city; and, on examination closely, the heat had not penetrated but about two inches in any instance, from which I conclude it might be used to advantage in the construction of fire-proof vaults."

I would gladly add other testimonials, if I did not fear that I had already occupied more space than is usually assigned to such papers.

Cost.

Messrs. Bandman & Jaffé, manufacturers of cement stone in this city, give the following estimate for the cost of 100 cubic feet of cement, viz:

87 cubic feet of broken stone and sand....................	$3 00
13 cubic feet of Portland cement, at $1.25 per cubic foot...	16 25
Labor	3 50
Total..................................	$22 75

If hydraulic lime be used instead of cement, say five parts lime to two parts of Portland cement and eight of broken stone and sand, one hundred cubic feet of superior wall can be built, according to close calculation, for $16.75. This is considerably less than one-half the cost of construction with brick and mortar.

Lintels, sills, caps and arches can all be made at the same time, and with only a slight increase in expense. The partition walls need not be eight inches in thickness; four or at most five inches will be sufficient.

I will here remark that, by the addition of proper colors, the brown stone of New York city is imitated so accurately in Portland cement stone that the eye can scarcely detect the difference. With regard to the proportionate cost of these two stones, I would state that the price-list of one of the companies in this city shows that the rates for ashlers, caps, corner-blocks, keys, etc., range from one-half to one-third those usually paid in this market for blocks of cut brown stone of corresponding shapes.

For such stone, as well as for ornamental work, only fine washed sand is used as an admixture for the cement. The cost of artificial stone being so much smaller for plain work, it is evident that the difference must be much greater for ornamental work; for the cost of producing the most elaborate designs, the moulds being once made, is but little more than that of the simplest blocks. When we consider that in the ornamentation of our public and private edifices there is no limit except that of design, and that duplicates of celebrated statuary can be furnished with ease, it is at once apparent that the invention of Portland cement is to sculpture and architecture what photography is to the arts of drawing and painting.

Uses.

With regard to the uses to which Portland cement can be applied, it may be remarked that they are almost innumerable. For submarine constructions there is no material which can take its place, be it for concrete, or in blocks, or as mortar in brickwork. For bridges, cisterns, aqueducts and sewers, it is in great demand. For flagging and sidewalks its use is daily extending. As it is impervious to water and can be laid in a continuous surface, no heaving or disturbance can result from frost in the ground, provided it be properly drained. There is no material better adapted for the construction of cheap and elegant dwellings. Those who visited the Paris exhibition of 1867 will perhaps remember the row of dwellings near the Bois de Vincennes, which are models of convenience for families, as well as of cheapness in construction. They were executed after the ex-emperor's designs, and present one monolithic structure of béton.

Foundations for machinery in béton are cheaper than stone masonry, and quite as good. For engines, a cubic yard of foundation corresponds to one horse-power, and thirty horse-power would require, therefore, thirty cubic yards. Water-pipes of the same material are made at half the expense of those of iron, and they cost little for repairs.

Furthermore, it is especially serviceable for floors in damp or wet cellars in private dwellings and warehouses, and for floors in granaries, sugar refineries, breweries and malt-houses, and it is also being used for gasometer reservoirs and reservoirs for petroleum. And, as an instance of the more recent applications of the cement in question, I mention the coating of the inside of iron ships.

For ornamental work, Portland cement has not yet been superseded, and its use for this purpose is daily extending. Delicate traceries, sharply defined *alto* and *basso relievos*, can all be most artistically executed in this stone. Some work of this kind can be seen in the Gilsey House; and, we will add, that the front of the new Lyceum Theater, in this city, is being executed, after elaborate designs, in cement stone. To conclude with a remark of the Scientific American, I may say that, "with anything so greatly in demand as good building material, the slightest advance becomes of immense importance, and cannot fail to benefit the entire civilized world."

Adjourned.

March 29, 1872.

Prof. S. D. Tillman in the chair; Robert Weir, Esq., Secretary.

The President read the following items of scientific news:

I. The Flow of Glaciers.

Prof. Tyndall, in a recent lecture on the movement of glaciers, after describing the observations and measurements made by himself on the Mer de Glace, gives the following clear statement touching the relative motion of different parts of a crooked river of ice: When a glacier moves through a sinuous valley, the locus of the point of maximum motion does not coincide with the center of the glacier, but, on the contrary, always lies on the convex side of the central line. The locus is, therefore, a curved line, more deeply sinuous than the valley itself, and therefore crosses the axis of the glacier at each point of the contrary flexure. This law holds good for water, substituting the word river for glacier. The idea, then, as to the similarity between a river and a glacier, becomes marvelously strengthened. The glacier is like a river, because the central part moves faster than the sides; it is like a river, because its top moves faster than its bottom; and, again, it is like a river, because the point of swiftest motion follows the sinuosities of its sides.

Dr. J. W. Richards said that these facts proved that the ice was not a solid body, but that there must be a softening and change of position of the different parts. It was now supposed that there was no such thing as an absolute solid.

II. Ball Lightning.

Mr. C. F. Varley has recently given to the Royal Society of London an account of new experiments made with a Holtz electric machine, having brass balls at the poles, about an inch in diameter. A strip of wood about three inches in length was bent around the negative pole, so as to project on each side of it toward the positive pole. On rotating the machine, two bright spots are seen on the positive pole. If the positive pole be made to rotate on its axis at the same time, the luminous spots do not rotate with it; but when the negative pole with its filament of wood is rotated, the spots on the positive pole rotate also. On interposing a non-conductor, like plate-glass, between the poles, the luminous spots disappear. On removing the wood from the negative pole, there was sometimes a glow over a large portion of the surface of the positive ball. If, in this state, two or three small pieces of sealing-wax, or even a drop of water, be placed on the negative pole, corresponding non-luminous spots will appear on the positive pole, and these spots will rotate when the negative pole is rotated. It is evident that lines of force pass through the intervening air from the negative pole to the positive, a distance of about eight inches. This experiment, Mr. Varley believes, may explain the cause of "ball lightning." If a cloud be negatively electrified sufficiently strong to produce a flash from the earth, a point on such cloud would correspond to the projection of wood on the negative pole of the electric machine; and such point moving along the surface of the cloud would cause a responsive action near the surface of the earth, and a luminous spot would appear, which has been described as "ball lightning" by those who have witnessed this rare phenomenon.

Dr. L. Bradley—I think I have seen ball lightning. I saw it go into a mill, and it was all in flames in an instant. It seems to be totally unaccountable.

Prof. P. H. Van der Weyde—I have once seen a ball of lightning. This is the first explanation I have heard having any appearance of truth.

III. MINERAL COTTON.

Mr. Coleman Sellers, of Philadelphia, exhibited, at a recent meeting of the Franklin Institute, a sample of a product formed by allowing a jet of steam to escape through a stream of liquid slag, by which the slag is blown into the finest threads, sometimes two or three feet in length. These threads of glass readily break up into much shorter ones, which, being white, resemble cotton—hence the name. The material is a slow conductor of heat, and as great quantities of air must be retained in its interstices, it is well adapted to many purposes where so-called non-conductors of heat are required.

IV. SINGULAR ACTION OF LIGHT UPON CHLORINE.

Mr. E. Budde has described, in Pogg. Annalen, No. 10, 1871, a series of experiments which show that chlorine gas expands much more under the action of the violet rays than when exposed to the red rays of the spectrum. The same result was obtained on substituting bromine for chlorine, thus revealing the new fact that some bodies increase in volume under the actinic rays as others do under the heating rays. He offers the following explanation of the phenomenon: 1. Light may decompose the chlorine molecule into atoms. 2. The more refrangible rays of light may effect some unknown change, which results in heat and causes expansion. 3. It may be assumed that there are bodies which increase in temperature more under exposure to the violet than to the red rays. The author, regarding the first view as the most probable, believes the expansion of chlorine is the effect of a temporary separation of atoms under the influence of the more refrangible rays.

Prof. P. H. Van der Weyde—The first explanation, I think, is the most probable. It may be that light has the same effect upon substances as ozone. If that is the case, the volume must increase. Ozone is heavier than oxygen; for three atoms of ozone have the same volume as two atoms of oxygen. If we could split up all the chlorine into single atoms it would double its volume.

The President—The greatest expanding power of the spectrum is the red ray, and as these substances expand most in the violet ray, the only explanation is that the effect is produced by actual chemical decomposition.

Prof. Van der Weyde—Hydrogen and chlorine, when exposed to the actinic ray, will suddenly combine. When chlorine alone is exposed to the actinic ray it will partially combine with hydrogen, and on this fact Bunsen has formed an actinometer. If the actinic ray decomposes chlorine into single atoms, it predisposes it to combination with hydrogen, for which the single atom is required. There seems to be intimate relation between this discovery and that known fact.

Skeleton Leaves.

Mr. J. F. Robinson describes, in Hardwick's Science Gossip, a simple method of preparing skeleton leaves, which seems preferable to the old and tedious method of maceration, and which he recommends to all young botanists, especially to his fair friends, who take up the science of botany more as an intelligent amusement than for severe study. First dissolve four ounces of common washing soda in a quart of boiling water, then add two ounces of slaked quicklime, and boil for about fifteen minutes. Allow the solution to cool; afterward pour off all the clear liquor into a clean saucepan. When this liquor is at its boiling heat, place the leaves carefully in the pan, and boil the whole together for an hour, adding from time to time enough water to make up for the loss by evaporation. The epidermis and parenchyma of some leaves will more readily separate than others

A good test is to try the leaves after they have been gently boiling for an hour, and if the cellular matter does not easily rub off betwixt the finger and thumb beneath cold water, boil them again for a short time. When the fleshy matter is found to be sufficiently softened, rub them separately but very gently beneath cold water until the perfect skeleton is exposed. The skeletons, at first, are of a dirty-white color; to make them of a pure white, and therefore more beautiful, all that is necessary is to bleach them in a weak solution of chloride of lime, a large teaspoonful of chloride of lime to a quart of water; if a few drops of vinegar is added to the solution, it is all the better, for then the free chlorine is liberated. Do not allow them to remain too long in the bleaching liquor, or they become too brittle, and cannot afterward be handled without injury. About fifteen minutes will be sufficient to make them white and clean-looking. Dry the specimens in white blotting paper, beneath a gentle pressure. Simple leaves are the best for young beginners to experiment upon; the vine, poplar, beech and ivy leaves make excellent skeletons. Care must be exercised in the selection of leaves, as well as the period of the year and the state of the atmosphere when the specimens are collected; otherwise, failure will be the result. The best months to gather the specimens are July and August. Never collect specimens in damp weather, and none but perfectly matured leaves ought to be selected.

The President then introduced Dr. Henry Morton, who read the following paper:

ON CERTAIN PHENOMENA OF FLUORESCENCE.

By HENRY MORTON, Ph. D., President of the Stevens' Institute of Technology, Hoboken, N. J.

Though Sir John Herschel and Sir David Brewster, as well as others, had noticed some actions now known as fluorescent, it is to Prof. Stokes that we owe the first thorough study of the subject, and the true explanation of the action involved; and though much labor has been since expended in the same direction, by Becquerel, Gladstone, Hagenback, and others of less note, little has been done beyond adding to the store of facts which may, perhaps, enable some future philosopher to throw light upon the recondite methods of actions, whose general result alone we are able, as yet, to recognize.

This general relation of cause and effect is, however, a very interesting one, and with its illustration I will ask you to occupy your selves this evening.

In order that my relation should be connected and consecutive, I

PLATES I & II.

Fig. 1.

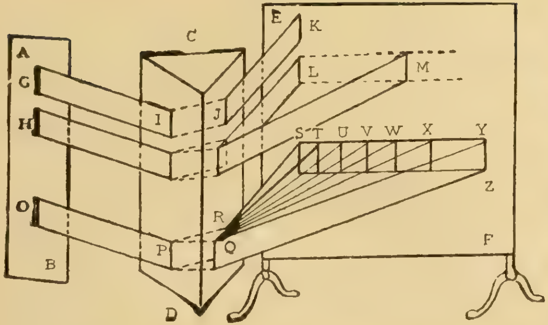
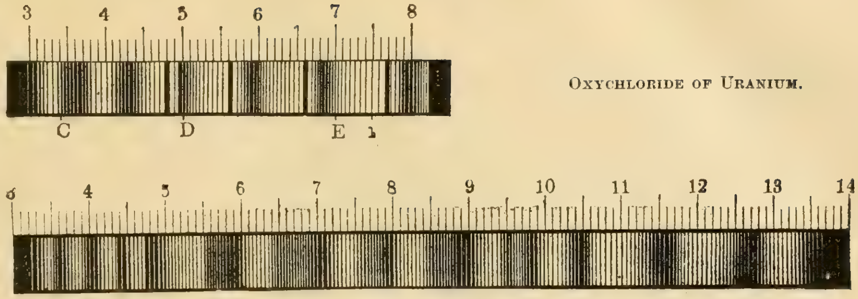


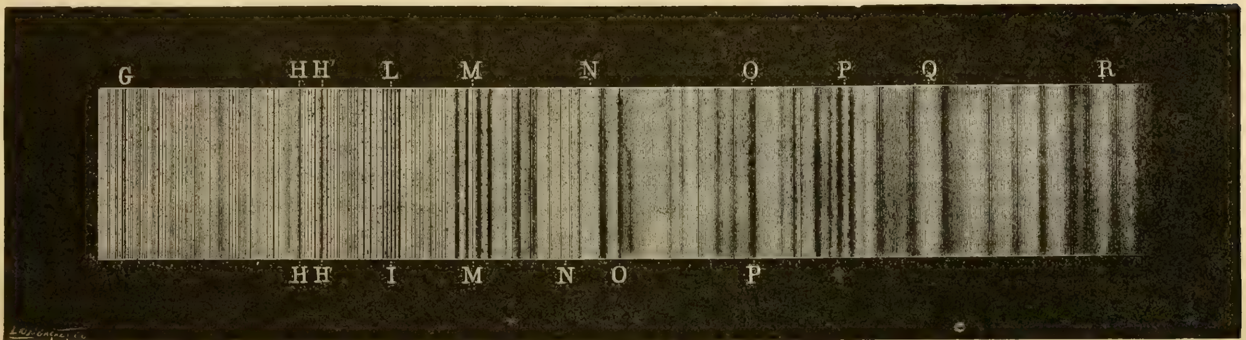
Plate II.



Oxychloride of Uranium.

Sodio-Uranic Acetate.

Fig. 2.



must briefly refer to some elementary principles but these I will simply recall to your minds, and hasten to the special department of the subject which at present engages our attention.

Light, we now fully believe is simply a vibratory or ripple-like motion, and colors differ from each other simply in the number of waves included in a given time or space; or, in other words, in the lengths of the individual waves which constitute them.

Thus, a crimson color may be compared to the long, heaving billows of the ocean, while a blue tint would find its parallel in the ripple which the fitful zephyr rouses on some summer's lake.

Again, we know that when these waves strike obliquely on some medium denser than that through which they have been traveling, but which is nevertheless capable of transmitting them; their directions will be changed, and that this change will be greater with the little waves than with the great ones. Such an action as this evidently leads to a separation between the waves of different lengths, and this separation we call "dispersion," while we give the name "refraction" to the mere act of bending, without regard to its varying degree with reference to the different colors.

The following diagram will exhibit the case now of most importance to us, in which this action of disperson is developed and utilized. (See Plate I, Fig. 1.)

Let A, B represent a screen, behind which are located various sources of light, emitting rays which respectively pass through slits at G, H and I.

Let C, D be a prism and E, F a screen. If the light-rays passing by G are all of one wave length, then they will be all equally bent by the prism at I and J, and will fall upon the screen in a single line at K.

Again, suppose that the light passing through the opening H were a mixture of two wave-lengths or colors, one part like that coming through G, and the other of greater wave length, or, as we say, of a lower color. Then that portion which resembles the former will be equally bent, and will fall on the screen in a single line at L, while the other part will be less bent, and will form another single line at M.

Lastly, if a beam were to come through O, composed of a great number of colors, or waves of various lengths, it would be separated by the prism into as many lines from L to Y; or if this number were very great the lines would blend with each other, and give a continuous band.

The name spectrum is applied to the resolved, or separated light, after its passage through the prism, whether that separation be into a continuous bend, as at SY, which is found when the incident light contains waves of every variety in length, or into a few separate lines, as at LM, where the incident light is made up of only two sorts or lengths of waves, or when, as at K, the incident light is entirely made up of waves of the same length or is purely of one color, or, to use a single word, is monochromatic, and is then not separated at all, but is simply refracted, and goes all to one place.

When pure white light, such as we get from luminous solid, or, indeed, dense bodies generally, is thus dispersed, separated, or, as we often say, analyzed, as above, by the prism, it yields a continuous spectrum, *i. e.*, a long band of blended colors, beginning at one end with red and running through various tints of vermilion, orange, yellow, green, blue and purple, to violet at the other.

But this is not all, with the stronger sorts of light. We find that this spectrum runs on beyond the violet for a distance more than five times as great as that usually visible, in what are called actinic rays; that is to say, waves so short and quick that under no ordinary condition do they affect the sense of sight, though they are potent in producing those changes which are recognized in photography.

For present example of this, you see on the screen a photograph of the actinic or extra violet spectrum of sunlight.

The dark lines indicated by letters we cannot pause now even to allude to, otherwise than to remark that they are found all through the solar spectrum, and are useful as points of reference. (See Plate I, Fig. 2.)

Slight as seems to be the difference between colors, according to the view I have just explained, *i. e.*, merely a question of length of waves; yet, except in the case which is the subject of our present study, so fixed and unchangeable is each element of the most composite beam, that not the least change of tint is ever found to occur. Red light, though it be passed through a hundred prisms or lenses or other optical machines, cannot be made one atom more or less red, and still less, therefore, changed to yellow or green or any other color.

But, you may well ask, to what then are due all the colors which we see in nature? Does not the white light find itself changed into green when it falls on a leaf, and into red when it encounters a brick wall?

I answer no. White light consists of or contains all colors. When it falls upon a leaf all the colors but such as produce to us the effect of green are absorbed and destroyed, or changed to other forms of force, and only the green-appearing rays are reflected to our eyes. So again the red objects absorb all but the red rays.

In proof of this I will now illuminate this brightly colored banner with light of various tints in succession, and you will see that in each single color only the object of the same color shows, all the others looking black; while if the colored objects could change the color of the light, then certainly the red object would still look red in the green light, and the green objects would show in the red light.

Such being the all but universal condition of objects in relation to color, you will appreciate the surprise which was experienced by the first observers when they encountered substances which, illuminated with one kind of light or color, exhibited another.

To give you an idea of such a phenomenon I have here arranged two rough pictures of a flower with leaves and buds alike in outline, but one, as you perceive, showing by the ordinary light many vivid colors, while the other shows only a yellowish shade in parts, and that so faint that it might easily escape notice.

If now these are both illuminated with bright yellow light, the highly colored picture fades and loses all its distinctive hues, as did the banner before, and is as colorless as its companion, which remains in this light unchanged, and so also if red or green lights are used; but if violet light is substituted, see what a wonderful change we have. The colored picture indeed is as dull and tintless as with the yellow light, but the uncolored one now seems fairly to glow and burn with brilliant green and blue and red.

Here is certainly an astonishing thing; a substance or substances which, receiving violet light, neither absorb nor reflect it, but change it into blue or green or red.

In the first place, then, let us inquire more particularly as to the limiting conditions of the exciting light. We have seen that in the substance just used, red, green and yellow light will not produce the effect, but that violet, or that a mixture of blue and violet, will. Is this, then, universal? Thousands of experiments have evoked answers to this question, and I will give you in brief a summary of their replies.

Violet light alone develops fluorescence in all bodies that are capable of exhibiting this phenomenon, but every sort of color may evoke fluorescence from some body. Thus, in the picture of a flower which you first saw fluorescent, the material which gave a blue color is only "excited" by violet light, that which gave a green color is excited by even the lowest of the blue rays, and by all above, but with variations in intensity; that is, one color or particular length of wave acts upon it more strongly than those of neighboring lengths.

Lastly, the center of the flower was, you noticed, red, and the body which developed this color is not only excited by the violet rays, but also by those of red light, though not by all the colors between.

So again, chlorophyl, which can be best obtained by exhausting tea leaves repeatedly with boiling water, so as to remove all that water will dissolve, and then treating them with strong hot alcohol, is excited by certain particular wave of red, other special tints of orange, some of green and special ones of violet.

So we might cite a hundred cases, all varying more or less, but yet all obeying this general law discovered by Prof. Stokes, that the exciting light is always of a less wave-length than the fluorescent light which it develops.

Thus, violet light may develop a blue fluorescence, but a blue light can never develop a violet fluoresence, and if, as in chlorophyl, the exciting light is red, that developed must be of a lower red or longer wave.

Thus you see, when I expose this flask of chlorophyl to the beam of united blue and red light now proceeding from the lantern, its original olive green color is replaced by a magnificent luminous crimson, as of blood.

We see then that sources of light rich in the violet rays will be the most efficient in exciting this action of fluorescence, and of such sources we have first of all in this regard the electric discharge obtained from an induction coil. In proportion to the total amount of light it gives, this is the richest in very short waves; that is, in those visible as violet light, and those active in effecting chemical change, though, as a rule, invisible.

