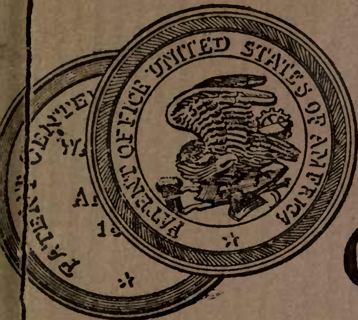

PATENT CENTENNIAL CELEBRATION

1891

Proceedings and Addresses

[Patent centennial]

CELEBRATION, 1891.

OF THE

· · BEGINNING · ·
· · · OF THE · · ·
SECOND CENTURY

OF THE

American Patent System

AT

WASHINGTON CITY, D. C.

APRIL 8, 9, 10, 1891.

PUBLISHED BY THE EXECUTIVE COMMITTEE.

WASHINGTON, D. C.:
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Proceedings of the Congress

HISTORY OF THE MOVEMENT.

The celebration of the beginning of the Second Century of the American Patent System was the outgrowth of a spontaneous desire to recognize publicly the benefits which that system has conferred upon our Nation and upon the world.

This movement took practical shape when, at the last of several meetings, duly advertised in the papers, held at the Arlington Hotel, November 11, 1890, of which Mr. Robt. W. Fenwick was Chairman and Mr. James T. Dubois was Secretary, the Chairman was "empowered to appoint a committee of seven to make arrangements for the celebration," having in view the successful accomplishment of two purposes, to wit:

1st. The celebration in an appropriate manner of the beginning of the Second Century of the American Patent System by the reading of scientific and historical papers by eminent citizens of the United States, and other exercises.

2d. The formation of a National Association of Inventors and Manufacturers of Patented Articles.

The following gentlemen were then chosen members of the Central Committee:

JOHN W. BABSON, Chief of Issue and *Gazette* Div., U. S. Pat. Office.
BRAINARD H. WARNER, President, Columbia National Bank.
PROF. OTIS T. MASON, Curator, U. S. National Museum.
MYRON M. PARKER, President, Washington Board of Trade.
HON. JOHN LYNCH, President, Potomac Terra Cotta Co.
MARVIN C. STONE, Manufacturer of Novelties.
J. ELFRETH WATKINS, Curator, U. S. National Museum.

To which were added the Chairman (Robt. W. Fenwick), and Secretary (James T. Dubois), of the public meetings.

Extracts from the newspapers relating to the movement will be found in the Appendix.

At the first meeting of the Central Committee, held December 1st, 1891, John W. Babson was chosen Chairman, and J. Elfreth Watkins, Secretary.

It having been decided to issue an address to the public which should embody the objects and aims of the Celebration, the following, "Circular No. 1," was prepared and given to the press for publication. Several thousand copies were subsequently printed and distributed throughout the country.

TO THE INVENTORS OF AMERICA AND THE MANUFACTURERS OF INVENTIONS.

The completion of the First Century of the American Patent System marks so important an epoch in the history of the Nation that it is eminently proper that the beginning of the second shall not pass unnoticed.

The centennial anniversaries of other important national events have been celebrated in a manner worthy of a people proud of their country and its growth. Surely the system that has aided the agriculturist in the field, the mechanic in the shop, and the toiler in the mine; that has stimulated invention and helped every branch of modern industry, has played no small part in a history so full of the triumphs of human achievement.

Believing that the American inventor and manufacturer of inventions will regard it a privilege as well as a duty to coöperate in making due recognition of these facts, it is proposed to hold a celebration at the National Capital in April, 1891, which shall in a fitting manner commemorate the important event and place on record the Nation's appreciation of the labors of those whose ingenuity, patience and tireless effort have exercised such a potent influence in accelerating the prosperous growth of the Nation, and in aiding the progress of our civilization.

The necessity for a National Association of Inventors organized for mutual benefit has been frequently discussed in the technical and other journals. No time could be more opportune for the formation of such an association than when men from every part of the country meet to celebrate so important an anniversary. Surely the occasion is most inspiring.

All inventors and manufacturers and others interested are requested to coöperate with this Committee in the purpose above set forth. Correspondence appertaining thereto should be addressed to

J. Elfreth Watkins, Secretary,
U. S. National Museum, Washington, D. C.

This circular elicited many favorable comments from the public press, and inventors and manufacturers of patented articles expressed by letter their desire to coöperate in the movement.

On the 16th of February the following circular was mailed to such persons who it was thought would be interested in the formation of a National Association of Inventors and Manufacturers:

Office of the Executive Committee
for the
CELEBRATION OF THE BEGINNING OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM BY INVENTORS AND MANUFACTURERS OF PATENTED INVENTIONS.

EXECUTIVE COMMITTEE:
Hon. John Lynch,
Chairman.
J. Elfreth Watkins,
Secretary.
J. W. Babson,
Geo. C. Maynard,
Marvin C. Stone.

811 G Street N. W.,
Washington, D. C.

February 16th, 1891.

Dear Sir: Your attention is invited to the accompanying circulars relating to the Patent Celebration to be held in Washington on the 8th, 9th and 10th of April next, which it is hoped you will attend.

It is proposed on that occasion to organize a permanent National Association of Inventors and Manufacturers of Patented Articles for the purpose of securing coöperation in all proper matters tending to the improvement of the American Patent System.

At this time, when social and economic questions of the gravest importance fill the public mind, the influence of judicious organized effort can be beneficially exerted to remedy existing defects and to provide against danger in the future.

You are earnestly requested to unite in the formation of this Association, and to contribute your personal assistance and coöperation to that end.

The annual report of the Commissioner of Patents to Congress, bearing date January 1st, 1891, again calls attention to the well-known need for more office room, lack of sufficient examining force and inadequate pay of every Patent Office official. The Commissioner remarks that "the pace kept up in the Patent Office now, as in all recent years, is inconsistent with that high degree of care which the patent system calls for," and that "a patent should evidence such painstaking care in examination that upon its face it should warrant a preliminary injunction, and there can be little doubt that the continuance of the 'American' examination system depends upon so conducting examinations into the novelty of alleged inventions as to make the seal of the Patent Office create a powerful, if not a conclusive, presumption that the patent is valid."

The Commissioner further reports that during the past year the Patent Office has earned a surplus over every expense of the Office of $241,074.92, and that the total balance now in the Treasury of the United States is $3,872,745.24, and adds that the statement that the inventors of the country cannot understand why the government takes their money and then fails to provide necessary facilities. The prime reason of this state of affairs is that the inventors of the country have never brought concerted effort to bear upon their representatives in Congress to the end that proper laws should be enacted, nor have they properly supported the government officials in their attempts to secure adequate office space and means to facilitate the carrying out of present regulations.

Many of the most prominent Inventors and Manufacturers in the country have expressed decided opinions to the effect that concerted effort at this time, on the part of those most interested, may be the means of effecting such improvements in the patent system as shall secure to every owner and user of a patented invention the just and speedy enforcement of his rights.

The Executive Committee of the Patent Celebration, desiring to coöperate with persons interested in the organization of the proposed Association, have provided a suitable place for its deliberations, and will arrange the program to accommodate those who desire to take part both in the Celebration exercises and in the business meetings of the Association.

An expression of your views upon the subject is requested. If you find yourself unable to attend the meetings, you are invited to bring such matters as you desire before the Association by letter. Correspondence may be addressed to

J. E. WATKINS,
Secretary.

N. B.—If you desire to address the Association upon any subject, please furnish the committee with an abstract of address, and state length of time to be consumed in delivery, in order that the preliminary organization may have information to govern them in arranging the program for meetings.

THE PRESIDENT ACCEPTS THE INVITATION TO PRESIDE.

The following letter addressed to the President of the United States, inviting him to preside at the first meeting of the Congress on April 8th, elicited a favorable reply :

WASHINGTON, *January 24, 1891.*

The President: On the eighth, ninth, and tenth of April next there will take place in this city a National Celebration of the Beginning of the Second Century of the American Patent System. This is being organized by the Inventors and Manufacturers of the whole country, and it is expected that thousands of representative men of these classes, from every part of the United States, will attend the meetings.

A number of prominent men have promised to deliver addresses upon this occasion, and the topics to be discussed, as you will see by the enclosed provisional list, relate to the history of the Patent System, its effect upon the progress of invention and its relations to industrial and social progress in every direction.