For such purposes as the present, this discharge, when taking place in the little tubes containing highly rarefied pure nitrogen, is most effective, and I have accordingly arranged here a multitude of these, which we can illuminate with this immense induction coil.

I turn them toward you and you perceive what a blaze of violet light they emit, and now turning them away they light up the whole stage, and cause every fluorescent object on it to glow.

The electric discharge from a powerful galvanic battery, which we have already used, and shall use again, is another efficient source of the fluorescence-exciting rays; so is the light from burning magnesium from the ignited lime of the lime-light, only in these cases we must sift out the excess of the longer waves, which are also present, by the use of a plate of blue glass. Sunlight I have strangely omitted, as it comes next to the electric arc, but requires the blue glass also. I may mention here that a very neat arrangement has been made by Messrs. Hawkins and Wale, of Hoboken, to exhibit this fluorescence. It consists of a card with a flower painted in fluorescent material on it. This is contained in a little folding pocket of glass, which can be carried in one's pocket, and exhibited at a moment's notice, in daylight brilliantly, and even to some extent by gas-light.

Such, then, being the limitations as to the exciting light and the sources from which we can derive it, we inquire as to what bodies are capable of exhibiting this action.

If we apply the most accurate tests and use the most powerful means of excitement at our command, we find that it is much easier to say what does not than what does fluoresce, for almost all organic matters and many minerals possess this property in some degree. Thus, paper, muslin, leaves of plants, alumina or clay, in many of its combinations, the sulphides of lime, etc., show this property.

(*Note.*—I hold, with Hagenbach, the identity in nature of fluorescense and phosphorescence.)

But if we confine ourselves to bodies whose fluorescent properties are easily perceived, our list is by no means so long.

One of the first substances in which this property was perceived is a solution of the acid sulphate of quinine.

This I will exhibit to you in the following manner:

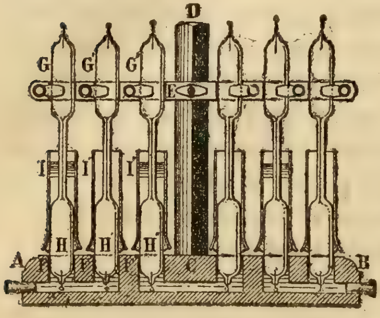
I have here some large vessels of water, so placed that they will be lit by the electric light, filtered of all its blue and violet rays by means of a plate of glass.

Into one of them I pour a little of this solution of quinine sulphate, and as it mixes with the water you see that it all lights up with a blue luminosity which makes it seem opaque, but yet this candle shows clearly through it, and, by the gas-light, the water looks as clear as before.

Into this other jar I pour a solution of æsculin, the principal of the horse-chestnut bark, and you see that it lights up in a similar manner. The quantity required in this case is so small that a fluorescence could be detected in water which contained but 1-20,000,000 part of æsculin.

Into this last I pour a little extract of the seeds of the stramonium, which lights up, as you see, with a green color.

(Fig. 1.)



Note.—To compare the fluorescent power of different solutions, the apparatus shown in Fig. 1, was employed. In this a number of nitrogen spectrum tubes G, G, G, etc., were jacketed by tubes I, I, I, etc., and supported in a stand with a minute channel of mercury at the bottom, so arranged that the current from an induction coil would be made to traverse any number of them.

The solutions to be tested are placed in the jackets and directly compared.

The stramonium extract and the æsculin, and also the quinine, when painted on paper, show, likewise, a fluorescence which is very marked, as these specimens testify.

The fluorescent painting of a flower, which I first showed you, had its leaves painted with a new body, which I recently discovered in certain petroleum distillates, namely, in the last run of the still, when the residues left from the distillation of illuminating oils are redistilled for lubricating oils and paraffine.

For this substance I would propose the name thallene, from the Greek word *θαλλος*, meaning a fresh sprout or twig, which is appropriate not only to its brilliant green fluorescence, but also to the fact that when its fluorescent light is observed with the spectroscope, two brilliant green bands appear as the most prominent features.

The flower is painted with a substance which I have obtained from the foregoing, by exposing its solution to sunlight, and for it I would propose the compound name petrollucene, in allusion to the fact that it comes from petroleum, and shines as you see by fluorescence, with a very vivid blue light.

The solutions of both these substances are richly fluorescent with a blue color, as I will show you presently in another way; but as these bodies are only soluble in such inflammable liquid as alcohol, benzine, benzole, and the like, I did not think it prudent to handle, in this place, such large quantities as would be needed to show you the properties of these bodies in the manner just employed with those soluble in water.

A solution of morin, which is a principle obtained from the yellow dye-wood, called fustic or Brazil wood, gives a brilliant green fluorescence. A solution of bi-chloranthracene in alcohol, gives a rich purplish blue, and so does a solution of comenamic acid in water with ammonia. For this body I am indebted to Mr. Henry How, of King's College, Nova Scotia.

All these I now show you in a series of what, from their inventor, are called Geissler tubes, in which a spiral tube containing a trace of nitrogen gas is surrounded by a jacket of glass filled with the substance whose fluorescence we desire to show.

A number of tubes, with various solutions, and arranged in different patterns, were then exhibited.

Among the substances that were earliest shown to possess fluorescent properties was glass colored of a yellowish green with oxide of uranium. This goes by the name of canary glass among the manufacturers. Its fluorescent power is well shown by these Geissler tubes, in which a portion of the tube is made of this sort of glass, which is seen to fluoresce with a very beautiful green light. I have placed among these canary glass tubes some of ordinary glass, in which the electric discharge is seen of its natural purple color.

This fluorescence is, without doubt, due to the uranium, most of whose salts fluoresce very brightly. Among these should be specially noticed the acetate, the double acetate of sodium and uranium, the sulphate and the double sulphates generally.

When I hold this large bottle of uranium acetate in the blue beam of the electric light, filtered through blue glass, you perceive how brilliantly it lights up, while this other, filled with a salt of an almost identical color (ferro cyanide of potassium), looks utterly dull and dark.

Solutions of these salts have, however, so little fluorescence that, though by the use of certain accurate tests it may be distinguished, it is yet difficult to develop, and in the Geisler tubes, though the contrary has been asserted by high authorities, cannot be made in the faintest degree perceptible.

In addition to the salts of uranic oxide, which fluoresce with a green color, we have the platino-cyanides, which fluoresce with a great variety of tints. Thus the platinocyanides of potassium and strontium give a blue color, that of barrium a brilliant green, and that of magnesium a rich red.

Having thus noticed the nature of the exciting light, and of the bodies capable of being excited to fluorescence by it, we come naturally to a consideration of the nature of the fluorescent light emitted. When a beam of sunlight, reflected from the mirror, A, of a port lumiere placed in the window of a darkened room, is concentrated by a lens, B, and sifted from all but its blue and violet rays by a little tank of ammonio-cupric-sulphate, and is allowed to fall upon a fluorescent body at C, and the light which is emitted by this last examined by a spectroscope, D, we see in the case of some substances, such as solutions of quinine, æsculine, fustic, stramonium and the like, only a continuous spectrum. But in the case of the uranium salts, of thallene and petollucene, either in the solid state or in solution, of bichloranthracene, in solution, etc., we find spectra made up of a series of bright bands, as a rule, very regularly disposed.

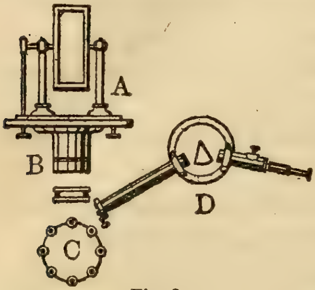


Fig. 2.

In the case of the uranium salts these are very remarkable, both for the regularity and diversity of character which they present.

Plate II shows a number of these, which I have observed and carefully measured.

At the time when these observations were made it had been observed by Stokes and Becquerel that a difference existed between the fluorescent spectra of two or three uranium salts, but these differences had neither been measured nor in any way accurately described. Very recently, Becquerel has published in the Comptes Rendus, vol. 75, p. 296, an extract from some as yet unpublished memoir, in which the subject is much more fully discussed, but yet in a manner far from perfect, since many of the results announced as general are only true with respect to a few examples, and some of the most remarkable characteristics of certain salts are overlooked.

A glance at the plate will show how easy it is by this means to distinguish between most of these salts, and how, as in the case of the mixed acetate and double acetate, it is possible to recognize the mixed character of the body and the factors of which it is composed, and this without so much as opening the bottle in which the substance is contained.

I would draw attention especially to the curious arrangement of bands in the chloride, with the sharp, dark lines running through the centers of the bright bands, and to the narrow bands found in the red portion of the sodio-uranic acetate, and also in many of the other double acetates.

In addition to their fluorescent spectra these salts show, as a rule, very marked absorption bands, which are indicated on plate I, A in the various spectra by the dark lines above 9 of the scale.

Though these are shown on the same drawing with the fluorescent bands, they are, in fact, seen by a different method of observation. In this case (see Fig. 2) the port lumiere A, and lens B, and tank of ammonio-sulphate of copper, C, are arranged as before, but the object, D (a crystal or crystalline film of the salt, or a solution of the same), is placed in such a position that the light which passes through may be examined with the spectroscope, E.

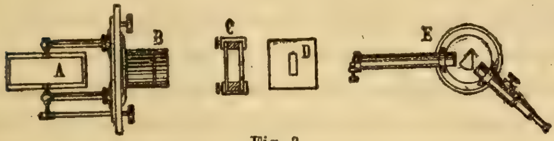


Fig. 3.

Except in their similarity of arrangement, no connection has been found between these bands of absorption and the luminous bands of fluorescence.

Indeed, while solution almost entirely destroys the fluorescence of these salts, I have found no change in the absorption bands of the solution compared with those of the solid, except in the case of the oxalate, where a slight displacement downward in the spectrum occurs, and, perhaps, a still smaller change in a few other salts of uranium.

The platino-cyanides give spectra which are, in a certain degree, monochromatic, that is to say, are confined to a certain tint, and those above and below it for a moderate distance, but do not present a series of bands, as do the uranium salts.

Passing next to the substance which has been so useful to us as a means of investigation, I will ask your attention for a few moments while I point out the relations of its spectra, under different conditions, to each other, and to an allied body, commercial anthracene.

When treated in the manner already described for the observation of fluorescent spectra in the uranium salts (see Fig. 2), the body, which we have already described under the name thallene, shows the spectrum seen as No. 1, of Plate III, the bright bands at 7 and 8.5 of the scale being of light and dark green color, and the broad one, from 4 to 5.5, being orange and yellow.

Commercial anthracene, even when purified with the greatest care, by repeated distillation and recrystallization, shows the spectrum given at No. 2 of the same plate.

It was this resemblance, together with its wonderful power of fluorescence, which first drew my attention to this substance in a specimen of petroleum distillate sent me by Prof. E. H. Horsford, of Cambridge, Mass.; though the material with which I have chiefly worked was obtained through the kindness of my friend Dr. G. F. Barker from Mr. John Truax, of Pittsburg.

On exposure to sunlight in hot solution, anthracene loses this banded spectrum, which is thus proved to belong to a body first observed by Fritzsche, and called by him chrysogen (see Comptes Rendus, tome 54, p. 910), and which is decomposed by exposure to sunlight.

It thus appears that the bright bands observed by Becquerel in a yellow hydrocarbon obtained from Fritzsche (see La Lumiere, by E. Becquerel, vol. 1, p. 382), as well as the bands described by Hagenbach in Paggendorff's Annalen, 1872, vol. 26, p. 286, as belonging to Photen (anthracene), are not due to that substance in a pure state, but are due, probably in both cases, to traces of chrysogen.

When the solution of thallene in boiling benzole is exposed for several hours to the direct rays of the sun, or, better, for ten to fifteen minutes in the focus of a large burning glass some eighteen inches in diameter, it does not lose its fluorescent bands, but has them all moved upward in the spectrum, as is shown in No. 3, of Plate III, and then emits not a green but a blue light by fluorescence.

A similar effect to this, varying in degree, is produced by solution. Thus the solutions in benzole and chloroform, which take up about the same amount of thallene, give an upward displacement of the bands nearly as great as the permanent one effected by sunlight.

Bisulphide of carbon which dissolves much more, shows a less displacement, and ether and turpentine, which dissolve very little, displace the bands most of all.

So far, this relation of solubility to displacement of bands is the only one which I have been able to trace, no relation seeming to exist between the densities or refracting powers of the solvents and this movement of the bands.

In the case of impure anthracene (chrysogen), an exactly similar change in the position of its fluorescent bands, by solution, is to be noticed, varying with a change of solvents in the same way as does thallene, but the exposure to sunlight, in place of elevating the bands as with thallene, removes them altogether, and renders the spectrum of its fluorescent light continuous.

No. 4, Plate III., shows the fluorescent spectrum of chrysogen dissolved in benzole.

Beside, the fluorescent spectra, anthracene, or we should more correctly say chrysogen and thallene, have absorption spectra, but these, unlike the absorption bands of the uranium salts, are in every way intimately connected with the bands of fluorescence.

Thus No. 5, Plate III., shows the absorption spectrum of solid chrysogen, and No. 6 the same as displaced by solution in benzole, and it will be seen that the upward displacement corresponds with that of the fluorescent bands.

So again, in Nos. 7 and 8, which represent the absorption spectra of solid and dissolved thallene, a like connection is to be noticed.

But yet more than this, when a pure spectrum is thrown on a screen of paper painted with these substances, decided maxima of fluorescence are observed, corresponding in position with these absorption bands, and when tanks containing solutions of the same bodies are substituted for these screens, the maxima are again strongly developed and found to be in exact correspondence with the displaced absorption bands of the same solution.

The method by which this observation is made, is exhibited by part of Fig. 3, where A is again the port lumiere, with a narrow slit at B, admitting light to a prism, C, from which it passes to a corrected lens at D, by which a pure spectrum is thrown on the screen E.

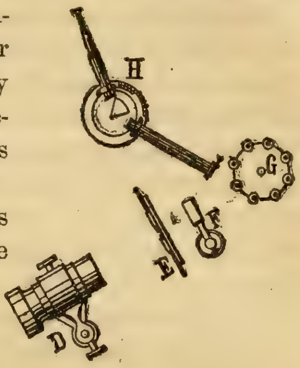


Fig. 3.

The other parts of the figure are for another purpose, and will be alluded to further on.

It would thus appear that the absorption bands correspond, in all respects, with the maxima of excitability; but there is this curious exception, namely, that with thallene solutions a brief exposure, thirty minutes, to strong sunlight removes all the absorption bands, but only destroys the first maximum of fluorescence—that, namely, which is immediately above F, and corresponds to the first band of absorption.

Curiously, also, the solution in turpentine, which seems to give but the faintest trace of a band at this same place, shows also only a very faint maximum at the corresponding point; and yet, if the thallene be recovered from the turpentine and dissolved in benzole, this line of absorption comes out as strongly as ever.

By arranging a slit in the screen, E (see Fig. 3), and placing a lens at F, and the objects to be examined at G, we can, with the spetroscope, H, study their deportment in the various rays of the spectrum.

As a rule, however, the fluorescent light yields the same spectrum with any rays that are capable of exciting it.

While there exists the remarkable similarity between the fluorescent properties of chrysogen and thallene which are evident on inspection of Plate III, yet we must not fail to notice the following: The fluorescent spectrum of thallene wants the lowermost division of what corresponds with the first and second bright bands of chrysogen, this portion being, with it, all one broad band.

On the other hand, there is in the spectrum of thallene a band, very faint, indeed, but yet distinguishable, if a violet glass is added to the copper tank (see Fig. 1). This band, though not shown in No. 1 of Plate III, exists at about ten of the scale, but the corresponding displaced band, is seen much more plainly in the solarized thallene, and is shown in No. 3 of Plate III.

In the next place, in exposure to sunlight, the chrysogen is entirely decomposed, or, at all events, ceases to give any bands of fluorescence, while, as we have seen, the thallene, while losing its yellow color, only has its fluorescent spectrum displaced.

Again, the absorption band, between ten and eleven in thallene, is a decidedly double one, while that which corresponds to it in chrysogen is single.

These, combined with marked differences in their boiling points and solubilities, serve, we think, to establish the individuality of the new body.

April 5, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

The chairman opened the meeting by reading the following paper:

ON THE TRANSMISSION OF HEAT.

By SAMUEL D. TILLMAN, LL.D.

The uses to which heat is applied in the arts are so numerous and important that methods for its more economical generation and transmission are always examined with interest, more especially since science has demonstrated that, with the best contrivances yet employed, but a small portion of the actual heat product of combustion has been converted into available power. Our subject will be best illustrated by treating it under different heads.

Of Boilers.

Heat, as a motor, is unrivaled, because with proper fuel it may be generated at any time and in any place. The two best mediums for its use are the cheapest and most universally distributed, namely, Water and Air. Of the two, water has the greatest specific heat, yet it is by far the most convenient, since just in proportion to the quantity of water evaporated in a closed vessel the pressure of steam will be increased; therefore the boiler has become the most generally used generator and receptacle of force. It consists of two parts having entirely distinct functions, namely, the fire-box or furnace, and the metallic shell containing the water and steam. That portion of the shell, including the tubes connected therewith, which separates the water from the burning fuel, and the gaseous products of combustion, acts at the same time as the sole medium through which the heat is transferred from the fuel to the water.

The application of heat to one side of a metallic plate, and its absorption in sufficient quantity by the water on the other side, result in the generation of steam. The displacement of water from the heating surface in the state of vapor, and its replacement, is the ever-repeated action in the process of boiling. It is apparent that the steam cannot pass away from the heated plate without carrying with it a portion of the water, which should be followed by an equal amount of cooler water, thus forming a current. When this movement does not take place, the whole mass of water is sometimes lifted above the heating surface, and is, doubtless, often the incipient cause of disaster. In vertical tubes, through which the smoke and gases resulting from combustion pass off, the contact of water is impeded by the constantly ascending vapor, and this contest of particles is so great that only the lower portion of each tube is fully effective. To remedy this evil, I propose to fasten on each tube a series of metallic disks or plates, in close proximity to each other, and in an inclined position. When a cast-iron tube is used, these disks are cast on the tube. In a cylindrical boiler, standing on its end, with a fire-box beneath, the vertical tubes, through which the products of combustion escape, are arranged in a circle a few inches from the shell, which, in this case, is not exposed to fire. The disks surrounding the tubes are inclined, so as to be lowest on the side nearest the shell; they project from one to two inches beyond each tube, and the disks of adjoining tubes are in close proximity, or actually united so as to form complete rings, thus the water can only escape by following the direction of the disks, and rising to the inner portion of the boiler. The object of this arrangement of disks is to more rapidly lower the temperature of the tube by quickly transmitting the heat of the tubes into the disks on such tubes, so as to extend it over a much larger area of surface in contact with the water; thus preventing that over-heated condition of the tube which repels water and often throws it into the spheroidal state. Experience proves that a given area of metal at a high given temperature will not produce ebulition as rapidly as double that area having a temperature only half as high, measured from that of the surrounding water.

Another object of still greater moment is effected by means of the disks, namely: Every particle of steam formed between the disks is immediately conveyed away from the tubes and entirely beyond the limits of the disks; to which it cannot return to interfere with the further process of boiling. Both water and steam will be carried inward and upward; the steam will remain in the highest portion of the boiler, while the water at the surface will gradually descend along and near the inner surface of the shell; and, on its passage downward, will supply every disk with the required quantity of water, thus producing constant and complete circulation of water in the lower part of the boiler. As the steam generated between every pair of disks is immediately discharged upward, thus providing room for the incoming water, it is apparent that every portion of each tube, from its bottom to the water line, is rendered effective; and as metal is a vastly better conductor of heat than water, increased facilities are provided for arresting the heat contained in the ascending gaseous products of combustion, and transferring it to the surrounding water; thus less heat will escape up the chimney, unutilized, than in the case where the tubes used have no covering of disks. Arrangements are being made for ascertaining by experiment the exact amount of water evaporated with a given amount of fuel in two boilers of the same size; one containing plain tubes and the other tubes covered with disks, with the intention of laying the result of such comparative test before this Association at a future meeting.

OF STEAM HEATERS.

Tubes or pipes covered with disks, as already described, may be used in heating air, for warming purposes, by means of steam. As the disks or plates are, virtually, a series of strengthening bands, the pipe surrounded by them may be made of very thin metal which will permit the heat to pass more rapidly outward. A very compact and effective apparatus may be constructed by arranging a series of vertical pipes, after they have been covered with thin plates of disks, so as to be connected at each end with a hollow metallic ring. The steam is admitted into the upper hollow ring, and, after passing through each of the vertical pipes simultaneously, is discharged, either as steam or water, through the lower hollow ring into an exit pipe. The thin plates or disks surrounding the vertical pipes are inclined so as to be lowest on the outside of the apparatus. As the air, drawn in on all sides, is heated in its passage between each pair of disks, it moves inward and upward; and after escaping through the upper ring continues to rise until it reaches the ceiling of the room, and, passing along its whole area, displaces the colder air, which sinks, and is soon carried to the heating apparatus, thus insuring, by perfect convection, a uniform temperature. A novel feature in this arrangement is the method of preventing the air, which has passed between the heating disks, from being immediately exposed to other heating surfaces before it escapes from the apparatus. When this steam heater is placed in the basement of a building, the cold air may be admitted through the upper ring, and be discharged outward on all sides, in which case the disks are inclined so as to be lowest on the inside of the pipes.