It is deemed eminently fitting that the President of the United States should be asked to be present at the opening of this Celebration, which is a tribute from the citizens of the United States to the long-continued efficiency of one of the branches of the general government. As Chairman of the

Executive Committee, in behalf of all interested in the success of the movement, I have the honor to invite you to take the chair at the first meeting, on the afternoon of Tuesday, the eighth of April.

Respectfully,

JOHN LYNCH,
Chairman of Executive Committee.

Invitations were also extended through the Executive Committee to the officials of the various foreign patent bureaus to attend the celebration.

The following is the form of invitation :

CELEBRATION OF THE BEGINNING OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM AT WASHINGTON, U. S. A., April 8, 9, 10, 1891.

SIR : I have the honor to inform you that arrangements have been made to celebrate, in an appropriate manner, the beginning of the second century of the American Patent System, in the city of Washington on the 8th, 9th and 10th of April next.

This celebration is being organized by American Inventors and Manufacturers, and it is expected that thousands of representative men of these classes from every part of the United States will attend the meetings.

Prominent statesmen, jurists, engineers and political economists will deliver addresses upon topics relating to the history of our patent system, its effects upon the progress of invention, and its relations to industrial and social progress in every direction.

You are requested to unite with these citizens of the United States in this celebration, which is their tribute to the long continued efficiency of one of the branches of the general Government.

In behalf of all interested in the success of the movement, I have the honor to invite you and such citizens as you may desire to accompany you to take part in this celebration.

Very respectfully yours,

(Signed) JOHN LYNCH,
Chairman of the Executive Committee.

(Signed) J. E. WATKINS,
Secretary of the Executive Committee.

A number of the replies to the invitations are published below.

The following is the form of the invitation that was sent to inventors and others whose presence at the Celebration seemed desirable.

CELEBRATION OF THE BEGINNING OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM BY INVENTORS AND MANUFACTURERS OF PATENTED INVENTIONS, IN THE CITY OF WASHINGTON, April 8, 9, 10, 1891.

DEAR SIR: You are cordially invited to become a member of the Congress of Inventors and Manufacturers of Inventions, to be held in the City of Washington, April 8, 9, 10, 1891, to celebrate the beginning of the Second Century of the American Patent System, which marks so important an epoch in the history of the Nation.

The centennial anniversaries of other important National events have been celebrated in a manner worthy of a people proud of their country and its growth.

Not less worthy of commendation is the system which has aided the agriculturist in the field, the mechanic in the shop, and the toiler in the mine; and has stimulated invention in every department of modern industry.

In the belief that American Inventors and Manufacturers will regard it a privilege as well as a duty to coöperate in the movement, definite steps have been taken to hold this celebration, which shall in a fitting manner commemorate the important event and place on record the Nation's appreciation of the labors of those whose ingenuity, patience and tireless effort have exercised such a potent influence in accelerating the prosperous growth of the Nation, and in aiding the progress of our civilization.

It is expected that one of the outgrowths of this Congress will be a National Association of Inventors and Manufacturers of Inventions, the necessity for which Association has frequently been discussed. No time could be more opportune for the organization of such a society.

It is earnestly hoped that you will take part in this celebration.

If you desire to accept this invitation, you are requested to sign your name to the enclosed blank, and to forward it, accompanied by a fee of five dollars, to Col. A. T. Britton, President American Security and Trust Co., and Treasurer Patent Celebration Fund, 1419 G street N. W.

This action will constitute you a member of the Patent Centennial Congress and will entitle you to attend the public meetings (admission to which will be by ticket), as well as the proposed excursion to Mount Vernon on the anniversary of the signing of the first American Patent Law by Washington.

Each member will receive all the publications of the Congress, which are expected to consist of two or more handsomely printed volumes which shall contain the addresses delivered at the celebration by the eminent statesmen and political economists whose names appear upon the programme, together with a series of biographies of the great American inventors. These volumes will contain the most valuable contributions to the history of invention and the American Patent System ever published.

In behalf of the Executive Committee.

J. E. WATKINS,
Secretary.

To..

....

....

Regulations governing the preliminary arrangements for the Celebration were adopted by the Central Committee and published early in February, substantially as follows:

ORGANIZATION, LIST OF COMMITTEES, DUTIES, ETC.

THE ADVISORY COMMITTEE.

A first act was to secure the earnest coöperation of men prominent in official positions, high in literary and scientific attainments, and actively interested in the welfare and growth of our country, to give support to this undertaking. The letters placed on file from the gentlemen named below, selected as an Advisory Committee, were of the most inspiring character and express the warmest sympathy with the movement:

HON. H. M. TELLER, Chairman, Committee on Patents, U. S. Senate.

HON. O. H. PLATT and HON. GEORGE GRAY, Members of Committee on Patents, U. S. Senate.

HON. BENJAMIN BUTTERWORTH, Chairman, Committee on Patents, House of Representatives.

HON. H. E. PAINE, Ex-Commissioner of Patents.

HON. ELLIS SPEAR, Ex-Commissioner of Patents.

HON. E. M. MARBLE, Ex-Commissioner of Patents.

HON. M. V. MONTGOMERY, Ex-Commissioner of Patents.

COL. F. A. SEELY, Principal Examiner, U. S. Patent Office.

J. B. MARVIN, Chief of Draughtsman's Division, U. S. Patent Office.

PROF. A. GRAHAM BELL.

PROF. S. P. LANGLEY, Secretary, Smithsonian Institution.

DR. G. BROWN GOODE, Assistant Secretary in Charge, U. S. National Museum.

MAJOR JOHN W. POWELL, Director, U. S. Geological Survey.

PROF. T. C. MENDENHALL, Superintendent, U. S. Coast and Geodetic Survey.

HON. A. R. SPOFFORD, Librarian of Congress.

HON. EDWARD WILLITS, Assistant Secretary of Agrculture.

COL. A. T. BRITTON, President, American Security and Trust Co.

DR. J. C. WELLING, President, Columbian University.

REV. J. HAVENS RICHARDS, President, Georgetown University.

T. E. WAGGAMAN, Trustee, Catholic University of America.

REV. J. E. RANKIN, President, Howard University.

REV. BYRON SUNDERLAND.

HON. THOMAS WILSON, Smithsonian Institution.

HON. JAMES BUCHANAN and HON. GEORGE D. TILLMAN, Members of Committee on Patents, House of Representatives.

HON. CHARLES ELIOT MITCHELL, Commissioner of Patents.

HON. ROBERT J. FISHER, Assistant Commissioner of Patents.

COL. MARSHALL McDONALD, Commissioner of Fish and Fisheries.

HON. CARROLL D. WRIGHT, Commissioner of Labor.

GEN. A. W. GREELY, Chief Signal Officer, U. S. A.

GEN. M. C. MEIGS, U. S. A.*

COMMODORE WM. M. FOLGER, U. S. A.

SURGEON JOHN S. BILLINGS, Army Medical Museum.

CAPTAIN R. W. MEADE, U. S. N.

GENERAL W. S. ROSECRANS, Register, U. S. Treasury.

DR. F. O. ST. CLAIR, Chief of Consular Bureau, Department of State.

HON. J. W. DOUGLASS, Commissioner, District of Columbia.

HON. J. W. ROSS, Commissioner, District of Columbia.

COL. H. M. ROBERT, Commissioner, District of Columbia.

HON. M. G. EMERY, President, Second National Bank.

J. M. TONER, M. D.

GEORGE C. MAYNARD.

HON. SIMON WOLF.

A. L. BARBER, President, Barber Asphalt Co.

CROSBY S. NOYES, Editor, *Evening Star.*

HON. BERIAH WILKINS, Daily *Post.*

GEN. H. V. BOYNTON.

CHAS. A. ELLIOT.

A. D. ANDERSON, Secretary, Board of Trade.

COL. WM. M. MEREDITH, Chief, Bureau Engraving and Printing.

THE EXECUTIVE COMMITTEE.

By resolution of the Central Committee the Executive Committee is charged "with the duty of arranging the program for the celebration"; and all other committees are directed to "report to and receive their instructions from the Executive Committee"; "no indebtedness shall be incurred, except by the authority of the Executive Committee, and no expenditures shall be made from the funds collected for the purposes of the celebration except upon vouchers approved by said committee."

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* Gen. M. C. Meigs was elected chairman of this committee at its first meeting, and served in that capacity at each subsequent meeting.

The chairman of each sub-committee will be ex-officio a member of the Executive Committee when matters pertaining exclusively to his committee are under consideration.