Of Condensers.

Air being about 815 times lighter than water, at the mean temperature of the atmosphere, and having much less specific heat, it is evident that it cannot be substituted for the condensing water used in ordinary low-pressure engines of large size on account of the great number of tubes which must be exposed to cold air; but in engines of very small size, varying from one man to one horse-power, it is feasible to add a series of apparatus, similar to that described for heating by steam, in which the quantity of inflowing cool air will be sufficient to condense the exhaust steam from such an engine. The air which thus absorbs the heat of the steam would be conducted into a chimney, the draft of which would be sufficient to provide a full supply of cold air. It is evident that in winter the air, thus heated, could be utilized with such an apparatus, and the water thus condensed, could be pumped directly into the boiler.

Of Stoves.

The steam-heating apparatus described may be modified so as to be applicable to stoves; all that would be required is the substitution of the upper plate of the fire-box for the lower hollow ring. The heat generated, and contained in the products of combustion, would pass through a series of pipes inclosed with disks, and such gaseous products, after losing most of their heat, be discharged within the circle of the hollow ring, upward. In this case the whole apparatus could be constructed of cast iron.

In the several structures described, the same general features are found, the novelty of which consists in furnishing very great area of heating surface, at the same time securing to the fluid to be heated a rapid ingress and egress.

The Chairman invited the closest criticism of the paper just read, for he was as anxious as any present to detect a fallacy in his reasoning.

Prof. P. H. Van der Weyde—I see one advantage in the proposed plan which has not been mentioned. Those who have experimented with the boiling of fluids, know that there is sometimes an explosive boiling. It generally occurs when the vessel in which the liquid is boiled is very smooth. Sometimes sand is put in to prevent this. A steam-boiler which is smooth inside, or the tubes of which are smooth, is more in danger of explosive boiling than it would be if it were rough or had many projecting points. It is much better to have steam developed in small bubbles than in large bubbles. I think that this plan will tend to prevent explosive boiling and priming in steam-boilers.

Mr. J. K. Fisher—As you have invited criticism, I will freely suggest the doubts that arise in my mind as to the advantages of the proposed plan. In the illustrated catalogue of Morris, Tasker & Co., of their tubes, instructions are given, if the water is to be outside of the tubes, to reckon the outside surface of the tubes, and if the water is to be on the inside, to reckon on the inside surface. That indicates their opinion that the surface exposed to the water parts with its heat more readily. When the tube is to be used in a heater, with steam on one side and gas on the other, they act direct, taking the mean of the two surfaces. That seems to me to conflict with your view, that it is necessary to extend the surface exposed to water. In the case of the Perkins steam-boiler, made in London, twenty-five or thirty years ago, which consisted of a series of tubes, with water circulating through them, and passing under the fire, Perkins allowed 2.6 feet of heating surface in the fire, to 1.6 in the water. His experiments led him to adopt that as the best proportion. That also indicated that it requires less surface in the water than in the fire of gases. I should not regard these projections, then, as heating surface. According to these authorities, the surface exposed to the water is already superabundant. They had formerly in London a form of pipe in which there were pins sticking into the smoke, to take up the heat. That was abandoned; partly from cost, and partly from the difficulty of cleaning. Any addition to the surface costs something; and the question is whether this is the most economical mode. It seems to me likely that the same amount of additional surface, put in the form of a greater number of tubes, would answer as well.

Prof. Van der Weyde—I should not consider the difference between measuring on the inside or outside of a pipe as amounting to much on a question of this kind; even when the tubes are small and the thickness considerable. The question is whether the tubes ever get too hot. If they do they take up heat faster than they can radiate it. I say that as a matter of fact they do get too hot. Then this prevents it. You cannot get one of these tubes red hot, while it is surrounded with water. And you cannot prevent the tubes from getting too hot, in this mode, without putting the heat exactly where it is wanted—in the water.

The President—Suppose the temperature of the fire to be 1,000°. The amount of heat the pipe will take up is in proportion to the difference of temperature between the pipe and the gases of the fire. If the pipe is heated up to 500°, it will take from the fire far less heat than if it is kept nearly as cool as the water. We must remember that water is a bad conductor of heat; that we heat it by convection. Iron is a very much better conductor of heat than water. These projections or disks come in contact with the largest possible amount of water, and in a manner to secure the most rapid convection of the heat. The pipe is thus kept at the lowest possible temperature, and in a condition to take up the largest possible amount of heat from the gases.

Mr. J. K. Fisher—Your reasoning is very good, from the premises; but I consider the premises unduly assumed. You assume that the pipe gets hot. I know that when pipes get foul, from incrustations, for instance, they frequently do get hot. Sometimes they get too hot because the water has not free access to them. In the case of a locomotive boiler that burst at Providence, the tubes had originally been three-eighths of an inch apart. In rebuilding it, they left out some of the tubes, and put the rest three-fourths of an inch apart. The result was that it made steam as well as it did before. I have never found evidence that in a well-proportioned and clean boiler, where the water had free access to the tubes, the tubes got sensibly hotter than the water. This is a question which can easily be settled by experiment; by putting on rings of metal of different degrees of fusibility, ascertained beforehand by testing the same metal.

The President—The new method will be tested thoroughly.

Mr. W. E. Partridge—How will the tubes be kept from incrustation, or how would they be cleaned?

The President—There would be no incrustation, because the water would always pass very rapidly through these spaces.

Mr. W. E. Partridge—There is a very successful heater, upon this principle—that is, having a series of cast-iron disks upon the tube; but they are at right angles with it.

The President—That is simply for increasing the amount of radiating surface, which is but a small part of the benefit claimed for the new plan.

Dr. J. W. Richards—The stove of Dr. Nott was upon the same principle. He taught his classes that the rougher the stoves, the more heat they gave; and this radiation of the heat in the water is upon the same principle. Points of metal running into these pipes would increase the effect; but it would be difficult to clean them.

The President—Mr. Fisher has referred to the fact that where there are too many vertical tubes, the central tubes may be overheated because the water cannot get to them. It is evident that no such result can occur upon the plan that I propose. Dr. Nott's stove has been referred to. He was the first man who burned hard coal in close stoves with success, and his idea was this: to have a generator of heat in one place, and a radiator of heat in another. He had a generator lined with fire-brick, in which the coal was burned; and above that was a sheet-iron or cast-iron radiator. But his greatest invention was in passing the draft across the bottom of the fire; this is the principle of all the modern "base-burning" stoves, and is, doubtless, the most economical way to burn anthracite coal continuously.

Mr. J. K. Fisher—If you were to hang a plate inside of the pipe, it would absorb heat from the smoke and radiate it against the tubes, and thus increase the effect. Or if you were to make it a partition, it would be still better. I believe that increasing the receiving surface will have more effect than increasing the surface exposed to the water.

Mr. Osborne—I think that in the distillation of petroleum we have an indication that the pipes do get too hot. If we take kerosene, volatilizing at from 110° to 150°, and distill it in the ordinary way, we get coke; and that coke must come from destructive distillation, which cannot take place below 600°.

With regard to the remark of the President, that the heat taken up by a pipe will be in proportion to the difference of temperature, I think it is in a geometrical ratio and not a mere proportion, so that I think there will be a greater difference in favor of the extended surface than he calculated.

With regard to the deposit and incrustation, I believe that always occurs where there is an eddy formed, or where there is a sudden access of heat; so that the deposit would be at the bottom of the boiler, and these spaces would be kept clear.

Prof. P. H. Van der Weyde—When the projections are on the inside of the pipe they take up heat from the smoke, and the pipe is hotter than it would be without them, but it cannot give the heat readily to the water. One-quarter of an inch of water will totally obstruct the radiation of heat. The plates projecting into the water, on the other hand, enable the water to take up the heat from the pipe. In illustration of the impossibility of radiating heat through water, we may take a differential thermometer so sensitive as to be moved by the approach of the hand, and cover the bulb with a thin layer of water, then pour on ether and set it on fire, and the thermometer will not start by a hair's breadth. Or we may freeze water in the lower part of a tube, and, holding it obliquely over a flame, boil water in the upper part of the tube for a quarter of an hour without melting the ice.

Mr. Slangsby—I think there can be no doubt that more heat will be taken from the fire by this means than with a tube in an ordinary form. The only difficulty I see is in the construction of the boiler. I do not see how the tubes can be removed.

The President—That is a difficulty, but it has been overcome. They are screwed on at one end and the other is put on with a thimble.

Dr. L. Bradley—I always, when I can, act as mediator between contending parties. I propose to bring these two theories together, and to take the heat from the fire by projections within the smoke-tubes, and to impart it to the water by projections on the outside of the tubes. I think that would be better than either alone; but I apprehend there would be difficulty in casting the pipes.

The President—That plan had also been thought of by myself, and Dr. Bradley has stated the real objection to it.

Manna.

Dr. J. V. C. Smith read a paper on the manna described as gathered by the Israelites in the wilderness, maintaining that it was entirely different from any known substance, and was miraculously furnished to them.

Dr. J. W. Richards said that the Jewish manna seemed to have been an animal product, resembling what is called honey-dew, the exuviæ of small animals found under certain trees, mostly beech trees, at certain seasons; but that there is now nothing known anywhere corresponding to the description of manna.

Dr. J. V. C. Smith expressed the belief that the very pot of manna put up to be kept for generations, would yet be discovered.

SUSPENDED RAILWAY.

A model of a street railway, suspended from the houses, and not interfering with the street below, and especially adapted to narrow streets closely built up with brick buildings, was exhibited by Julius H. Striedinger.

ON THE DETERMINATION OF THE INVISIBLE AQUEOUS VAPOR IN THE INACCESSIBLE UPPER STRATA OF THE ATMOSPHERE.

Prof. Van der Weyde—Early in this century Leslie measured the clearness of the sky by the radiation from the bulb of a differential thermometer placed in the focus of a horizontal parabolic reflector. The mirror being a polished surface radiated no heat, but merely reflected that radiated by the bulb. If the sky was clear, the heat would be radiated, and there would be no return, and the thermometer would fall; but if there were clouds, the thermometer would remain stationary. Leslie states that sometimes when the sky is clear, the thermometer will fall fifty degrees; and at other times, when it is apparently just as clear, it would not fall at all; and at that time this anomaly was unexplained. Experiments have recently been made by Tyndall on the radiation of heat through different vapors. All gases and vapors absorb heat; but common air, nitrogen, hydrogen and oxygen, absorb the least. He found, for instance, that the vapor of patchouli absorbs fifty times as much heat as common air; and that other vapors absorb still more. And he found that the vapor of water is the great cause of absorption of heat by the air. A moist atmosphere acts like a valve, admitting to the earth the intense solar rays of heat, and preventing their radiation. It is found, therefore, that the amount of cooling of the differential thermometer indicates the amount of invisible moisture in the atmosphere. When clouds are formed, radiation is entirely stopped.

Dr. Bradley—It may be added that the moist atmosphere not only absorbs the heat that is radiated, but radiates it back again to the earth.

Adjourned.

April 12, 1872

Prof. S. D. Tillman, in the Chair; Robert Weir, Esq., Secretary.

Balance Elevator.

Mr. Charles B. Sawyer, of Fitchburg, Mass., exhibited and explained a model of his balance elevator. He claimed it to be a balancer of speed, and that by its use the velocity of elevation could be readily doubled. After some discussion on its merits, the Chairman introduced the newly elected president of the Institute, Dr. F. A. P. Barnard, who spoke substantially as follows, on the subject of

Metrological Reform.

I have been requested to address you this evening upon the present state of the question of metrological reform. When we speak of the present state of anything, we imply that there is something in the existing condition of the matter spoken of, which makes it differ from the past. In order to understand the present state of this question of metrological reform, it will be necessary to look back to, and compare it with, the characteristics of its past state. We will therefore go back one century, to the year 1772, and see what progress has been made, since that time, in regard to systems of weight and measure.

The characteristics of that age were these two:

1. A wide diversity of systems, different countries, provinces, districts, and even towns, having been in this respect independent of all the rest.

2. Confusion in the systems themselves, not only in regard to the manner in which the different weights and measures were derived from their unit bases, but also in the fact that there existed a great many different systems of weights and measures in the same country, the same province, the same district, and even in the same town.

But notwithstanding this wide diversity, it is nevertheless true that the names of the weights and measures throughout all Europe, throughout all Christian nations, were the same; not that they were the same words, but that the names in different languages had the same significance. All the people in Europe had an ell, they all had a foot, they all had a pound, etc. At first sight it would seem very remarkable that when everybody had the same names for these standards, nevertheless not even in towns thirty miles apart on the continent of Europe did those names mean the same thing.

How did it happen that measures grew up all so different and yet all called by the same name? The reason appears plainly when we consider the early history of the derivation of measures. To begin with measures of length, most of these were derived from some part of the person of man; for instance, the extent of the arms was a fathom; the yard measure was the girth of man, the circumference of his body; the foot measure came from the human foot; the ell was the distance from the elbow to the end of the finger; the cubit used by Noah in building the ark was the same.

These measures originated without forethought or method. Each man made his own measures. When societies began to find different measures in the same neighborhood, they were adjusted by the measures of some distinguished man, a chief or king. The foot made its first appearance in Greece, and was first derived from Hercules; if you go back to the time of the Israelites in Palestine, every city was the head-quarters of a kingdom; and so it was in Italy soon after the founding of Rome. All the early Roman wars were with powers scarcely a day's march from the city. Down to the middle ages the whole of Europe was divided up into little principalities, and each had its own separate system of weights and measures.

In regard to measures of capacity, although they were not derived from the human person they were got up with as little forethought or method. Some convenient natural vessel was chosen, such as a cocoanut-shell or an egg-shell, or the shell of a gourd; and each community had its own measures.

Measures of weight are not adapted to every primitive society; but measures of length are necessary even in barbarous society, and therefore originated at a time when people did not think at all about science or methods. The weights were made to correspond with some convenient measure of capacity. The Saxon weights were actually derived from the weight of a fluid or grain in a measure of capacity. But people soon found that when they weighed a given measure full of wine, and the same measure full of grain, the grain was the lightest. Accordingly, there were two kinds of weights.

The measure of grain gave Troy weight, and the measure of wine gave avoirdupois weight. If you took equal weights, the measure of corn would be larger than the measure of wine. Hence, there arose two different systems of measures—dry measure and liquid measure. John Quincy Adams, many years ago, very highly commended our present system, because it had two different measures proportionate to the specific gravity of wine and wheat, and two weights proportioned in like manner. But it so happened, at that very time, the British Parliament came to the conclusion that they would establish uniform measures of capacity, and they adopted the imperial measures which differed both from the old wine and the old grain measures, and which made no distinction between wine and grain, the imperial bushel being a multiple of the imperial gallon.

There is also a great confusion in the manner of the derivation from the unit base, of the higher and lower denominations. In our lineal measures there are five or six different ratios. There are twelve inches in a foot, three feet in a yard, five and a half yards in a rod, forty rods in a furlong, eight furlongs in a mile. In our surface measures the relations are even more cumbrous. There are 144 square inches to the foot, nine square feet to the yard, thirty and a quarter square yards to the rod, etc. The measures of solidity are still more irregular. There are 1,728 cubic inches to the foot; there are twenty-seven cubic feet to the yard, and there are 166⅜ cubic yards to the cubic perch. This makes the labor of the computer immense. It is so burdensome that a great many of our artisans have, for their own purposes, abolished these inconvenient ratios. They use inches not divided into eighths nor into twelfths, but into tenths. The civil engineer uses the foot as his unit, and divides that decimally. The land surveyor rejects both the inch and the foot, and makes the chain his unit, and divides that decimally into 100 links, each of which is 7.92 inches. At the United States mint, although in determining the weight of single coins it is necessary to use the grain, because the law provides for their weight in grains; yet, in weighing bullion, they use only the ounce and decimals of the ounce.

The diversity of ratios is not confined to measures of length and capacity, but extends also to weights, as seen in the last example. The Troy pound is divided into twelve ounces, of twenty pennyweights each; and these are subdivided into grains. But the apothecaries' pound is divided into twelve ounces of eight drams each, and each dram is subdivided into three scruples, each containing twenty grains.

Comparing our condition to-day with that of a century ago, this difference is manifest, viz., that we are now all earnestly endeavoring to find some way to get out of the confusion. On the continent of Europe, many nations have already succeeded in this struggle. We have so large and so homogeneous a country that we have not felt the necessity to be so urgent, and we are behind them; but the modern increased facilities for traveling and intercommunication between nations are bringing us up to the desire for a common system. A century ago, however, the spirit of reform did not exist in the slightest degree. The people had not thought of such a thing as changing their weights and measures. They looked on the existing system as they would on dispensations of Providence, and they would as soon have thought of changing the weather or the climate.

When the idea of change first originated, one would suppose that it would have come from men who had to deal with weights and measures every day. But the familiarity of such persons with these things made them insensible of the possibility of getting rid of the confusion; and the idea that there might be a reform sprang up first with an individual of a class having of all men the least to do with weights and measures, an ecclesiastic; who in his closet thought out the remedy, and whose plan was laid before the French Assembly a short time before the French revolution. Had it not been for the extreme violence of the course pursued by the radicals, in overthrowing their monarchy and setting up a republic in which nobody was permitted to be free, I suppose the nations of Europe would have agreed to the proposition, and a convention would have been called which would have soon settled upon a common basis.

In order to determine accurately the fundamental measure of the new system proposed in France, since called the metric system, it was necessary that there should be an elaborate measurement made of a great arc of the meridian, the ten-millionth part of a meridional quadrant having been adopted as the meter. This measurement took seven years. After this measurement had been made, France again invited the nations to convene, by their representatives, to verify the determination. The representatives of Holland, Denmark, Switzerland, Italy, Spain, and some of the governments of Germany, came together and established definitively the value of the meter-base. This value was officially adopted in 1799 by France, where the metric system had already been legalized; and since that time, in Russia, Austria, Sweden and Denmark (which have never yet adopted the system) all the scientific journals have used that system.

No system can be so useful as a decimal system. Our federal currency illustrates that. Every child can perform operations in the decimal currency without difficulty. We need not throw aside the convenient divisions by two. We have not thrown them aside in our federal currency. We have the half dollar, the quarter of a dollar, and we used to have the eight and the sixteenth. We did not find those smaller divisions necessary, and have now abandoned them. We might reduce our system to a much greater degree of convenience, without adopting the meter, if we would decimalize our foot, and make the higher denominations multiples of the foot. If we want to know the number of feet in a given number of miles, there are two ways to perform the operation. We may multiply by 5,280, the number of feet in a mile, or we may multiply by eight, the number of furlongs; then reduce the furlongs to rods, and reduce the rods to feet; either of these is very troublesome. But suppose we had 1,000 feet to the mile, as the French have 1,000 meters for their mile, we should then know the number of feet instantly. Why should we not decimalize our own system as the Danes, the Swedes, and the Norwegians have done? But if we adopt the meter, we shall put ourselves in harmony with all the world.

When we talk about the advantages of a new system of weights and measures, people are very apt to say that they cannot change, and that we cannot make them change. We do not intend to make them change; we wish them to change voluntarily. But if you will look at the history of the world, you will find that there have already been changes which have involved equal difficulties.

For instance, for a thousand years half of Europe had one system of numeration and the other half had another system. One was the Greek and the other was the Roman system. We have rejected the Greek for all uses now, because the Greek alphabet is not in our printing offices; but we still retain the Roman system upon our clocks, for paging in parts of books, for headings of chapters, etc. We do not use it for arithmetical operations. We do not extract the square root by means of the Roman numerals. The Roman had to learn the Greek notation if he went to Athens; and the Athenian had to learn the Roman notation if he went to Italy.

In the tenth century there arose a remarkable man by the name of Gerbert, a peasant, who worked upon clocks, and who manifested great ingenuity. That was in the middle of the dark ages, when the little light that there was in Europe was not in the possession of the Christian nations. There were a few philosophers, but their labors brought upon them persecution, because they were believed to be dealing with evil spirits; and there were a few monks by whom learning was kept alive. But the most enlightened people were the Moors, in Spain. Gerbert had very little opportunity for education;

and as the Moors did not allow Christians to go to their universities, he put on a turban and went to their famous universities at Cordova and Seville as a Mahometan. When he went back to France he carried with him the Arabic numerals; and that was their first introduction among the Christian nations of Europe. They were gradually introduced, and without any special legislation they supplanted all the systems of numeration which had been in use for a thousand years. Gerbert may have been censurable for going there as he did; but it is to be presumed that he repented, for he became archbishop of Rheims, chancellor of France, and finally pope, under the name of Sylvester II. To him we owe not only the Arabic notation, but a demonstration of the fact that we can root out any usage, however deeply entwined with the associations and habits of the people.