The Executive Committee will determine the time and place or places for holding the public meetings, and the character of the literary exercises and entertainments afforded the members of the convention; and also have the general oversight and arrangement of all affairs pertaining to the celebration.

It will prepare and issue to the public and distribute to individuals, in the best possible way, such circulars, letters and invitations as will secure a full attendance of those persons whose coöperation is desired.

It will cause to be printed and bound the volumes of the papers read at the literary sessions of the Congress, together with such portions of the proceedings of the business sessions as may be determined upon, and will forward to each member of the convention, who has paid a membership fee of five dollars, one copy thereof.

It will provide tickets of admission to the literary and business sessions of the convention, and to all entertainments and receptions, and determine the regulations under which they shall be distributed.

All sub-committees will report to the Executive Committee at least once a week (on Tuesday evening), and oftener if necessary, at the rooms at No. 811 G street, which will be open daily from 9 A. M. to 5 P. M. until the close of the convention.

Sub-committees can hold their meetings in these rooms by giving notice to the Secretary.

HON. JOHN LYNCH, Chairman.

J. ELFRETH WATKINS, Secretary. MARVIN C. STONE.

JOHN W. BABSON. GEORGE C. MAYNARD.

The Committee on Literature.

The Committee on Literature will designate what subjects shall be discussed at the public exercises and will provide the persons to deliver the addresses; and will receive, examine and prepare for publication, or other proper disposition, such additional addresses or papers as may be offered.

Dr. G. BROWN GOODE, Chairman.
Hon. AINSWORTH R. SPOFFORD. LLEWELLYN DEANE.

The Finance Committee.

The Finance Committee will be charged with the duty of obtaining the necessary funds for the expenses of the celebration, giving suitable acknowledgment to all persons contributing. All funds when collected will be paid over to Col. A. T. Britton, Treasurer.

The character and value of the papers to be read before the Congress by the eminent gentlemen who have volunteered to prepare them being such that their preservation is desired, it has been determined to publish them in book form, together with such portions of the proceedings of the Association as may be determined upon. These will make one or more volumes of 400 pages. Each subscriber will be entitled to a copy, together with a ticket of admission to all public meetings of the Congress, and to all excursions, entertainments and receptions, upon the payment of a fee of five dollars.

From these fees it is expected that a large revenue will be derived, and that the first receipts will be available sufficiently early to so far provide for current expenses that twenty per cent. only of the subscriptions will be called for before March 31st.

Subsequent calls will be determined by the receipts of fees. No more calls will be made than are necessary to meet exigencies. Whatever funds accumulating from membership fees remain on hand after the expenses of the convention are paid will be returned to the subscribers to the guarantee fund, and *pro rata* to the amount paid in.

JOSEPH K. McCAMMON, Chairman, 1420 F street.

HON. W. W. DUDLEY, Pacific Building.
REGINALD FENDALL, 344 D street.
H. V. PARSELL, 458 Pennsylvania avenue.
JAMES T. DUBOIS, 715 Eleventh street.
GEO. C. MAYNARD, 1409 New York avenue.
JOHN C. POOR, 411 Tenth street.
CHAS. E. FOSTER, 931 F street.
JAMES H. GRIDLEY, Pacific Building.
HON. WM. McMICHAEL, Mills Building, N. Y.
CHARLES C. LISTER, Drexel Building, Phila.
HON. J. W. WHELPLEY, 300 East Capitol street.
WHARTON McKNIGHT, 44 Penn. avenue, Pittsburg, Pa.
M. I. WELLER, 326 Pennsylvania avenue, S. E.
MUNN & CO., New York, N. Y.
CAPT. GEO. E. LEMON, 615 Fifteenth street N. W.

COMMITTEE ON PUBLIC COMFORT.

This committee will negotiate for quarters, either at hotels or private houses, for persons desiring them, and will invite and obtain the names, addresses and rates of such householders as will furnish accommodations for visitors. They will keep a list of obtainable accommodations at headquarters, 811 G street northwest, from which information can be given to those who apply in person or by letter, and will take such other steps as will, in their opinion, insure the comfort of the guests.