But we have examples in our own time. When the British government abolished their system of measures of capacity, there was no difficulty about it; and now even we Americans are occasionally adopting the imperial gallon, although we have two gallons of our own. Every year some of our countrymen go to Paris. It takes them about ten days to learn the metric system of weights and measures, and then they have no further trouble. We have a much more difficult system to learn, and yet men come to the United States by thousands every year, and they change their habits without any complaint, and soon talk about pounds and ounces as well as we do. What we need is to familiarize the minds of the people with the necessity for a change.

The meter is founded upon a natural dimension, and therefore, if by any accident the base should be lost, it would only be necessary to measure an arc of the meridian again in order to restore it. It is true it is asserted, as the result of modern English investigations, that the meter is in error; but how much do you think the error is? It is 1-170th of an inch, a quantity so small that I doubt if there is a person in this room who has a hair upon his head fine enough to indicate that error. Let me tell you what I myself saw in 1867. The arc of the meridian was measured in toises, and when the length of the meter was ascertained, there were twelve standard meter bars made of iron, and two of platinum, and four bars made equal to the standard toise in length. These bars were verified, and the iron bars sent to different countries as standards. One of them was brought to this country by Mr. Hassler (afterward of the coast survey), in 1800. Subsequently the French government sent over several other bars, and upon a comparison of them there seemed to be a slight discrepancy.

When I was in Paris, in 1867, this iron meter bar was sent over to me to be compared with the standard there (which is only used once in ten years to verify the other standards, lest the comparison should injure the ends), and the difference actually observed, with the delicate instruments used in the comparison, was only .00017 millimeter, or 1-160,000th of an inch, a difference that could not be determined at all except by these marvelous mechanical and optical means.

But even were the standard meter 1-200th of an inch in error; what difference does it make? If you know how much more or less it is than 1-10,000,000th of a quadrant, it can be re-established with as much certainty as if it were that exact quantity. By the law of England the length of the yard was established by comparison with the length of the pendulum; and hence it could be restored, although it was shorter than the pendulum.

There are but few natural dimensions which are invariable; but there are several which have been proposed as standards of measurement.

One of these is derived from the velocity of light. How are we to determine it? One method is by comparison of the observed times of the eclipses of Jupiter's satellites with the times given by calculation. It is found that these appear to occur earlier when the earth is nearest to the planet; and that the difference arising from the motion of the earth is about eight and one-fourth minutes for a progress through a space equal to the distance of the sun from the earth. But how are we to know how far off the sun is? Our only means is by comparison of its distance with the diameter of the earth; and thus the magnitude of the earth becomes, after all, the real standard.

Another method of determining the velocity of light was contrived by Foucault, which was certainly very ingenious. It consisted of a measurement by a filar micrometer of the deviation of a ray of light passing over a given space, and reflected by a rapidly revolving mirror Hence, in order to obtain the result, it was necessary to determine with very great accuracy, three things; the distance traversed by the light, the velocity of the rotation, and the amount of deflection; a process requiring so many delicate adjustments as to be obviously unfit to be relied upon to furnish a standard of measurement.

The length of the pendulum has been proposed as a natural standard. But what is the length of a pendulum? A pendulum, in theory, is a point having weight, suspended by a line which has no weight. But a pendulum in practice is a heavy body suspended by a rod; and the length of the practical pendulum is the distance between the point of suspension and a point below the center of gravity, the center of oscillation. You must find this center of oscillation, which requires an exact knowledge of the precise form of the whole structure of the pendulum, and of the density of every part. Then it must be a seconds pendulum, vibrating in a vacuum, at a certain determinate level or the result must be reduced to correspond with these conditions. Kater's pendulum has the remarkable property of the exchangeability of its point of suspension and center of oscillation; and when it is so adjusted that, upon being suspended from either end, the rate of oscillation is precisely the same, the distance of these two points is the exact length of the pendulum. That is certainly very ingenious; but the practical difficulty is, that we must have a seconds pendulum, or a pendulum of an exactly known rate. We cannot determine the rate of its oscillation with sufficient accuracy, unless we can attach it to a clock, and allow it to run a long time. Now, we cannot adjust Kater's pendulum in this way; and if we could, it offers so much resistance to the air, that practically it will not aid us in furnishing a standard for measurement.

Another proposition is to take for the standard the length of an undulation of light. These undulations are very short, but they are very constant; and if we could ascertain the exact length it would answer the purpose. But the difficulties of measuring these undulations are very great. Their mean length is about 1-50,000 of an inch. The method adopted by Newton for measuring them was exceedingly ingenious. Placing a convex lens on plane glass, colored rings are formed, which are called Newton's rings. He discovered that they are connected with the distances between the surfaces, and follow a regular law. At the first bright ring the distance is one-fourth of an undulation, or 1-200,000 of an inch. If, then, we know the convexity of the lens and the diameter of the ring, we can calculate the distances of the surfaces. Newton measured the diameter of the ring with dividers, a very clumsy mode, but obtained an extraordinarily close determination of the length of the undulations, agreeing nearly with modern determinations by a more certain method. The measurement is now made by means of *gitters,* consisting of equi-distant lines ruled upon glass; the length of the undulation being determined by the angle at which the colors are shown, with a certain distance of the lines. But it is necessary that the lines should be exactly equidistant, and Mr. Rutherford states that it is almost impossible to make a perfect gitter. If there is any error of distance, the error will become serious when multiplied several million times to make the standard.

There seems, then, to be no other natural standard suitable, except the earth's dimensions. The length of the earth's axis might be better than the meridional quadrant, if we were now free to choose; but the choice has been made for us, and there is no sufficient reason for making any change.

We may make, if we please, an approach to the metric system without any great change in our measures of length. We may adopt, for instance, a metric foot, equal to three decimeters, and less than two-tenths of an inch shorter than an English foot.

[The speaker, in conclusion, proceeded to state, in some detail, the progress which has already been made toward the adoption of the metric system, of which the results may be summarily presented in the following tabular view.]

I.—*Peoples adopting the Metric System in full.*

STATE.	Year.	Population.
France	1866	38, 067, 064
French colonies	1866	2, 921, 000
Holland	1868	3, 638, 467
Dutch colonies	1868	22, 453, 000
Belgium	1866	4, 839, 094
Spain	1868	16, 642, 000
Spanish colonies	1868	2, 030, 000
Portugal	1863	4, 349, 000
Italy	1868	25, 527, 000
North German Confederation	1867	29, 910, 517
Greece	1864	1, 348, 522
Roumania	1867	4, 605, 000
British India	1866	150, 767, 851
Mexico	1865	8, 218, 080
New Granada	....	2, 800, 000
Ecuador	1858	1, 040, 000
Peru	....	3, 374, 000
Brazil	1867	9, 858, 000
Uruguay	....	387, 000
Argentine Confederation	1869	1, 736, 000
Chili	1868	1, 908, 000
Total	....	336, 419, 595

II.—*Peoples adopting Metric Values.*

STATE.	Year.	Population.
Wurtemberg	1867	1, 778, 396
Bavaria	1867	4, 824, 000
Baden	1867	1, 438, 000
Hesse	1852	854, 319
Switzerland	1860	2, 510, 494
Denmark	1850	2, 413, 000
Austria	1867	34, 861, 000
Turkey	....	35, 360, 000
Total	....	84, 039, 209

III.—*Countries in which the Metric System is permissive.*

STATE.	Year.	Population.
Great Britain	1871	31,817,108
United States	1870	38,555,983
Total	....	70,373,091

IV.—In Sweden (population, 1867, 4,195,681) and Norway (1867, 1,701,478, total, 5,897,159) the decimal division has been, adopted, without as yet the metric values.

As the peoples in the second class above may be regarded as committed to the ultimate adoption of the metric system in full, we may count, as already enlisted on this side of the question, a total of about 420,000,000. [The speaker continued.]

I do not ask that any change shall be made without ample preparation. We want first that the system shall be thoroughly taught to the rising generation in the schools. Then let the government introduce it in the post-office. It was made optional with the postmasters, and they did not introduce it. And then let us introduce it in the custom-houses, where it will be a great blessing to the importer; for a large part of the merchandise that is imported is invoiced upon the metrical basis, and must be transformed into our denominations, pounds or yards, in order to pass through the custom-house. Let the government do this, and the intercommunication of the people with each other and with European countries will make the adoption of the system certain.

Mr. J. K. Fisher—I see by the last Engineer that Austria has adopted the metric system, optional from the 1st of January, 1873, and compulsory from the 1st of January, 1876.

The thanks of the Association were tendered to Dr. Barnard for his lecture on the metric system.

Adjourned.

April 19, 1872.

Prof. S. D. TILLMAN in the chair; ROBERT WEIR, Esq., Secretary.

The President read the following paper:

NEW RECORDING INSTRUMENT FOR SUBMARINE TELEGRAPHS.

Until quite recently, the only telegraphic instrument which could be used in connection with the very feeble electric force manifested through long submarine cables, is that known as the mirror-galvanometer, by which a spot of light is made to follow, in its movements, every variation in that force; and these varying strengths being followed by the eye, are thus interpreted under circumstances in which ordinary telegraphic instruments indicating the mere presence or absence of a given current would be useless. The author of this mirror-galvanometer, Sir William Thompson, has invented another instrument that records the transmitted message. It is now in practical operation at the terminus of the French cable at Duxbury, Mass. His instrument draws or marks on a strip of paper a curved or broken line, giving graphic representation of the varying strength of the current; or, if required, of electric potential at the receiving end of the cable, and gives a permanent record of every feature of the effect due to the sender's action. The instrument is available for the system of varying strength, including, of course, the simplest system, viz.: of two strengths called positive and negative, or for the system of long and short signals, of which the Morse alphabet is the simplest type.

The difficulty in producing such a recorder as this has been due to the difficulty of obtaining marks from a very light body in rapid motion without impeding that motion. To effect this, the inventor connects (either by direct attachment, or by stretched thread or fiber) to the body moved by the received current, a light marking-needle or tube, from the end of which ink or other fluid is spurted upon paper. The signals which are to be recorded give rise to motions of the marking end, which are parallel to the plane of the paper, while the paper is drawn along its own plane, and in a direction perpendicular to the line of the motions caused by signals. He employs for the marking-needle, by preference, a capillary tube, or a bristle, dipping at one end into a stationary reservoir of ink or other fluid, and he causes such fluid to be spurted from, or drawn from, the opposite end, by means of an electric force, or by means of rapid vibrations maintained in the needle or in the paper, in a direction perpendicular to the plane of the paper. These vibrations may be maintained mechanically or pneumatically, as by the agency of sound, so that the paper receives ink by a succession of fine contacts, between each of which the tube or bristle is quite free to move. When the electric method is used the paper is drawn over a metal plate, electrified, say, positively, and the capillary tube negatively, and a powerful difference of potential is maintained between the tube and the metal plate, such as would tend to cause a succession of sparks to pass between them, and which, in the circumstances, produce a fine stream of ink, or a succession of fine dots spurted from the tube on to the paper, leaving a record of the position of the tube at each instant, and drawing a sensibly continuous line on the paper without impeding by friction the motion of the tube, as directed by the receiving instrument. It has been found most convenient to let the paper move in a vertical plane, and to use a small glass siphon, with its short leg dipping in the ink reservoir, and its long leg pointing obliquely downward at the paper, and close to it. The receiving instrument used in connection with this marking apparatus is a peculiar arrangement, in which the received current passes through a very light coil of a small number of turns of fine wire.

Part of this coil is placed in a very powerful magnetic field, produced by permanent magnets, or by electro-magnets, which act with great force on the coil when the current passes through it. The coil is kept stiff, without any complete frame-work or bobbin, by the use of stiff pieces, or booms, drawn asunder by threads or strong fibers stretched to fixed points, and serving to support the coil while giving it the requisite freedom to move and the needful stability. The message recorded by this ingenious apparatus appears like a continuous line, but when examined closely it is found to be made up of a series of ink dots. The line made in a longitudinal direction, corresponds to spaces in the Morse alphabet made by breaking the current, and the to and fro transverse lines, which may be long or short, as the cable current varies in strength, accomplish the same purpose as the dot and line made by the Morse pen. Thus the swinging motion of a delicate coil is perfectly recorded with a minimum expenditure of force. The inventor has accomplished what was deemed an impossibility by most electricians, and brought out an instrument which is not only theoretically correct in its construction, but which has been found to work well in actual practice.

Dr. L. Bradley spoke of the progress made in telegraphing in the United States; lines now being worked by the fluctuation of the tension of the electricity, no current going through the line.

Lignites of the Far West.

By Professor J. S. Newberry.

Coal constitutes the main spring of civilization, and over the western half of our continent, our population will be dependent for their fuel mainly upon the beds of lignites of the far west, so that the subject upon which I have consented to say a few words this evening is one of great practical importance, as well as of scientific interest. Attention has long been called to the existence of these lignites, but very little has been said in regard to any accurate estimate of their value as fuel. A large proportion of the territory where they are found is destitute, to a large degree, of wood. There is much less forest there than in most other parts of the United States. The question, what they shall use there for fuel, is one of special importance. They require fuel, not only for ordinary uses, but for metallurgical purposes.

Our country, as a whole, is better supplied with mineral fuel than any other in the world. We have in the Mississippi Valley several great coal basins, comprising an aggregate area of 150,000 square miles. Great Britain is better supplied with coal than any other country in Europe; and it owes its great wealth and power mainly to its store of fossil fuel. But it is calculated that within 300 years, in all probability, its store of coal will be entirely exhausted; and then Great Britain must lose the position she occupies and sink to the position of a second, a third, or even a fourth rate power.

The great coal basins of our own country, which belong to the carboniferous age, are altogether found in the Mississippi valley and on the Atlantic coast. Here you will see upon the map the Allegany coal field, which reaches 750 miles, from the southern boundary of the State of New York to Alabama, comprising an area of 60,000 square miles. The out-liers of this coal field, separated from it by natural convulsions, are a line of detached basins, containing, in many cases, a semi-bituminous coal. In Rhode Island, and partly in Massachusetts, there is a small coal basin where the anthracite has been partially converted into the condition of graphite. There are coal basins still further north, beyond our limits, in Nova Scotia. There is a small coal basin in Michigan, and there is a coal field in Illinois, and another on the west of the Mississippi, reaching, with irregular outline, from Iowa into Texas, the western border of which is concealed by the overlying rocks.

West of this we have no more carboniferous coal. All the area west of Omaha is without carboniferous coal, and yet there are deposits there of a carbonaceous material that rivals in thickness any of the coal beds. They are all much more modern, being either cretacious or tertiary, within our lines; while south of our lines there are some which are triassic. These are the beds of lignites, or imperfectly formed coal.

I have here a table and specimens of the various kinds, showing the progress of the transformation of wood into coal. The first change is its transformation into lignite, which is another name for fossil wood. Where the wood is covered by something which excludes the oxygen, the loss of material goes on slowly, and the constituents react upon each other, and after a time the wood changes its physical character, although it may perfectly retain its original form. In lignite there has been a loss of some of the constituents of the wood, and they have combined in a new form, making a decided approach toward the condition of coal. Lignites exhibit all the different varieties that we find in coal. In some places the transformation has been more, and in others less complete. This specimen from Alaska, where the conversion into coal has progressed rapidly, has an appearance very much like our carboniferous coal, although it is a modern formation.

Cannel coals differ from other coals simply because the circumstances of their formation have been different. Whatever remains you find in cannel coal are typical of aqueous deposition. You will find evidence, wherever the cannel coal is found, that there was formerly an open lagoon, into which there was a leaching of the vegetable tissue which sank to the bottom of the water, forming a carbonaceous mud, which, during the formation of the coal, was constantly saturated with water. The cannel coals are rich in gas, which has a higher illuminating power than that derived from other coal.

The coals that can be burned in the open grate have lost a portion of their volatile matter, but they contain the bitumen, and these are the furnace coals so extensively used in the west.

The next step is anthracite. When the material has been exposed to heat, the volatile matter has been more or less completely driven off, and the residuum is a hard, flinty mass, which has been cemented together by the action of the heat. Coke is the same, excepting that it has not been subjected to pressure, and the gases have expanded it until it has become a cellular mass.

Sometimes not only is the volatile matter all driven off, but the carbon itself is removed, and there remains a larger per centage of earthy matter than in coal; and here we have a graphite tendency, like this specimen, which is from Rhode Island, in which the coal is so nearly converted into graphite that it is almost incombustible. When the process is carried still further, the result is graphite, in which all the bituminous matter and the greater part of the carbon has been driven away, and the substance assumes a peculiarly brilliant condition, with no oxygen, and generally a large per centage of earthy matter.

When herbaceous vegetation is acted upon by the conditions which convert wood into coal, we have peat as the result.

The substances that are driven off in the formation of coal are sometimes found stored at a point more or less remote from the coal from which they are derived, as in the case of the coal-oil deposits.

To return to the lignites. I have here many typical specimens of them. They contain more than ten per cent of water, and sixteen per cent of oxygen. The oxygen we do not want to buy by the ton, and the water is not only useless, but it must be converted into steam and driven off. For these reasons the lignites are inferior in value to bituminous coal. Some of them contain so much water that they crack into minute fragments, and there is great loss in mining and in handling them. At Santa Fe there is a lignite which is saturated with water, and so soft that it can be cut with a spade, but it is of no value as fuel. In Sonora there are beds of coal of the triassic age; and there are, in that vicinity, some small beds of lignite which have been converted into anthracite coal.

The lignites of the far west being of less intrinsic value as fuel than coal, can only be used with economy where they are produced; and they sometimes contain, when taken from the mine, so large a proportion of water, that they cannot well be transported. The San Francisco market is supplied from various beds of lignites found in that vicinity.

Prof. N. exhibited specimens of lignites from Alaska, San Francisco, Denver, Wyoming, Utah, Sonora and other points, with tables showing their constituents, and showing upon the map the locations.

With regard to the value of these materials as a fuel, we have beds no less extensive than those of the carboniferous period. I have computed from the best data that I could obtain that there are not less than 50,000 square miles of them. They vary very much in value, from the different proportions they contain of oxygen and of water. The quantity of ash is not large, and they contain, on the average, about as much sulphur as our bituminous coal. To determine the calorific power of a fuel, we have simply to make an ultimate analysis of it; and then, supposing it to have the average physical condition, to be sufficiently compact and solid to be handled, to be put into the furnace, and allow the draft to pass through it, we can determine very nearly its value. To give you the result, without detaining you too long with the mode of computation, I find that the heating power of these lignites is about five-eighths of that of a good quality of our bituminous coal.

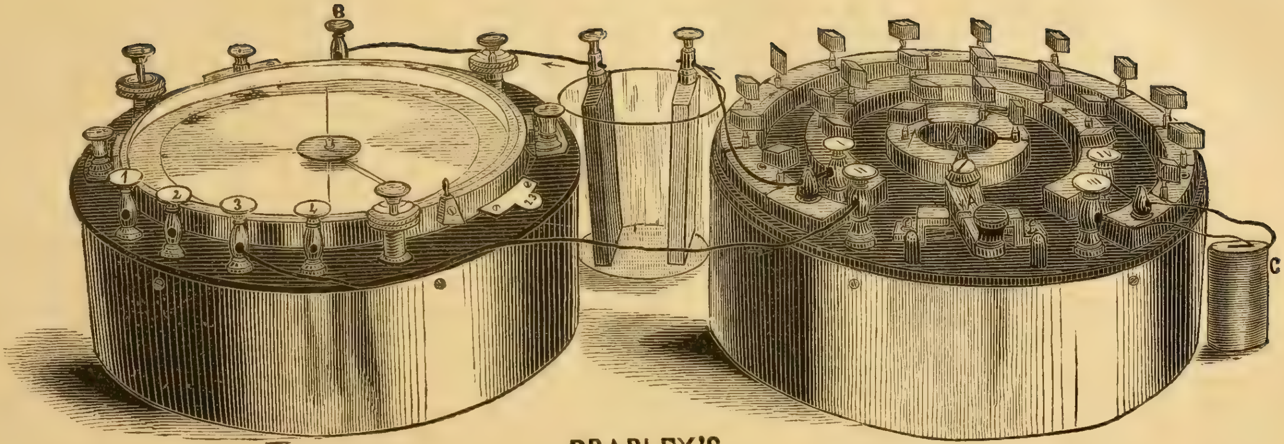
It has been proved that the best coals for making steam are those which have not lost all of their volatile constituents, but which have a long flame. On the average, bituminous coal is about the best standard for all purposes; so that it is a fair estimate of the efficiency of the lignites to say that it is about five-eighths of that of good bituminous coal.

The next question is, whether the combustion is sufficiently rapid, for we have not only the calorific quantity of power but the calorific intensity to calculate. It is easy to determine how much heat it will produce; but it makes a great difference in its value whether you can get out this heat from a given quantity of fuel in five minutes, or whether it takes an hour. For smelting purposes it is necessary that a large amount of heat shall be evolved rapidly. It can best be determined by trial, but I have great confidence that many of these lignites may be burned with sufficient rapidity for the smelting of iron or any other metallurgical purposes for which they may be required. The amount of hydrogen they contain gives them great combustibility. They burn rapidly; and although they do not make a very hot fire, I think it will be found sufficiently intense for metallurgical purposes. There has been an impression that they could not be used, and coke has been sent for at a cost of $160 per ton, when these lignites could have been had for but a small portion of that amount.

The beds of asphalt and of petroleum deserve a moment's notice, inasmuch as they are very conspicuous in some localities, and have led to the expenditure of large amounts of money. In southern California there is a great abundance of asphalt. Sometimes the ocean will be covered for miles with it. It is capable of being applied to a good purpose there, although it is not worth transporting to the Atlantic coast. There are similar deposits in Colorado, where they are called by the hunters "tar springs." There is no doubt in my mind that it is the residuum from the evaporation and distillation of petroleum.

The great question with regard to the value of the lignites is, whether they are applicable for smelting purposes. We know they are adapted for the generation of steam, for they are almost exclusively used for that purpose by the Pacific railroad. I hope that what I have said will inspire sufficient confidence in their value to cause their trial for smelting purposes. It will be necessary to adapt the furnaces to them; but when rightly burned I have great confidence that they will be found fully equal to every demand which may be made of them.

Adjourned.



BRADLEY'S
APPARATUS FOR
ELECTRIC MEASUREMENT.

April 26, 1872.

Prof. S. D. Tillman, in the chair; Robert Weir, Esq., Secretary.

The meeting was opened by the reading of the following paper by the author:

Apparatus for Electric Measurement, with Rules and Directions for its Practical Application.

By L. Bradley, Jersey City, N. J.

1. It is about eight years since the writer of this paper undertook the work of constructing an instrument for the measurement of resistances, intended to be used daily in regular business, as the grocer used his scale-beam. The result, though rude and imperfect, was still valuable, for it enabled him approximately to determine the resistances of all helices and electro-magnets manufactured and put upon the market by him.

The measurement of resistance was all that was then aspired to, and the apparatus received the name of *Anthistometer*, a Greek derivative signifying "a measurer of resistance."

From that to the present time, he has endeavored by indefatigable exertion and thougtht, to keep pace with the progress so rapidly making in electrical science, and especially in that of electric measurement generally.

Instead of a rude and imperfect measure of resistance, he now presents an apparatus so largely improved, and so well defined in its applications and capacities, that electricians in all departments find every desirable means for absolute and correct measurement, put up in a substantial, compact, cheap and portable form.

By this, telegraph companies may directly measure the resistance of their lines; also their insulation resistance up to millions of ohms. They may locate breaks, faults and crosses, when they occur, and they may determine the resistance, strength and electro-motive force of their batteries.

Metallurgists, engaged in electrolysis, may determine the quantity of metal of any kind deposed by a current in a given time with great accuracy; a desideratum to those engaged in electrotyping, gilding, etc.

Wire manufacturers may readily determine the quality of the metal they are working up; the specific resistance and conductivity of the wire put upon the market, compared with that of pure copper; a matter of great importance to those purchasing for telegraph or other electrical purposes.

In short, the capacities of all other instruments combined, for similar purposes, are embraced in this one, in a form so compact and substantial as to be exceedingly convenient, and comparatively safe from injury, by use or from rough handling.

This apparatus consists of his Tangent Galvanometer and his Rheostat as they have been recently improved.

2. The tangent galvanometer, of most recent construction, is composed of a compass dial, five or six inches in diameter, having a fine steel point in the center, which supports a needle of a form peculiar to this invention. Underneath these are placed coils of several capacities, designed to measure various currents, from those of great intensity with but little quantity, to those of great quantity with but little intensity.

3. The needle is composed of a thin circular plate of tempered steel, in the center of which is fixed an aluminium cup containing an agate to rest upon the point at the center of the compass, or it may be made of three or more oblong plates, riveted upon a flat ring of aluminium, so trimmed as to form a perfectly circular disk. From the meridian of the disk long slender aluminium pointers extend, to denote the degrees of deflection. The needle being properly polarized, and placed upon the point, obeys every electrical impulse with great celerity. Its weight is scarcely twenty grains, and in some cases not even half that.

4. The coils are so placed that the current runs parallel with the meridian of the needle. They are half an inch or more wider than the diameter of the disk. By this means all parts of the steel composing the needle are subjected to the same inductive influence in all its deflections.

5. It is a condition indispensable in the construction of a true tangent galvanometer, that the current through the coil should act as uniformly upon the needle in all its deflections as the earth's magnetism does; a narrow coil under a long needle does not fulfill this condition; for, as the extremities of the needle in its deflections pass more and more away from the coil, the inductive influence is less and less, as compared with the earth's influence.

6. On the contrary, if we place a very broad coil under a long needle, the same difficulty occurs, but in the opposite direction. While the needle is on the meridian it is under the influence of but few convolutions in the middle of the coil, but as it deflects it comes

under the influence of an increasing number of convolutions, and therefore the influence is more and more increased.

7. It being evident that the truth lay between these extremes, the expedient of a needle in the form above described was resorted to, and with entire success, for in this the condition sought is accurately fulfilled.

8. Coil No. 1 is composed of very fine copper wire, wound evenly back and forth over the whole width of the coil, and of a sufficient number of layers to give a resistance of 150 or more ohms.

No. 2 is of No. 30 wire, wound in the same manner and to twenty-five or thirty ohms risistance. No. 3 is of two layers of No. 23 wire, giving one to two ohms resistance. And No. 4 is a strip of sheet copper of the width of the coils, and wound three and a half times around, so that the current passes four times under the needle; the resistance of this may be considered as null, or not sufficient to be noticed or taken into account.

9. The outer ends of all the coils are connected with a common screw-cup, while the inner ones are connected each with its cup bearing its proper number.

One, two, or even three of the coils may be dispensed with in galvanometers for special purposes, according to the function to be performed.

10. Coil No. 1 is for currents of high intensity, No. 4 for those of great quantity, and Nos. 2 and 3 are for mixed or intermediate currents.

Galvanometers of different styles are made.

11. The tangential proportionality of these galvanometers has been tested, on several occasions, in the following manner, with corresponding results in all cases.

Taking galvanometer No. 16, and providing a resistance coil to be put in circuit with coil 3, to make its resistance precisely equal to that of coil 2, and then taking the deflection under different resistances from ten to 500 ohms, and dividing the tangents of the mean deflections, obtained from coil 2, by those from coil 3, we have the following quotients.

Coil 2.			Coil 3.		
Ohms inserted.	Mean deflection.	Tangents.	Mean deflection.	Tangents.	Quotients.
10	78° 55′	5.105	56° 50′	1.530	3.33
100	61° 30′	1.842	28° 40′	.5467	3.36
200	46° 55′	1.069	17° 50′	.3217	3.32
500	25° 35′	.4787	8° 12½′	.1442	3.32

Another test, made by putting two galvanometers (No. 18 and No. 9, coil 3) into same circuit, gave the following results:

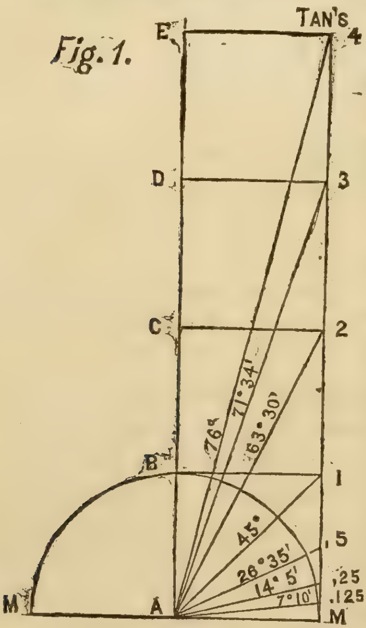
Galvanometer No. 18.			Galvanometer No. 9.		
Ohms inserted.	Mean deflection.	Tangents.	Mean deflection.	Tangents.	Quotients.
2	73.9°	3.465	68.9°	2.592	1.34
12	49.9°	1.188	41.5°	.8847	1.34
30	28.3°	.5704	21.7°	.3979	1.35
60	15.8°	.2830	11.8°	.2089	1.35

The near uniformity of these quotients gives evidence of very true tangent galvanometers.

12. The theorem, "*The intensity of currents, as measured by the tangent galvanometer, is proportional to the tangents of the angles of deflection*," may be verified in the following manner:

Call the terrestrial magnetism, whose tendency is to direct the galvanometer needle to the magnetic meridian, the unit of directive force, and let this unit be represented geometrically by the line A M (Fig. 1), which is the radius of the circle M B M—the line M A M representing the meridian. Now, let an electric current be sent through the galvanometer coil whose directive force is precisely equal to the terrestrial force, and whose tendency is to direct the needle in a line perpendicular to the meridian, and let this force be represented by the A B.

Fig. 1.



If the terrestrial force could now, for a moment, be suspended, the needle would point due east and west, but the combined action of the two equal forces will direct the needle toward the point of intersection of the line drawn perpendicularly from M, and that drawn horizontally from B at 1, which direction cuts the quadrant at 45°, the line M 1 being the tangent of 45°, which is 1.

Now, if we augment the intensity of the current through the coil to twice its present force, which will be 3, and will be represented by the line A C, the combined forces of A M and A C will direct the needle toward the point 2. If we now lay a protractor on the circle, we find that the line A 2 cuts it at about 63° 30′, of which the tangent is 2.

We may increase the parallelogram erected upon A M at pleasure, and the two forces combined will always so balance the needle between them as to make it point from A diagonally across the parallelogram to its opposite angle, the height of which is the tangent of the angle of deflection.

By inspection of the diagram it is seen that the law holds good in the subdivisions of the force as at .5, .25 and .125—a truth admitted by all experimenters as to the relations up to 14°.

13. The rheostat contains coils whose several resistances range from $\frac{1}{100}$ of an ohm to 4,000 ohms, any one or more of which may be thrown into the circuit by removing the proper plug or plugs on the top of the rheostat, so that any resistance may be introduced from $\frac{1}{100}$ of an ohm to 10,000 ohms.

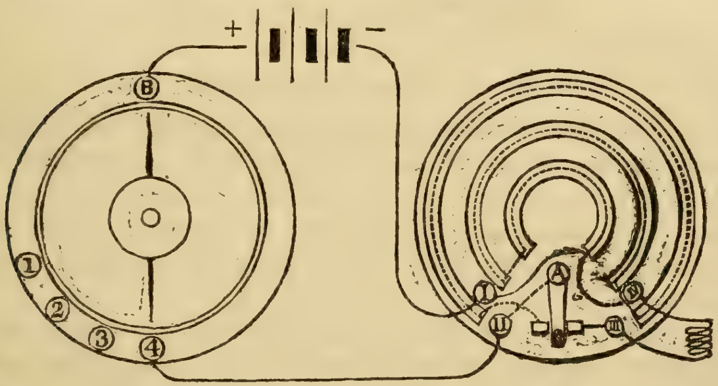


Fig. 2.

14. In addition to two screw-cups (I and II) for connection with the battery and galvanometer, there are two other screw-cups (III and IV) for connection of any conductor whose resistance it is intended to measure; also a switch (A) so arranged that the battery current may be directed at pleasure through the rheostat or the conductor. The whole apparatus is packed in a morocco case, nine inches in diameter and seven inches deep, having a handled strap, rendering it convenient for transportation from place to place.

15. *The Units of Electric Measurement,*

herein adopted, are those of the British Association, viz.: "ohm, volt and veber." The "ohm" is the unit of *resistance,* and is equal to the resistance of a prism of pure mercury, one square millimeter section and 1.0486 meters long at 0° C.

16. The "volt" is the unit of *electro-motive force,* which varies but little from the electro-motive force of a standard Daniell's cell.

17. The "veber" is the unit of *strength,* or *quantity,* or *electro-chemical equivalence* of a current, as it is variously called, and represents that quantity of electricity which flows through a circuit having an electro-motive force of one volt and a resistance of one ohm in one second.

18. One veber of electricity decomposes

.00142 grains water, or develops
.000158 grains hydrogen, or
.1821 C.C. mixed gas, at a temp. of
0° C, and barometric pressr. of 760 $^{m}/_{m}$.

$$\frac{e=1 \text{ volt}}{r=1 \text{ ohm}}=s=1 \text{ veber per second.}$$

19. *Resistance of Conductors.*

To determine the resistance of any conductor, attach its extremities to the screw-cups III and IV of the rheostat, one pole of the battery to B of the galvanometer, and the other to I of the rheostat.

The wire leading from II of the rheostat is connected with one of the screw-cups one, two, three, four, of the galvanometer, as may be required.

For resistance of 1,000 ohms or more, the No. 1 screw-cup, with a compound or intensity battery, is most suitable; No. 2, from twenty to 1,000 ohms; No. 3, from two to twenty ohms; and No. 4, with a single large cell of battery (or, what is better, two or more cells arranged for quantity) for very small resistances, two ohms or less.

20. Before measuring small resistances, it is necessary to balance the apparatus, as we would a scale-beam, before weighing small quantities. To do this, connect III and IV by a short wire, such as may be used in connection with the thing to be measured; the rheostat being fully and carefully plugged. If, now, on turning the switch to the right, the needle goes up, it shows that the short wire does not have resistance enough to balance; therefore, a wire of larger resistance must be selected; on the contrary, if the needle falls back, plugs

must be removed sufficient to balance the needle, the amount unplugged must be deducted from the result.

21. The current is now to be directed through the conductor to be tested, by turning the switch to the right, and the galvanometer deflection noted; the switch is then turned to the left, directing the current through the rheostat. Plugs are now removed to introduce sufficient resistance to bring the needle to the same degree, so that on oscillating the switch back and forth, the needle remains stationary. The resistance of the conductor is now equal to the sum of the resistances of the several rheostat coils introduced.

By this method any resistance may be directly measured, from $\frac{1}{100}$ of an ohm to 10,000 ohms. Helices, relays, and other electro-magnets are measured in this way.

Measuring and Testing Telegraph Lines.

22. In using this apparatus for testing in a telegraph office, great care should be taken to avoid the disturbing action of masses of iron, the magnets of instruments, and the currents passing through wires, either under the table or along the walls. All the lines should frequently be tested for conductivity and insulation, and the tests recorded in a book kept for that purpose. The records greatly facilitate the accurate location of faults, whenever it becomes necessary to test for them.

Testing for Conductivity.

23. This test should be made in fine weather, when the insulation is good. Have all the relays of the line taken out of circuit, and the line connected to earth or ground wire, at distant end, without battery. Arrange the wires as in last diagram (Fig. 2), putting the line wire and the ground wire to III and IV. When the needle is balanced, the resistance unplugged is equal to the resistance of the line.

No. 9 wire should not exceed twenty ohms per mile of length, and No. 8, seventeen ohms. Higher resistance than this indicates defective joints in the line or poor ground connections.

In all these measurements and testings, it is proper to reverse the direction of the current through the line (which is readily done by changing places of the connections at I and II), and taking the mean of the two results.

Testing for Insulation.

24. The connections are the same as in the last case, except that the line is open at the distant end instead of being "grounded." If the

line is not very long, or the insulation is good, the resistance will frequently be above the range of the apparatus. This may also happen in testing for conductivity on a very defective wire. In this case another method is adopted.

25. First arrange the wires as before; then unplug 10,000 ohms resistance, using galvanometer coil No. 1, and an intense main battery. Note the deflection obtained through the whole 10,000 ohms resistance, and call this the maximum of the galvanometer. Now turn the switch to the right, directing the current through the line, which is open, of course, at the distant end. Note the deflection as before. The tangents of the deflections will each be inversely proportional to the resistance under which it was produced.

Suppose the deflection with the 10,000 ohms to be 30°, giving tangent .5774, while that through the line is 10°, whose tangent is .1763.

Therefore,

Tan. 5774 : 10,000 ohms : : tan. .1763 inversely : 32,751 ohms.

$$i.\ e.,\ \frac{5774 \times 10{,}000}{.1763} = 32{,}751 \text{ ohms.}$$

This is the insulation resistance of the line, and this, multiplied by the number of miles in length, gives the insulation resistance per mile.

26. It is proper here to caution those using this apparatus against directing the current from an intense battery, through rheostat coils of low resistance, lest they should be spoiled by burning. Forty cells of Grove's battery would be likely to greatly damage a fifty ohm coil, or perhaps one of a hundred or two hundred ohms, if the current were directed through it alone. Batteries of no greater strength should be employed than is necessary to accomplish the work desired —ten or twenty cells of any sulphate of copper battery are sufficient for measuring great resistances.

27. The daily testings of a line should be recorded in a form something like the following:

Date.	Maximum. 10,000 ohms.	No. 1 Wire. Conductivity. Resistance. Ohms.	No. 1 Wire. Insulation. Deflection.	No. 1 Wire. Insulation. Ohms.	No. 2 Wire. Conductivity. Resistance. Ohms.	No. 2 Wire. Insulation. Deflection.	No. 2 Wire. Insulation. Ohms.	Weather.
April 1..	30°	4050	10°	32,500	5000	30°	10,000	Rain.

*Testing for Location of Faults.**

28. The principle upon which the methods of distance testing are founded, is that of finding the resistance of the line wire between the testing station and the fault, by the methods above described.

It is very essential that the resistance of each circuit should be frequently measured and recorded, so that when a fault occurs the actual resistance of the line per mile may be known.

If the broken line gives a full ground, its resistance, divided by the resistance per mile, at once gives the distance of the break from the testing station; and if the distant station obtains a like result, the confirmation is complete.

Thus, in a line of 100 miles, if the tests from the two extremities indicate distances of forty-five and fifty-five miles respectively, the locality of the interruption is clearly indicated.

29. As the fault, however, usually gives a very considerable resistance at the point where the line is in contact with the earth, and the sum of the two resistances, measured from stations at the opposite ends of the lines, greatly exceed the resistance of the line itself when perfect, it is usual in such cases to estimate the fault midway between the two points indicated. Thus, when the respective distances indicate eighty-six and twenty-six miles, the sum of these exceed 100 miles by twelve, and, therefore, half this excess, or six, is deducted from each of the measures, the resistance of the fault having been included in each measurement.

30. When the line is unbroken, but shows a heavy escape or partial ground, sufficient to weaken signals, two methods are available for determining its locality. The first is that of direct measurement, alternately from each end; the distant end at the same time being insulated, or, in other words, left open, as before explained (24).

In this case the resistance of the fault is measured twice over, and is roughly allowed for by the method of calculation above given (29).

The Loop Test.

31. A second and more accurate method, which gives a measure entirely independent of the resistance of the fault, is known as the loop test. It is only available, however, in cases where there are two or more parallel wires on the same route. In making this test, let the operator proceed as follows:

32. Make the length to be tested as short as possible, and have all the instruments in circuit taken out; select a good wire, similar, if

* Pope's Modern Practice of the Electric Telegraph, pp, 80–82.

possible, to the one it is required to test. These wires must then be connected together in a loop at the nearest available station beyond the fault, without ground connection. The resistance of the faulty wire, when perfect, must be ascertained. This may be taken from previous records, or it may be found by a test taken as follows:

33. Connect the apparatus as in the diagram (Fig. 2, also frontispiece), putting the loop in place of the resistance, to be measured as shown in the diagram; that is, connect the good wire of the loop to III, and the bad wire to IV, and ascertain the resistance as directed (19–21).

34. Having ascertained the resistance of the loop, arrange the connections, as shown in the following diagram (Fig. 3).

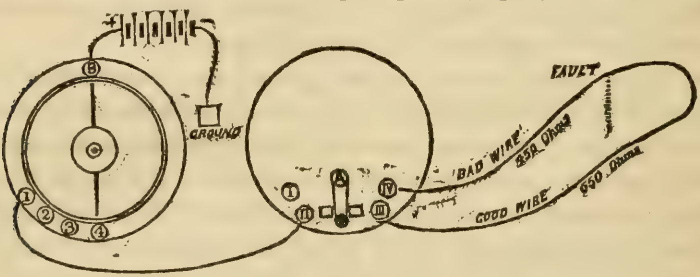


Fig. 3.

Now turn the switch A to the right, and note the deflection; then turn it to the left, and unplug resistance until the same deflection is obtained; the resistance unplugged, deducted from the total resistance of the loop, and divided by 2, is the resistance of the bad wire between the apparatus and the fault.

For example, suppose the resistance of the loop to be 1,000 ohms, and 1,000 ohms have been unplugged to balance the needle; the fault is 450 ohms from IV. Suppose the loop of 1,000 ohms is fifty miles in length, then by proportion

1,000 ohms : 50 miles : : 450 ohms : 22.5 miles.

35. When there is a fault on a line, and there is but one wire, it may be located by the following method: Ascertain, from former record, the normal resistance of the line; call this r.

Also the resistance of the defective line, when grounded at the distant end, as before directed (23); call this s.

Also the resistance when open at the distant end, and call this t; and call the resistance of the wire between the fault and the testing station x; then

$$x = s - \sqrt{(s^2 + tr) - (ts + rs)}$$

i. e., multiply s by s and t by r, and add the products together; subtract from this amount t times s, and r times s; subtract the square root of the remainder from s, and the remainder will give the resistance of the wire between the fault and the testing station.

This test should, if practicable, be taken from both ends of the wire, and greater accuracy is secured by taking the mean of several observations.

To Locate a Cross.

36. The two wires in contact form a loop; open both wires at the nearest available point beyond the cross, and measure the resistance of the loop. Half of this will be the resistance between the testing station and the cross. The cross itself sometimes has considerable resistance, which would make its true position somewhat nearer than its apparent position.

37. A cross may also be located by the method given (34), by putting one wire as a ground, which will make an escape at the point where the cross is situated, and which, of course, may be located in the same manner as any other escape, by either of the methods above given.

Conductivity and Resistance.

38. The conductivity of two conductors of same metal are directly proportional to the areas of their transverse sections; or, if of round wire, they are directly proportional to the square of their diameters. The resistance of the same wires are inversely proportional to the squares of their diameters.

Specific Conductivity and Resistance.

39. The relative specific resistance of two metals may be determined by taking the resistance of a wire of each, of a given length and diameter; their resistances will denote their relative specific resistances, or they may be computed from wires of different diameters (their lengths being equal), by the following formula:

$D =$ diameter of standard wire.
$R =$ resistance of standard wire.
$d =$ diameter of wire to be tested.
$r =$ resistance of wire to be tested.
$D^2 : R :: d^2$ inversely $: r$.

i. e.,

$$\frac{D^2 R}{d^2} = r.$$

Example.

Suppose we take as a standard a copper wire, ten feet long, No. 26 by the American gauge (Darling, Brown & Sharp), whose diameter by the following table is sixteen mils (thousandths of an inch), and find its resistance to be .44 ohms, and another wire of same length, No. 30, whose diameter is ten mils; the square of the latter is 100, and that of the former 256.

$$\frac{256 \times .44}{100} = 1.13.$$

1.13 ohms, therefore, should be the resistance of the No. 30 wire, if the specific resistance of the metals of which the two wires are composed are equal; but on trial we find its resistance to be 1.9 ohms.

Assuming 100 as the specific resistance of the standard metal,

$$1.13 : 100 :: 1.9 : 168;$$

the specific resistance of the tested metal is, therefore, sixty-eight per cent greater than the standard, *i. e.*, 168 to 100.

Brown & Sharp's sheet metal gauge, which determines the diameter of a wire to the $\frac{1}{1000}$ of an inch, is the best measure for this purpose.

Table of Diameters of Wires expressed in mils (thousandths of an inch).

Number.	American gauge.	Birmingham gauge.	Number.	American gauge.	Birmingham gauge.
	Mils.	*Mils.*		*Mils.*	*Mils.*
0000	460.	454.	19	35.89	42.
000	409.64	425.	20	31.96	35.
00	364.80	380.	21	28.46	32.
0	324.95	340.	22	25.35	28.
1	289.30	300.	23	22.57	25.
2	257.63	284.	24	20.1	22.
3	229.42	259.	25	17.9	20.
4	204.31	238.	26	15.94	18.
5	181.94	220.	27	14.19	16.
6	162.02	203.	28	12.64	14.
7	144.28	180.	29	11.26	13.
8	128.49	165.	30	10.02	12.
9	114.43	148.	31	8.93	10.
10	101.89	134.	32	7.95	9.
11	90.74	120.	33	7.08	8.
12	80.81	109.	34	6.3	7.
13	71.96	95.	35	5.61	5.
14	64.08	83.	36	5.	4.
15	57.07	72.	37	4.45	
16	50.82	65.	38	3.96	
17	45.26	58.	39	3.53	
18	40.3	49.	40	3.14	

40. Or the following method may sometimes be more available, and is more exact:

It has been determined (Latimer Clark on Electric Measurement, page 64) that one nautical mile, 2,029 yards, pure copper wire, weighing one pound, has, at 60° Faht., 1,155.5 ohms resistance.

1 ℔.=7,000 Troy grains.

2,029 yds. : 7,000 grs. :: 10 yds. : 34.5 grs., and

2,029 yds. : 1,155.5 ohms :: 10 yds. : 5.695 ohms.

Therefore,

10 yds. pure copper wire, weighing 34.5 grs., has 5.695 ohms resistance.

The resistance of a given length of wire is inversely proportional to its weight; hence, if ten yards wire weigh ten times as much, 345 grains, its resistance will be one-tenth=.57 ohms.

If, on trial, we find its resistance to be greater, say .67 ohms, its conductivity is less than the pure copper in the inverse ratio of the resistance; that is:

67 : 57 :: 100 : 85;

or the metal has a conductivity of 85, the pure being taken at 100.

Example.

Suppose ten yards pure copper weighs 173.4 grains, and has a resistance of 1.2 ohms;

34.5 grs. : 5.695 ohms :: 173.4 grs. inversely : 1.133 ohms; *i. e.*

$$\frac{34.5 \times 5.695}{173.4} = 1.133.$$

For specific resistance:

1.133 : 100 :: 1.2 : 105.91;

and for specific conductivity, the same proportion inversely:

$$\frac{1.133 \times 100}{1.2} = 94.2.$$

Therefore, taking both the resistance and the conductivity of pure copper at 100, the specific resistance of the specimen tested is 105.9, and its specific conductivity 94.2.

41. For convenience, we may take the product of 34.5 grains × 5.695 ohms=196.4775, as a constant quantity, to be divided by the weight in grains of any specimen of ten yards of copper wire. This will give the resistance, in ohms, which the specimen would have if pure. Dividing this (multiplied by 100) by the actual resistance, gives the specific conductivity, or, dividing the actual resistance (multiplied by 100) by this, gives the specific resistance.

Effect of Temperature.

42. The resistance of copper increases about .208 per cent for each deg. Faht.,* which is to be added or subtracted as the temperature is below or above 60°.

Example.

If a wire has 22.73 ohms resistance at 70°, what will it have at 60°?

$$22.73-(22.73\times.00208\times10°)=22.257.$$

The following table will be found convenient in making corrections for temperature:

Table for calculating the resistance of Copper at different temperatures.

To increase from lower temperature to higher, multiply the resistance by the number in column 2.				To reduce from higher temperature to lower, multiply the resistance by the number in column 4.			
No. of degrees.	Column 2.	No. of degrees.	Column 2.	No. of degrees.	Column 4.	No. of degrees.	Column 4.
0	1.			0	1.		
1	1.0021	16	1.0341	1	0.9979	16	0.9670
2	1.0042	17	1.0363	2	0.9958	17	0.9650
3	1.0063	18	1.0385	3	0.9937	18	0.9629
4	1 0084	19	1.0407	4	0.9916	19	0.9609
5	1.0105	20	1.0428	5	0.9896	20	0.9589
6	1.0127	21	1.0450	6	0.9875	21	0 9569
7	1.0148	22	1.0472	7	0.9854	22	0.9549
8	1.0169	23	1.0494	8	0.9834	23	0.9529
9	1.0191	24	1.0516	9	0.9813	24	0.9509
10	1.0212	25	1.0538	10	0.9792	25	0.9489
11	1.0233	26	1.0561	11	0.9772	26	0.9469
12	1.0255	27	1.0583	12	0.9751	27	0.9449
13	1.0276	28	1.0605	13	0.9731	28	0.9429
14	1.0298	29	1.0627	14	0.9711	29	0.9409
15	1.0320	30	1.0650	15	0.9690	30	0.9390

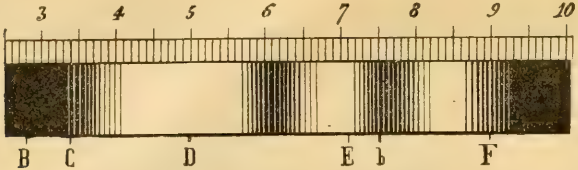
Resistance of Batteries.

43. In determining the interior resistance of batteries, the resistance of the galvanometer coil used, if it has any appreciable resistance, with the connections, must be known. In taking deflections where accuracy is required, the direction of the current through the galvanometer should be reversed, and the mean of the two deflections taken; for we can scarcely fail to observe some difference.

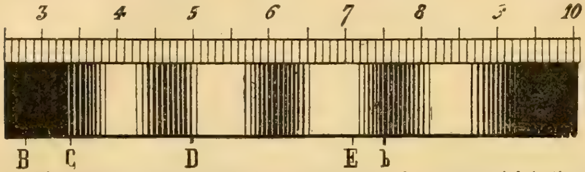
If we have no adjustable rheostat, we must be provided with one or more standard coils, whose resistances are correctly known; one

* On Electric Measurement. By Latimer Clark, p. 68.

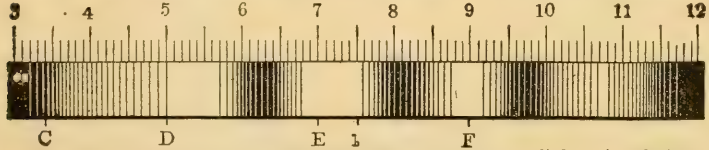
PLATE III.



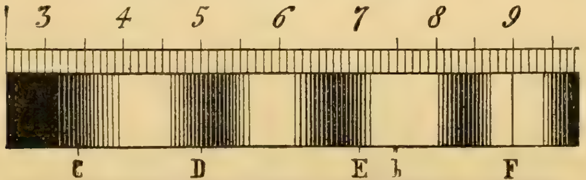
No. 1—Fluorescent spectrum of solid Thallene.



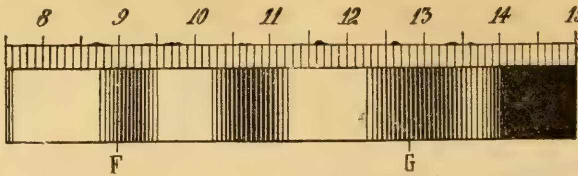
No. 2.—Fluorescent spectrum of Chrysogen, as seen in commercial Anthracene.



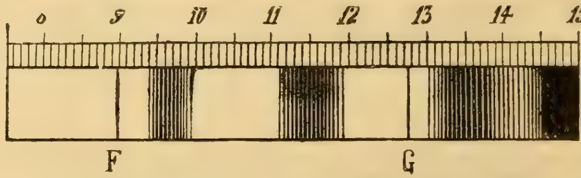
No. 3.—Fluorescent spectrum of Thallene, after exposure to sunlight or in solution in Ether.



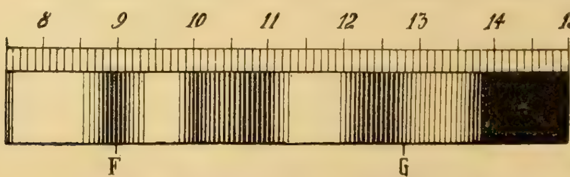
No. 4.—Fluorescent spectrum of Chrysogen, dissolved in Benzole.



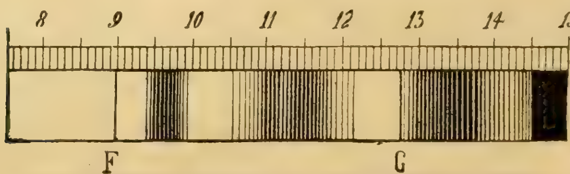
No. 5.—Absorption spectrum of solid Chrysogen in Anthracene.



No. 6.—Absorption spectrum solution of Chrysogen in Benzole.



No. 7.—Absorption spectrum of solid Thallene.



No. 8.—Absorption spectrum of solution of Thallene in Benzole.

or two ohms is sufficient when a single cell is to be measured, but larger when a number of cells are to be measured.

44. The following formula brings us to a simple and correct rule:

Let e = electro-motive force.
r = resistance of the battery.
r^1 = a known resistance to be inserted.
s = strength of current = tan. of deflection.
s^1 = tan. of deflection when r^1 is inserted.

According to Ohms law,

$$\frac{e}{r} = s \text{ and } \frac{e}{r + r^1} = s^1.$$

Two equations, involving the two unknown quantities e and r, which, cleared of fractions, become

$$e = rs, \qquad \text{1st equation.}$$
$$e = rs^1 + r^1s^1, \quad \text{2d} \quad \text{do.}$$

Eliminate e by substituting rs of the first equation for e of the second equation

$$rs = rs^1 + r^1s^1, \qquad \text{transferring } rs^1;$$
$$rs - rs^1 = r^1s^1, \text{ and dividing by } s - s^1, \text{ we have}$$
$$r = \frac{r^1s^1}{s - s^1},$$

or the following simple proportion,

$$s - s^1 : r^1 :: s^1 : r.$$

If the galvanometer has resistance, subtract it from the result, and we have the interior resistance of the battery.

45. Another method is sometimes employed, in which the resistance of the galvanometer must be null, and the wire of an adjustable rheostat so large as not to be essentially heated by the current.

$\frac{e}{r} = s =$ tangent of deflection, and

$\frac{s}{2} =$ tan. of deflection when a resistance is inserted equal to the interior resistance.

Therefore, divide the tangent of deflection by two, and find the degree corresponding to this half tangent; then interpose rheostat coils to bring the needle to the same degree.

The resistance thus interposed will be equal to the interior resistance.

46. The resistance of two cells of equal strength, or two series of two or more cells, each of equal strength, may be obtained by con-

necting two like poles of the two together, so that they neutralize each other, and connecting them by screw-cups III and IV, and taking their resistance as we do that of any conductor.

47. The following method, too, discovered and first used by the writer, is found to be correct and reliable. The cell to be tested is connected between III and IV, using two or more cells for main battery. The switch being to the left, the deflection caused by the main battery is noted. On turning the switch to the right, the force of the cell is added to that of the main battery and the deflection is increased. Now, reverse the poles of the cell so that its force opposes that of the main, and the deflection is much diminished; add the tangent of the smaller to that of the larger deflection and divide by two. Find the degrees corresponding to this mean tangent. Now turn the switch to the left, and introduce rheostat resistance to bring the needle to the same degree. The amount introduced will show the resistance of the cell.

Constant Multiplier.

48. To determine the electro-chemical equivalent of a current by a tangent galvanometer, it is necessary to find a number by which the multiplication of the tangent of its degree of deflection will give the equivalent sought.

This is done in various ways. That recommended and employed by most authors is by the electrolysis of water in the voltameter, and the production of its elementary gases, the volume of which, when properly corrected for temperature pressure and moisture, is directly proportional to the strength of the current.

49. The correction may be made by the following

Formula.

v^1 = volume of gas observed.

v = vol. corrected for temp. pressure and moisture.

b^1 = barometric pressure observed.

b = same corrected for temperature.

e = tension of vapor of water at t°C.

t = the number of degrees above freezing point.

$\frac{1}{273}$ = Regnault's co-efficient of expansion for each degree C.

$$v = \frac{v^1\, 273}{273 + t} \times \frac{b - e}{b}$$

Barometric Correction.

50. The barometric column is to be corrected for temperature, for which we may employ the following table (51), where the scale is of wood, graduated for millimeters; or we may multiply the co-efficient

of expansion for 1°C .00018153, by the number of degrees C, and the product by the height in millimeters, and subtract the last product from the apparent height.

The co-efficient of the expansion of glass, for each degree, is .0000092, and of brass, .0000188. Where the scale is of one of these materials, its co-efficient must be subtracted from that of mercury.

51. *Table for correction of Barometric Indications, measured by wooden scale in millimeters, calculated from the co-efficient of Regnault,* .918153 *the dilation of mercury, from* 0° *C. to* 100° *C. That for* 1° *C. is* .00018153.

°C.	1 m/m.	°C.	1 m/m.	°C.	1 m/m.
1	.00018	16	.00290	31	.00563
2	.00036	17	.00309	32	.00581
3	.00054	18	.00327	33	.00599
4	.00073	19	.00345	34	.00617
5	.00091	20	.00363	35	.00625
6	.00109	21	.00381	36	.00654
7	.00127	22	.00399	37	.00672
8	.00145	23	.00418	38	.00690
9	.00163	24	.00436	39	.00708
10	.00182	25	.00454	40	.00726
11	.00200	26	.00472	41	.00744
12	.00218	27	.00590	42	.00762
13	.00236	28	.00508	43	.00781
14	.00254	29	.00526	44	.00799
15	.00272	30	.00545	45	.00817

Multiply the co-efficient for the number of degree C, by the apparent height in millimeters, and subtract the product from the apparent height.

52. The following table gives the factor *e:*

Table of the tension of aqueous vapor, expressed in millimeters of mercury, at 0°C *for each degree from* 0°C *to* 35°C (*Regnault*).

°C.	Tension in m/m.	°C.	Tension in m/m.	°C.	Tension in m/m.
0	4.600	12	10.457	24	22.184
1	4.940	13	11.062	25	23.550
2	5.302	14	11.906	26	24.998
3	5.687	15	12.699	27	26.505
4	6.097	16	13.635	28	28.101
5	6.534	17	14.421	29	29.781
6	6.998	18	15.357	30	31.548
7	7.492	19	16.346	31	33.405
8	8.017	20	17.391	32	35.359
9	8.574	21	18.495	33	37.410
10	9.165	22	19 659	34	39.565
11	9.792	23	20 888	35	41.827

Example.

53. Suppose, $v^1 = 154$ C.C. in 200 minutes.

$b^1 = 760$ $^{m}/_{m}$.

$b = 757$ "

$e = 18.5$ "

$t = 21°$ C.

$$v = \frac{154 \times 273}{273 + 21} = \frac{42042}{294} = 143$$

$$757 - 18.5 = \frac{738.5}{757} = .9755$$

$v = 143 \times .9755 = 139.5$ C.C. in 200 min.

$= .6975$ C.C. per minute.

$= .01162$ " second.

Reducing this to vebers,

.1721 C. C. : 1 veber : : .01162 C.C. : .067518 vebers per second.

54. Now, dividing this product by the mean tangent of the galvanometer deflection under which it was produced,

1.1189 gives .060343, *a constant multiplier*,

by which we may multiply the tangent of any deflection of that same galvanometer, and thereby obtain the equivalent of the current producing it, in vebers per second.

55. We may now obtain the weight in grains per second, of any metal or element, whose salt we may submit to electrolysis, with this galvanometer in circuit, by simply multiplying the tangent of deflection by this constant, the product by .000158 grains (the hydrogen equivalent of one veber per second), and this product by the chemical equivalent of the element.

Example.

56. Suppose a salt of copper has been submitted to the same current with the voltameter in the preceding example, how much copper would have been deposited per second?

Tan. $1.1189 \times$ constant, $.060343 \times .000158$ grs. hydrogen $\times$ 31.7 chem. equivalent of copper.

$= .000338$ grs. copper per second.

$= .0203$ " " minute.

Multiplying .6975 C.C. per minute by .0292, the copper equivalent of 1 C.C. gives the same answer; .0203 grains copper per minute; thus verifying the calculation.

57. Hence we have the following

Table of Equivalents.

Veber 1	:	Element	Chemical equivalent	::	Veber .000158	:	Grains Troy per second.
"		Hydrogen	1.		"		.000158
"		Water	9.		"		.001422
"		Zinc	32.5		"		.005135
"		Copper	31.7		"		.005009
"		Silver	108.		"		.017064
"		Nickel	29.		"		.00458
"		Gold	196.7		"		.03108

Electro-motive Force.

58. We are now possessed of the elements for determining the electro-motive force of a battery.

Refering to the formula before given (44) for determining the interior resistance of a battery, and to the application of Ohms' law, to be found in all modern books on electricity, we see that

$$rs = e,$$

i. e., the whole resistance in *ohms*, multiplied by the strength in *vebers*, gives the electro-motive force in *volts*.

59. Such are the laws of electrolysis, as discovered and laid down by Faraday, who announced that "*The elytrolytic action of a current is the same in all its parts; that the same electric current decomposes chemically equivalent quanities of all the bodies which are traversed;*" from which it follows that "*The weights of elements separated in these electrolytes are to each other as their chemical equivalents;*" and that "*The quantity of a body decomposed in a given time, is proportional in the intensity of the current.*

On this is founded the use of Faraday's voltameter, in which the intensity of a current is ascertained from the quantity of water which is decomposed in a given time. (Ganot's Physics, p. 653.) It would seem, then, reasoning *a priori*, that a *constant* multiplier obtained for a true tangent galvanometer, should give correct and reliable results in all cases of electrolysis; that any one enaged in electroplating of any kind, having one of these galvanometers in the circuit, might readily know how many grains of the metal is being deposited per second, by multiplying the tangent of the angle of deflection by the *constant*, and the product by the proper number in the right-hand or fifth column of the foregoing table of equivalents (57). And so it would be if we were always dealing with elements that were perfectly pure, and with their salts that were perfectly neutral; but such perfection and purity we do not find in ordinary practice. Results, therefore, can be taken only as approximation to truth, which will be more or less remote as our materials are more or less impure.

60. In the investigation of these laws, the writer has made a great number of tests with water voltameters, and those of copper, silver and gold, the results of which were at first very discouraging; no two being found to agree in their equivalents.

61. But finally two copper baths, one of sulphate of copper, and one of nitrate of copper, were tried. The plates to be used were first coated with reguline copper, by deposition from solutions in which anodes were used of the purest copper to be obtained. Now, by using one of such plates as anode and another as cathode, and occasionally reversing the current until the solutions became so entirely neutral that the weight of metal lost from the anode, and that gained upon the cathode, were equal; and the transport in the two voltameters were also equal; these were, therefore, taken as giving correctly equivalent proportions for copper.

62. But in the electrolysis of acidulated water by the same current, it was found that no such voltameter as is described by Faraday or other authors would develop a measure of corrected gas sufficient to amount to the same equivalent—a circumstance evincing clearly the fact, that between electrodes of any considerable size a part of the current is conducted without decomposing the water.

63. But by fixing two pieces of No. 20 plantinum wire across a glass tube of an interior diameter of four-tenths inch, and a length of say six inches (the tube being broken and the wires put across and melted in), a voltameter was at length constructed which gives, in same circuit, a volume of gas precisely equivalent to the copper deposed in the copper voltameters, and from this true multipliers are obtained.

64. In common practice every operator can easily obtain for himself the constant multiplier, which, for his own galvanometer and bath, will determine the amount of work performed by the current with as much accuracy as is attainable by weights and measures.

65. To do this let him take a few articles (such as present large surfaces in proportion to their weights are best), and accurately weigh them; then let them be placed in the bath and remain a suitable time, which must be accurately noted together with the mean deflection of the galvanometer. Now, let them be accurately weighed again, and the weight per minute estimated in grains; dividing the number of grains by the tangent of the mean deflection gives the constant sought.

The following paper was sent to the Chairman of the Polytechnic by the venerable John D. Ward, Esq., of Jersey City, for many years one of the proprietors of the Novelty Works, New York. It was intended to be read during the discussions on the causes of boiler explosions, but was misplaced, and not found until those discussions had been closed.

Boiler Making.

The writer is aware that anything he may say upon the subject of boiler making will be, by many, regarded with suspicion; it being generally considered a waste of time and labor for any one who was ever really taught to use tools, in a workshop, to attempt to use a pen.

Notwithstanding this prejudice against the written opinions of practical men, he takes the liberty to make some remarks upon the character of the workmanship frequently, if not generally, to be found in the steam-boilers in use at the present day; and he assumes that his testimony in the case ought to have some weight, from the fact that in his early days he was a really practical boiler maker, and for years performed, with his own hands, every operation for the construction of good and efficient steam boilers. He made original designs, and working drawings in detail of the several parts, and patterns for cutting, punching and bending the plates; he punched, bent and fitted the plates for riveting; made bolts and rivets, and riveted and caulked the seams; and never met with a workman who was able to execute any portion of the work, usually performed by boiler makers, either quicker or better than himself.

The most important characteristic of a boiler is strength to sustain, with safety, the pressure of steam to which it is proposed to be subjected when in use; the price, probable durability, economy of fuel, etc., are, of course, considered by the purchaser; but the most important inquiries are, or ought to be, are the materials good, and the workmanship such as will, with good materials, render the boiler safe? And these are matters which unfortunately few purchasers are competent to decide, with the certainty which practical experience alone can give, and are, therefore, generally compelled to rely upon the opinions of others.

The high price of his boiler plates is one of the reasons why those of inferior quality are frequently used; and the lower the quality of the iron, the more likely it is to be injured by the operations of punching and bending. Both these operations impair the strength of the plates; the punching, or as it might, from the manner in which it is frequently performed, be called, tearing, the rivet holes with a tapering punch considerably smaller than the die, always strains, and sometimes fractures the iron between the rivet holes; and bending a plate, while cold, leaves the exterior of the curve in a state of tension, and the interior is, by the same operation, compressed, both which conditions tend to diminish their strength, and should, therefore, be avoided.

Besides the injury caused by wretched punching and cold bending, the rivet holes in the inner and outer plates seldom agree, and they are enlarged to admit the rivets by, what Chief Engineer Sewell, of the U. S. navy, calls, with more force than elegance, "that damnable steel drift pin." By the use of this the iron between the rivet holes is still further weakened and burrs are raised at the sides of the holes, which render it difficult to bring the plates into sufficiently close contact to form a tight joint; and, even after the riveting is completed, careless workmen will frequently cut deep grooves in the plates while chipping the seams, preparatory to calking them.

These are some of the prominent causes which lead to the producduction of weak boilers, some of which must, from time to time, explode, if worked with steam at pressures which are very common, and are held by many to be safe and economical.

The writer's opinion of good workmanship, in boiler making, may be learned from the account given, in "London Engineering," volume III, page 10, of Mr. D. Adamson's boiler works at Newton Moor, near Manchester, England. There "each plate is ordered from the mill two inches longer and wider than wanted for the boiler, so as to give a margin of one inch at each side, which is cut off by a sheering machine, and is made use of for testing the quality of the plate. This plan has the advantage of removing the rough ends of the plates, and, at the same time, avoiding the use of those portions which are always most likely to contain flaws, impurities or irregularities, for forming the rivet-seams of the boiler. The strips removed by the shears, which are justly considered to be inferior portions of the plate, are, as we have said, used for testing the quality. Each strip is bent by cold hammering, and is expected to stand doubling up until the ends nearly touch each other, without showing any cracks or fractures; and all plates which fail under this test are rejected. As a rule, the Bessemer steel plates stand more than this, allowing of being doubled up quite close without the slightest signs of fracture. * * * * With boiler plates, particularly with those of steel, the process of annealing is of the utmost importance.

"Mr. Adamson has found, by direct experiments, that a plate rolled very hot, and a 'black-rolled' plate, will expand at such different rates when heated as to strain the rivet-seams; and, when tested at the same temperature, the rates of elongation vary so much that two such plates, when joined, will never take the strain equally. The process of annealing is, therefore, carried on at the works, and is combined with that of bending the plates.

"After the process of bending, the plates are fitted together by means of a few temporary bolts which pass through holes previously punched through them. The diameter of these holes is much less than that of the rivet holes, in order that they may be drilled out to their proper size for riveting, after they have served their temporary purpose.

"The plates are next put under a drilling frame having six head stocks, with horizontal drills, all placed radially, and so arranged as to be adjustable to the diameter of each shell. The holes are drilled with great speed and accuracy, six at a time, and through both superposed plates at the same time.

"The plates, being drilled together, never change their relative position, and each rivet is thereby made an absolute mechanical fit. * * * * Riveting is effected by machinery, wherever the shape and position of the parts will allow the application of the machine. Mr. Adamson considers a machine-riveted seam superior to one made by hand, particularly when steel rivets are used; as, with hand-riveting, numerous blows with the hammer cause that degree of brittleness called 'hammer-hardening.' The machines used for riveting at Newton Moor are of Mr. Adamson's own design. They act by raising an adjustable weight through a series of compound levers, this weight actuating the riveting die by its sudden descent. This principle insures the exertion of an exact pressure upon each rivet, and this pressure, whilst it can be adjusted to each kind of work, cannot be altered by the workmen tampering in any way with the action of the machine."

By following this plan there is, first, a trial made of the quality of iron in every plate which is used. After the quality is ascertained, every sheet is annealed and bent into the required form, while softened by the heat, so that its strength may not be reduced by that operation. Drilling the rivet holes, in the manner described, not only leaves ten per cent more iron between them, but leaves the whole in much better condition. When the holes are punched they are always so irregular that for five-eighth rivets they are usually made three-fourths of an inch in diameter; and even with that allowance for error, the use of "that steel drift pin" is very frequently required.

To the improvement which will be effected in the strength and durability of boilers by adopting the modes of working described in the foregoing extract, the writer's experience enables him to bear unqualified testimony; and the importance of their introduction into American boiler shops cannot be too strongly urged, especially if the practice of working engines on board passenger boats with steam of twenty to fifty pounds' pressure per square inch is to be continued.

That boilers, made in the manner described above, would be more costly than such as may be made from plates picked up at random in the market, their quality subjected to no reliable test, and the workmanship bestowed upon their construction rude and imperfect, is unquestionably true; it is also true that they would not only be much safer while in use, but would probably be so much more durable as to be found, in the end, the cheapest.

The writer has only to remark, in conclusion, that age and its attendant infirmities compelled him, years ago, to retire from business; and that he has no interest, direct or indirect, in any work where steam engines or boilers are manufactured. He presents this paper for the single purpose of adding his mite to the general fund of information, which ought to be made sufficient to enable all interested in steam boilers, on shore or afloat, to form tolerably correct opinions respecting their fitness for the work to which they are applied.

Aniline Colors.

By Prof. C. F. Chandler.

Illustrated by specimens of the colors, and of articles dyed with them.

It is well understood that coal is an element of our national wealth, and that we derive from it our power. The combustion of 300 pounds of coal under a steam-boiler will produce a power equal to the mechanical force exerted by a man for a year. Another important application of bituminous coal is to the manufacture of illuminating gas. In this manufacture there are certain residual products, which were at first thrown away; and it is of these that I propose to speak to-night.

Coal tar is produced at the rate of about ten gallons to the ton of coal. Thousands upon thousands of barrels of coal tar were at first thrown away; but when the chemist turned his attention to this substance, he discovered so many products useful in the arts which could be made from it, that coal tar now finds a ready market at $1.50 per barrel. When coal tar is subjected to distillation, the liquid portion passes off, and there remains the heavy black pitch which is used for roofing and for pavements. The liquid portion, which comprises about one-fourth of the original coal tar, produces first a light fluid called naphtha, and then a heavy liquid which is called dead oil. The light liquid is a mixture of several hydro-carbons of which benzole is the type. Benzole consists of seventy-two parts of carbon to six parts of hydrogen, which is expressed in the new notation by $C_6 H_6$. Other substances found in naphtha are toluene $C_7 H_8$; xylene $C_8 H_{10}$; cumene $C_9 H_{12}$ and cymene $C_{10} H_{14}$; ordinary coal naptha also contains traces of olefines. Until recently, only the first two of the benzole series have had any practical importance in the arts. But lately another, xylene, is claimed to be a specific for the small-pox.

After the volatile portions have been removed, there remains this dead oil, which is heavier than water. This was for a long time used as a fuel in glass-houses. It was then found that the carbolic acid it contains was a most powerful disinfectant and antiseptic. It was found that it would prevent the spread of the cattle disease, that cattle having the disease in its worst form might be placed with others with safety, if they were protected by this acid. It was found, too, that the durability of timber was increased four or five fold by its application.

But I wish to-night to invite your special attention, to the beautiful colors which have recently been obtained from refuse coal tar. They are naturally subdivided into three groups, the aniline colors, those derived from naphthaline, and the carbolic acid colors. I shall confine my attention wholly to the chemical phase of the subject.

Benzole is a hydro-carbon. Bringing that in contact with nitric acid, an atom of oxygen carries off an atom of hydrogen, while hyponitric acid takes its place in the benzole; and we have nitro-benzole, which is a very fragrant oil, an artificial oil of bitter almonds, used instead of that substance in the manufacture of soaps. When the nitro-benzole is made to give up its oxygen and take up hydrogen, it becomes aniline.

Nitrogen is a protean element, which gives rise to a great variety of compounds. Ammonia, is $N H_3$, and these three atoms of hydrogen can be replaced by a great variety of substances. Aniline, or phenylamine, is a similar substance, composed of $C_6 H_9 N$. It is ammonia, replacing one atom of hydrogon by phenyl, which is $C_6 H_5$. There is no limit to the number of compounds that may be developed on this type; and it opens one of the most important fields of chemi-.

cal investigation at the present day. All the aniline colors are derived from $3\ N\ H_3 = N_3\ H_9$, converted by the process of substitution into new compounds. The first investigation in this direction, which, however, did not result in any practical product, was that of a German chemist, who found that, by treating aniline with chloride of lime, he produced a violet or purple tint. Perkin, who was the first successful manufacturer of color from coal tar, manufactured a substance to which he gave the name of mauve. It is a salt of mauveine, $C_{26}\ H_{24}\ N_4$. Then came the discovery of the rose aniline, which is produced from commercial aniline, a mixture of aniline and toluidine, pure aniline not answering the purpose. Subjecting commercial aniline to the action of nitric acid, and then to the action of nascent hydrogen, we obtain crude aniline oil, which, by treatment with chloride of mercury, chloride of tin, or a mixture of arsenic acid and hydrochloric acid yields rose aniline, which is $C_{20}\ H_{19}\ N_3$. The chloride, hydrochlorate, arsenitate, acetate, nitrate and other salts of this substance produced the beautiful tints, of which I have specimens here. Hoffmann found that he could change this beautiful red tint of the rose aniline to various shades of violet, by simply boiling it with more aniline. This introduced more phenyl in the place of hydrogen. One atom made it purple, another more bluish, and a third atom of phenyl made it the most beautiful blue that has ever been manufactured.

Replacing the hydrogen with ethyl, $C_2\ H_5$, or with methyl, CH_3, we obtain still further colors. In every case the beautiful rose red becomes more and more purple, until the substitution of the last atom of hydrogen converts it into a deep and perfect blue. On carrying the investigation further, it was found that by proper treatment the blue color could be converted into a green, by using the ethyl and methyl. Subsequent treatment developed an entirely different base, having the form $C_{20}\ H_{17}\ N_3$, with yellow tints; and further treatment produced a brown and finally a black; so that the most durable black for calico printing is now obtained from aniline.

From the coal tar obtained from a ton of coal, three-fourths of a pound of this beautiful color are produced. The coal, which is worth about \$6, produces the gas, the coke, the ammoniacal water, largely used for agricultural purposes, the carbolic acid, used for the preservation of timber and as a disinfectant, and finally this beautiful color, which alone is worth nearly as much as the coal originally cost. The amount of this industry has become so enormous that at present five tons of this raw aniline oil are manufactured daily, on the continent alone, and 90,000 lbs. of iodine are used in effecting the substitution; and yet it is an industry which has started since 1860.

A word with regard to the carbolic acid colors. The carbolic acid is obtained by treating the dead oil with an alkali. This furnishes a number of coloring matters. Carbolic acid is $C_6 H_6 O$; or it is the oxide of benzole, which is $C_6 H_6$. Treating carbolic acid with nitric acid, we produce picric acid, $C_6 H_3 (NO_2)_3O$. Picric acid is a substantive dye for silk and wool, uniting with them without any mordant. Treating picric acid with the cyanide of potassium, an acid is produced which gives beautiful garnet colors on silk and wool. By treating carbolic acid with soda and the oxide of mercury, it is converted into rosolic acid, which produces various shades of orange, and is used for coloring house paper. Treating this with ammonia, it produces a scarlet tint. The intimate connection existing between the rosolic acid and the aniline colors is shown by the fact that, by treating rose aniline with nitrous acid, the same result is obtained. From this orange red of rosolic acid can be produeed a deep blue color by the action of aniline.

There is a series of naphthaline colors, but they are not found to be fast, and I will therefore pass them by.

When coal oil is distilled, and twenty-five or thirty per cent of volatile products are removed, the last portion of the distillate is a solid crystalline hydro-carbon, called anthracene. Recently, from this, there has been artificially produced the coloring matter of madder. The colors from aniline had proved brilliant and durable for silk and wool, but not so well suited for cotton fabrics. It is now a question whether the colors from anthracene will supply this want; whether they will be found to be permanent. I have here specimens of calicos printed by these colors. As I am not practically familiar with the use of these colors, I ask leave to introduce to you my friend, Mr. Alfred Paraf, a distinguished chemist, who was a pupil of Schützenberger, of Paris, and who has made the chemistry of dyeing and calico-printing his specialty for many years.

Mr. Alfred Paraf addressed the Association as follows:

Mr. President and Gentlemen:

There is very little for me to say on the history of the production and manufacture of the aniline colors, after the beautiful manner in which it has been just presented to you by Prof. Chandler. At his request, however, I take great pleasure in explaining to you their practical application on textile fabrics; but as my time is limited, I shall confine myself to a few facts, which it has been my good fortune to discover.

One of the principal difficulties which existed in 1865, in applying the blue, purple and aniline red on calico by printing, was the want of a suitable compound which would render them insoluble in the cloth during the process of steaming, and cause them to resist the subsequent washing and soaping process. Albumen had been used with success, but was very expensive. Mr. Perkin, of London, had proposed the use of arsenite of soda in connection with the acetate of alumina, both of which were mixed with the aniline color before printing. This process met with very little success, owing to the alkaline reaction of the arsenite of soda which precipitated most of the acetate of alumina, thereby producing an insoluble color, which would naturally only fix itself partially on the cloth. The difficulty to overcome was to find a neutral arsenical salt, or a neutral solution of arsenious acid. You all know how slightly the latter is soluble even in boiling water. I had occasion to find that ordinary glycerine dissolved its own weight of arsenious acid; from this time the problem was solved. When one pound of white arsenic is added to a pound of glycerine, and heated to boiling for about fifteen minutes, the whole of the arsenic is dissolved, and the compound which is produced is an arsenical ether of glycerine.

The color for printing either a red, purple or aniline blue is prepared in the following manner: The crystallized color is dissolved in the above arsenical ether of glycerine and thickened with starch; the color is then allowed to cool, and a certain quantity of acetate of alumina is added. The color is then ready for printing, and is in an entirely soluble state; after printing, the cloths are steamed for thirty minutes, when the following reaction takes place: Under the influence of the steam, the arsenical ether of glycerine is decomposed, the acetic acid of the acetate of alumina is eliminated, and thereby the insoluble arsenite of alumina formed in the cloth, holding the coloring matter there in such an insoluble state that it will resist any amount of washing, and a great amount of soaping. For the exact proportions, I refer you to my United States patent, No. 63,084.

On the aniline green I have very little to say to you. About the middle of 1866, Prof. J. A. Wanklyn, of London, and myself, obtained a beautiful green by the action (under pressure) of iodide of isopropyl upon aniline red. All the aniline greens have been very successfully used for dyeing silk and wool, upon which fibers they fix themselves very readily. On cotton, however, up to the present time, the application has not met with success. The most useful color for cotton is undoubtedly the black. In 1864, I made my first attempts in this direction, having observed that a mixture of chloride of aniline (acid) and chlorate of potash, when heated in a porcelain dish, would (after a very powerful reaction had taken place) leave a brilliant black residuum. I was convinced that an aniline black could be produced by the sole action of a powerful oxidizing agent (like chloric acid) upon a salt of aniline. I then, for the first time, applied the old method of producing chloric acid in the laboratory to calico printing in the following manner. I prepared first the fluosilicate of aniline by heating together the aniline oil with hydrofluosilicic acid; the fluosilicate of aniline produced is a beautiful salt, very much like white naphthaline. This salt suitably thickened with starch, then mixed with a certain quantity of chlorate of potash, constituted my first aniline black color. In the cloth the black is produced in the following manner:

The fluosilicate of aniline combines with the potash of the chlorate of potash. The chloric acid thus freed oxidizes the aniline and produces the black. This process was not very practical, as it sometimes rendered the cloth tender. I mention it to you mainly for the novelty of the application of hydrofluosilicic acid to decompose the chlorate of potash in calico printing. In 1865 I obtained good results by using, for the first time in the confection of aniline, black chlorates more soluble than chlorate of potash, such as chlorate of soda, ammonia, etc. About that time, when I was personally presenting my results before the Industrial Society of Mulhouse, a *polèmique* took place, headed by such chemists as Rasenstiehl, Charles Lauth, Camille Kolchlin, all of them trying to prove that no aniline black could be produced without the use of a salt of copper or iron. My process was criticised in the scientific papers at the time. I never answered them, but, by the following discovery, proved, in the end of 1866, that they were wrong. I succeeded in obtaining beautiful aniline blacks on cotton, with an entire neutral color, composed solely of a neutral salt of aniline, a little chlorate of potash, and chromate of chromium (also called the binoxide of chrome). Under the heat of the aging process this chrome salt, insoluble when cold, decomposes into green oxide of chrome and chromic acid, which oxidizes the salt of aniline and produces the jet black.

For more particulars about this important color, I refer you to my United States patent, No. 60,546. This process is extensively used for all the aniline blacks at the Merrimack print works at Lowell, Mass., and Mr. H. Burrows, the skillful superintendent and chemist of these works, will testify any time that all the aniline blacks he produces now are produced by my process, and *without a trace of copper or iron.* Up to the summer of 1866 the aniline black, which is so useful, and to-day indispensable in calico printing, could not be produced on silk. The oxidizing agent, which is necessary to produce the black color (perfectly harmless to the vegetable fiber), would oxidize the animal fiber. The same color which would be a beautiful jet black on cotton would produce nothing but a dull buff on silk. I overcame this difficulty in the following manner:

It is a known fact, discovered by Schweitzer many years ago, that a solution of metallic copper in ammonia would, under the influence of the oxygen of the air, dissolve cotton as water dissolves sugar. Such a solution of cotton, which is perfectly clear, will, by the action of an acid, abandon again all the cotton it had dissolved in an insoluble form, although very finely divided state. I took a yard of white foulard silk, divided it into two parts; one part I left intact, the other part I padded in a solution of cotton. After squeezing the same between rollers, I immersed it in a weak solution of acetic acid, then washed the silk thoroughly in water; none of the brilliancy of the silk had gone, although every fiber was vegetableized with molecules of cotton. I printed the same aniline black color, on a piece of silk, untouched, and a piece of silk vegetableized as described. After aging, the result was a dull buff shade on the ordinary foulard silk, and a beautiful jet black on the vegetableized silk.

I must now, gentlemen, thank you for your kind attention.

On motion of Dr. Van der Weyde, the thanks of the Association were tendered to Prof. Chandler and Mr. Paraf for their interesting remarks.

Adjourned.

PROCEEDINGS
OF THE
PHOTOGRAPHICAL SECTION
OF THE
AMERICAN INSTITUTE.

October 3, 1871.

Vice-chairman H. G. Newton presiding; O. G. Mason, Esq., Secretary.

The committee on "The preparation and keeping of sensitized paper" reported progress.

Mr. H. T. Anthony stated that he had prepared paper, of good keeping quality, by floating twice on plain croton or soft water; then immersing, for a moment only, in a two-grain solution of oxalic acid, saturated with oxalate of silver, which was formed by adding a small quantity of nitrate of silver. The paper was fumed before printing, or printed with fumed pad or cushion in the printing frame. He also stated that H. O'Niel had found that silvered paper drawn through a saturated solution of alum, and thoroughly dried, would keep in good printing condition six days. The photographic prints exhibited were very fine in tone, the white portions appearing as pure as upon paper used immediately after silvering. A series of very fine photographic prints, made by J. Edward Smith, of Painesville, Ohio, were exhibited. The paper had been sensitized by Anthony's alum bath, containing only twenty grains of silver to the ounce, and the prints fixed after Newton's acetate of lead formula.

A member inquired whether the lead contained in such solution would not have an injurious effect upon the health of the operator using it? Mr. Newton replied that its chemical combination was such as to render it quite harmless when so used.

Two photographic prints, made by Mr. M. Carey Lea, of Philadelphia, in illustration of his collodio-bromide process, were received, through the hands of Mr. Anthony, for the collection belonging to the Section.

The Chairmam, in speaking of Mr. C. Wager Hull's recent article, published in the Philadelphia Photographer, upon "The Retarding Influence of Albumen when used as a Substratum in the Preparation of Dry Plates," remarked that Mr. D. Chapman had, at a meeting of this Society, held some years ago, called attention to the fact, the age of the albumen had great influence upon its action, in regard to sensitiveness, when so used. In his own recent experiments, he had used a sample of very old crystallized albumen, a solution of which he had applied, with a brush, in a line one-half inch wide, extending entirely around the edge through the entire length and breadth of the plate, and crossing at right angles in the center. A plate so treated, and upon which a negative had been made, was exhibited before the Section; it did not appear to have been in any way affected by the albumen so applied.

Mr. O. G. Mason said that, after reading Mr. Hull's article, he made a series of experiments with plain albumen, and also with albumen to which a trace of ammonia had been added. Mr. Hull's statement, that albumen, to which he always adds ammonia, increased the intensity in wet plates and retarded it in dry plates, having led him, Mr. M., to suppose that possibly a trace of the ammonia was liberated from the dried albumen and became incorporated with the collodion film during the exposure of the wet plates, which condition did not exist in the dry film. In the few experiments which he had made, the plain albumen seemed to be slightly preferable in point of sensitiveness.

Mr. H. J. Newton gave the following formula for developing plates prepared by Blair's Gum Tannin process: Water, one ounce; tannin, six grains; pyrogallic acid, six grains; ammonia, two drops; acetic acid, sufficient to clear the solution.

Mr. H. T. Anthony remarked that he had prepared very fine dry plates for transferring with Mr. Anthony's bromo-iodized collodion, to each of which one drop of iodide of iron had been added, sensitized in a bath rendered acid by acetic acid; after which the plates were well washed and flowed with a two-grain solution of phosphate of soda; then washed again and flowed with a two-grain solution of gallic acid. They were printed by contact, and developed with a one-grain solution of pyrogallic acid, a twenty-grain solution of citric acid, and a ten-grain silver solution and toned with gold. He stated that a very sensitive solution for solar camera printing could be prepared by precipitating the silver by means of caustic potash, and, after thorough washing, dissolving in a saturated solution of nitrate of ammonia, then saturate with oxide of silver, and reduce to the strength desired.

Adjourned.

November 7, 1871.

Mr. H. J. Newton in the chair; O. G. Mason, Esq., Secretary.

After the usual preliminary business, Mr. C. Wager Hull explained his recent experiments in the use of albumen as a substratum for wet and dry plates. He believed that the results obtained by him may have differed from those by Mr. Newton, from the fact of his having used a much heavier body of albumen.

Mr. H. J. Newton stated that the more complete the solution of albumen (in an alkaline condition), the more compact or harder it became, when dry, on the plate. He proposed albumen for this purpose made as follows: The white of one egg dissolved in ten ounces of water, afterward mixed with eight ounces of water, containing one ounce of alcohol, ten grains of iodide of ammonium, and five grains of bromide of potassium. The solution is improved by keeping it two or three weeks in a vessel tightly corked.

Mr. H. T. Anthony said he had been the first to use albumen as a substratum. At first he had experimented with a view of producing a sensitive film of albumen; but he found that the salted albumen dissolved, and mixed with the bath or sensitizing solution. He afterward found that by using collodion over the albumen, a very sensitive film was produced, and the action was much more uniform.

Mr. H. J. Newton stated that the fresh albumen of one egg mixed with six ounces of water, to which three or four drops of aqua ammonia had been added, made the best substratum for collodio-chloride plates. He believed that many photographers had discarded the collodio-chloride, when the real fault was in the albumen which they used.

Mr. J. B. Gardner preferred plain albumen, without the addition of ammonia. For the final cleaning of his plates, he used alcohol, acidulated by the addition of a small quantity of acetic acid. He flows the plate with albumen when perfectly dry, and thus avoids any liability to injure his silver solution from albumen on the back of the plate.

Mr. H. T. Anthony exhibited specimens of Mr. F. A. Wendroth's "argento pictures," and described the method by which they were produced. A positive carbon print is transferred to a metal surface brightly polished, in a peculiar manner, suited to the effect desired. The pictures had a very brilliant appearance, and were much admired.

Mr. H. J. Newton exhibited a negative of figures or hieroglyphics, on a piece of slate recently found in what appeared to have been a camping-place of the aborigines of Ohio. He also stated that he had made very sensitive dry plates by sensitizing and washing, as in the ordinary tanning process, and then flowing the plate with ten ounces of *hot* water, containing 200 grains of gum arabic, 100 grains of loaf or white sugar, and twenty grains of tannin. His stock developing solution contained six grains of tannin and six grains of pyrogallic acid to the ounce; this was used of full strength, or diluted with water to suit the subject under treatment.

Mr. H. T. Anthony stated that he had recently produced very fine positives on glass, by adding one grain of powdered asphaltum to each pound of collodion used. He had also produced with such collodion very fine negatives from life, which possessed great delicacy and had very brilliant effects.

Mr. C. Wager Hull exhibited a large collection of stereoscopic views made by Mr. George Barnard, a brother artist of Chicago, who was burned out during the great fire. The prints were very beautiful representations of the ruins of the burnt city.

Mr. O G. Mason exhibited several photographs of persons on whom the operation of skin-grafting had been performed at Bellevue Hospital.

Very fine specimens of engravings of photographic impressions by the "sand blast" process were exhibited, and elicited high praise for the delicate brilliancy and remarkable fidelity with which the finest detail of the photographic impression was rendered.

The Section then adjourned to the first Tuesday in December.

December 4, 1871.

Mr. H. J. NEWTON in the chair; O. G. MASON, Esq., Secretary.

Mr. H. T. Anthony, upon request of members not present at the October meeting, again gave his process for preparing and keeping sensitized albumen paper

A general discussion was then had upon the various methods of preparing and applying albumen substratum for collodion negatives.

Mr. H. J. Newton said, by using a substratum of albumen to which ammonia had been added, the film was much thinner than when plain albumen was used.

Mr. D. Chapman had found that the method of preparing and the time of applying the albumen substratum was very important. By some methods the plates were rendered much less sensitive. His method of preparation was to dissolve one ounce of albumen in twenty ounces of water, to which one dram of strong aqua ammonia had been added. After standing one month, filter, and it is in fit conditon for use. In time it will assume a tinge of red, and is then in the *very* best condition, and would render the superimposed collodion film one-fifth more sensitive than if used when first made.

Mr. H. J. Newton exhibited several very fine negatives by the gum tannin process, the details of which he had given at the November meeting of the Section. He had somewhat modified the developer, by adding to the stock solution one ounce of acetic acid No. 8 to 12. His sensitizing bath contained forty-five grains of nitrate of silver to the ounce of water, and was slightly alkaline by the addition of ammonia. The prints from the negatives exhibited by Mr. Newton were much admired for the delicate, harmonious effects produced.

A general discussion upon photographic literature followed Mr. H. T. Anthony's reading of an editorial in the December number of the Philadelphia Photographer.

In answer to inquiry, Mr. D. Chapman stated that plain collodion could be sensitized, and fully ready for use in one hour by the following method:

Use five grains iodide of cadmium and one and one-half grains bromide of ammonium. The bromide should be thoroughly ground, and dissolved in the alcohol used in making the plain collodion. The desired tint is then produced by addition of tincture of iodine; after filtering, and standing the length of time named, it is ready for use. By substituting the bromide of magnesium for that of ammonium, a very smoothly working collodion of great permanence was produced, though he had found it to be about one-tenth less sensitive than that containing ammonium.

Mr. H. T. Anthony stated that all collodions which were prepared by first adding the bromide salts were much more sensitive than those to which the iodides were first added; in which statement Mr. D. Chapman and Mr. H. J. Newton concurred.

The photographs of supposed hieroglyphics exhibited by Mr. Newton at the last meeting were then further discussed by Dr. Boynton and others; after which the Section adjourned.

January 2, 1872

Mr. HENRY T. ANTHONY in the chair; Mr. O. G. MASON, Secretary.

Most of the evening was taken up by a discussion upon the chemical composition and permanency of photographic impressions on albumen paper; in the course of which it was stated that sensitized paper, which had become discolored by keeping, could be restored to whiteness by merely passing it through pure water.

Mr. H. T. Anthony narrated the circumstances under which he was led to originate the process of fuming sensitized paper with ammonia. He had been experimenting with ammonia in fuming sensitized plates. While walking on Broadway the thought came to him that any acid condition of the sensitized paper must, in toning, produce an unnecessary reduction of gold, and that, consequently, there would be great economy in removing any such acidity, or, at least, in reducing it to a minimum. He immediately returned to his photographic room and tried the fuming of paper, in which he met with complete success.

Mr. O. G. Mason stated that, by a series of experiments which he had tried during the last year, he was led to believe that the chloride or iodide salts commonly used would remain permanently sensitive to light if rendered sufficiently acid to neutralize the effects of the atmospheric alkalies. He attributed the rapid deterioration of sensitized paper during the prevalence of warm, damp weather, to greater amount of alkaline vapor then present in the atmosphere. He had been able to keep sensitized albumen paper nearly two years without any apparent change, by merely rendering it slightly acid and excluding the continual contact of air by keeping it in a tin case. On such paper he had produced first-class prints after neutralizing the acid by ammonia fumes. He believed that a simple apparatus might be constructed for fuming tannin and other dry plates just previous to exposure in the camera; and that they might thus be rendered very nearly, if not quite, as sensitive as the ordinary wet plates.

Adjourned.

February 6, 1872.

Mr. H. J. Newton in the chair; O. G. Mason, Esq., Secretary.

Mr. J. B. Gardner stated that albumen prints, fixed in a fresh solution containing one ounce of hyposulphite of soda to six ounces of water, would remain much whiter than those fixed in a weaker solution. He believed that prints should be fixed in five or eight minutes, and the same solution should be used only once.

Mr. H. J. Newton spoke of a collection of prints which he exhibited before the Society several years ago. They were made on albumen paper, sensitized on five, ten and fifteen-grain silver solutions, and were fixed in the ordinary way. He had examined those prints to-day, and found that they remained as pure in tone as when new. He was not able to detect any change.

For sensitizing collodion, Mr. J. B. Gardner used sixty grains of bromide of cadmium in twenty ounces of water, forty grains of iodide of ammonium and forty grains of bromide of ammonium, dissolved in one and one-half to two ounces of water. When the aqueous solutions were added first to the collodion there was a tendency to cloud, but when added last there was no such tendency.

Mr. H. J. Newton exhibited a beautiful collection of negatives, glass positives and photographic prints on paper, made by the collodio-chloride process.

The collodio-chloride had been prepared as follows: Twelve grains of chloride of cadmium and twenty grains of citric acid were finely ground and dissolved in two ounces of alcohol, then poured into an eight-ounce vial, and forty-eight grains of prepared cotton added; then four ounces of concentrated sulphuric ether were poured on, and shaking the vial frequently during the pouring. The solution should thereupon appear perfectly clear. In a clean mortar, grind—in the smallest quantity of water that will dissolve it—forty-eight grains of nitrate of silver, and add two ounces of alcohol; then mix the latter with the previously prepared solution contained in the eight-ounce vial, a little at a time, and in the meanwhile shaking the vial. Mr. Newton albumenizes his glass with a solution of one part of albumen and six parts of water, adding to each seven ounces of this solution one-half dram of aqua ammonia. In the preparation of these plates it is necessary to dry them immediately. After sensitizing, they should be raised to a comparatively high temperature, and may be exposed to any diffused light which would not be objectionable in the sensitizing of albumenized paper. Mr. Newton warms his negative before placing it in contact with his sensitized glass. From fifteen to thirty minutes' exposure to strong light is required to produce a good print, during which time the effect may be examined with as great facility as is done in albumen printing. The prints are toned in an old toning and fixing bath of hyposulphite and gold, prepared as follows:

Two ounces of hyposulphite of soda and four grains of chloride of gold are dissolved in sixteen ounces of water; then to this add thirty-two grains of nitrate of silver dissolved in a small quantity of water. Before toning, the prints may be strengthened by the ordinary method of strengthening negatives, with pyrogallic acid and silver. It is requisite that the plates be varnished before being placed in contact with the sensitized film, otherwise the image will be destroyed by some obscure chemical action, which seems to be engendered by exposing the films to light.

In a discussion which followed, gum tannin plates were spoken of as being very sensitive.

Mr. Newton asserted that he had found them as sensitive as ordinary wet plates.

Adjourned.

March 5, 1872.

Mr. Henry J. Newton in the chair; Oscar G. Mason, Esq., Secretary.

The principal business transacted at this meeting related to the appointment of officers and to provisions for a more full report of the interesting debates which have usually taken place at every meeting of the Section. The committee having charge of the organization of this Section were recommended to make the following appointments: Henry J. Newton, president; William Kurtz, first vice-president; Daniel C. Chapman, second vice-president; Oscar G. Mason, secretary.

A resolution was unanimously adopted requesting the Institute to employ a short-hand writer to report, in full, the proceedings of the Photographical Section.

A resolution was also adopted cordially inviting the members of the German Photographic Society to attend all meetings of this Section.

Mr. H. J. Newton made some interesting remarks on the use of the salts of lead for the removal of hyposulphite of soda in silver prints, after being taken from the fixing solution.

Adjourned.

April 2, 1872.

Mr. Henry J. Newton in the chair; O. G. Mason, Esq., Secretary.

Mr. H. T. Anthony exhibited several graphotype prints, and gave a detailed description of the process by which they were produced. He also exhibited a collection of stereoscopic views made by Mr. W. H. Jackson, of Washington, D. C., while acting as official photographer to the recent government expedition for the exploration of the Yellow Stone region. He also exhibited J. W. Moses' device, consisting of a spring and strips of bibulous paper attached to the plate-shield, for absorbing the silver solution which drains from the plate during exposure in the camera.

Mr. John Stock exhibited his recently patented apparatus for working wet plates in the field, without a tent or a chemical room. The device consists of a plate-shield with front and back slides, a sensitizing box and developing box, so constructed as to admit of the operator's watching the action of the several solutions used.

Mr. Dolan explained the method of using the apparatus, and exhibited photographic prints from negatives made in it by Mr. Montgomery, at Brady's gallery on Broadway.

Mr. Stock also exhibited a camera box so constructed as to be packed in a very small space and yet be very firm, and well adapted to the requirements of field or tourist photographer. Then followed a general discussion on wet-plate apparatus. Hudson's, Edwards' and various English inventions for wet-plate work in the field, were commented upon at some length.

Messrs. C. W. Hull and O. G. Mason described their experience in the use of green glass for the windows of tents and chemical rooms for photographic purposes. Mr. H. T. Anthony and Mr. C. W. Hull were appointed a committee to make a series of experiments, with a view of determining upon the best tints of glass for use in windows of photographic chemical rooms.

Mr. H. J. Newton exhibited duplicate negatives, printed upon dry plates from collodio-chloride positives, in the preparation of which he had used a trace of bromide salt. He spoke of the experiments in this country and abroad for imparting to light a peculiar tint, or rather passing it through various colored media, thereby rendering it better adapted to photographic purposes. He had produced a fine printing quality of light, by flowing upon the back of the plate a solution of gum sandarach in plain collodion. He advised the use of five, ten or fifteen grains of the gum in each ounce of collodion, as may be required by the various negatives under treatment. The greater the quantity of gum used the more dense become film of coating when dry. It did not become transparent like ordinary gum varnish. The preparation was also very good for backing glass positives, serving as a substitute for ground glass. He also exhibited prints made upon albumenized paper, which had been sensitized on January twentieth last, and afterwards drawn through water saturated with alum. The prints were made on the morning of April 2d, and gave no signs of deterioration in the printing quality of the paper.

Mr. O. G. Mason exhibited photographs of skin-grafts, made at Bellevue Hospital, and made remarks on the treatment of disease by this process and the utility of photography in illustrating the history of results obtained.

Mr. H. D. Anthony called attention to the success of Mr. M. Carey Lea, of Philadelphia, in producing very sensitive collodio-bromide plates, and stated that Col. Stuart Wortley had, by the use of nitrate of uranium in collodio-bromide, produced plates more sensitive than those by the ordinary wet process. The plates were washed with water when about to be used, and exposed wet in the camera. They were developed with an alkaline developer, and strengthened with the ordinary redeveloper of pyrogallic acid and silver.

The Section then adjourned to the first Tuesday in May.

INDEX.

A.

B.

C.

V.

W.

X.

Y.

ERRATA.

Page 134, line 15, for " Kirchkoff" read " Kirchhoff."
Page 140, line 5, for " feculæ" read " faculæ."
Page 148, line 6th from bottom, for " spool-point" read " spear-point."
Page 153, last line, before " magnetic" read " south."
Page 154, first line, omit the word " south."
Page 159, line 21, for " sieved" read " sifted."
Page 162, line 2 from bottom, before " latitude" read " magnetic."
Page 165, line 8, for " town" read " now."
Page 165, line 14, for " Bennen" read " Benin."
Page 165, line 18, for " treads" read " trends."
Page 166, line 10, for " will prove" read " rise from."
Page 166, line 11, for " to" read " toward."
Page 172, line 19, for " ground" read " grand."
Page 172, line 21, for " are without all" read " follow no."
Page 172, line 24, for " times" read " time."
Page 172, line 30, for " spring" read " swing."
Page 172, line 33, before " arc" read " diurnal."
Page 172, line 33, for " in the visible path of" read " by."
Page 175, line 25, for " and" read " for."
Page 178, line 10, for " amount " read " intensity."
Page 178, line 8 from bottom, for " solved" read " evolved."
Page 178, line 2 from bottom, for " cores" read " cones."
Page 179, line 13, for " wing" read " ring."
Page 180, line 8, for " wing" read " ring."
Page 180, line 30, for " 1-20" read " 1-10."
Page 182, line 9 from bottom, for " put" read " pit."
Page 183, line 6, for " distance" read " squares of the distances."
Page 183, line 7, " for the distance" read " to the squares of the distances."
Page 183, in note, for " conlombe" read " Coulombe."
Page 184, line 10, for " issue from the same end of the coil" read " flow in the same direction through the galvanometer."
Page 184, line 25, for " magnetic-electric" read " magneto-electric."
Page 184, line 26, for " south" read " earth;" omit " to."
Page 184, line 30, for " from electricity and" read " of electricity."
Page 200, line 15, for " ashes" read " oxides."
Page 200, line 16, omit " ashes of."
Page 200, last line, for " producing" read " emitting."
Page 201, line 25, for " oxygen" read " unburned gas."
Page 656, line 12, for " 22.05" read " 2.205."

Page 656, line 15, for "77.25" read "7.725."

Page 658, line 7, for "cersomo" read cercomo;" for "paramerium" read "paramecium;" for "stylonyshia" read "stylonychia."

Page 658, line 14, for last word read "cerevisiæ."

Page 658, line 18, for "miero" read "micro;" for "mona" read "meso."

Page 676, line 17, for "Paleo" read "Paley."

Page 681, line 6, for "Architection" read "Architecture."

Page 681, line 7 from bottom, for "Brenneia" read "Brenerei;" for "Standpueskte" read "Standpunkte."

Page 682, line 17, for "Erpahrungen" read "Erfahrungen."

Page 682, line 18, for "Amvendung" read "Anwendung."

Page 682, line 25, omit the word "in."

Page 682, bottom, for "Ziegelöfer" read "Ziegelöfen."

Page 683, line 6, for "Wasserbankhurst" read "Wasserbaukunst."

Page 684, line 10, for "Harniepell" read "Harnikell."

Page 813, line 2 from bottom, for second "$\frac{135}{1080}$" read "$\frac{120}{1080}$."