W. C. DODGE, Chairman.

W. G. HENDERSON,	F. E. TASKER,
J. H. WHITAKER,	HENRY CALVER,
W. H. FINCKEL,	NELSON J. DITTO,
E. T. FENWICK,	A. M. SMITH,
L. W. SINSABAUGH,	R. S. LACEY,
T. J. JOHNSON,	JAMES A. ASHLEY,
BENJAMIN POOLE,	HENRY H. BLISS,
J. L. EWIN,	JAMES F. DUHAMEL,
A. H. EVANS,	G. H. HOWARD,
C. J. GOOCH,	M. E. GREGG.

The Reception Committee.

Upon the Reception Committee will devolve the duty of receiving and extending proper courtesies to distinguished guests during their stay, and the providing of sub-committees to be in attendance at receptions and entertainments, and, as may be necessary, at the sessions of the Convention.

WM. CRANCH McINTIRE, Chairman.
DEWITT C. LAWRENCE, Vice-Chairman.

A. A. WILSON,
MARCELLUS BAILEY,
M. W. GALT,
L. P. WRIGHT,
HON. THOMAS WILSON,
JAMES P. WILLETT,
DR. WM. B. FRENCH,
O. C. GREEN,
DR. G. W. HARRIS,
ROBERT BOYD,
JOHN KEYWORTH,
L. J. DAVIS,
J. J. HALSTED,
R. G. DU BOIS,
M. W. BEVERIDGE,
JNO. A. BAKER,
GEORGE E. LEMON,
R. G. DYRENFORTH,
G. T. HOWARD,
H. SEMKEN,
GEO. W. COCHRAN,
W. H. COLLINS,
W. B. COOLEY,
HENRY SHERWOOD,
FRANK R. WILLIAMS,
H. S. EVERETT,
H. L. CRANFORD,
T. M. GALE,
T. H. ALEXANDER,
CLEM. W. HOWARD,
H. O. TOWLES,
DR. D. S. LAMB,
GEO. B. WILLIAMS,
J. J. HARROVER,
H. A. SEYMOUR,
JNO. F. WAGGAMAN,
PHILIP T. DODGE,
WM. F. MATTINGLY,
JAMES F. BARBOUR,
FRANK HUME,
CHARLES EARLY,
GEO. M. LOCKWOOD,
JNO. PAUL JONES,
R. H. VOORHEES,
E. E. ELLIS,
EUGENE PETERS,
OCTAVIUS KNIGHT,
R. D. S. TYLER,
C. A. SNOW,
LLOYD B. WIGHT,
W. T. FITZGERALD,
W. D. CABELL,
E. G. DAVIS,
B. LEWIS BLACKFORD,
GEO. W. CASILEAR,
EDWIN LAMASURE,
D. P. LIEBHARDT,
E. M. DAWSON,
FRED. BRACKETT,
JOHN TWEEDALE,
PROF. HARRY KING,
W. V. COX,
A. HOWARD CLARK,
WALTER HOUGH,
DR. THOMAS TAYLOR,
PHILIP WALKER,
MAGNUS S. THOMPSON,
N. S. FAWCETTE,
HENRY W. RAYMOND,
COL. F. G. BUTTERFIELD,
MARTIN B. BAILEY,
E. A. DICK,
THOS. S. HOPKINS,
JAS. W. WHITE,
J. LOWRIE BELL,
ARNOLD B. JOHNSON,
W. J. HOFFMAN,
JAMES A. RUTHERFORD.

Committee on Transportation.

This committee will by interviews and correspondence endeavor to secure reduced railroad and steamboat rates from all points in the United States to this city, for the members of the Congress and their friends who accompany them. They will also be charged with the duty of making the necessary arrangements for the excursion to Mount Vernon.

Col. W. B. THOMPSON, Chairman.

JAMES L. TAYLOR,	C. C. SCULL,
GEORGE W. BOYD,	CHARLES R. BISHOP,
W. P. CAMPBELL,	Capt. W. T. ROESSLE,
C. C. DUNCANSON,	Capt. A. A. THOMAS,
S. M. BRYAN,	MORRELL MAREAN,
Lieut. CHAS C. ALLIBONE,	Col. JOS. C. McKIBBEN.

The Committee on Halls.

This committee will be charged with the duty of obtaining a hall for the principal place of meeting for the convention, and such other halls as may be needed for special or overflow meetings, and seeing that they are properly arranged and supplied with the requisite attendants and conveniences.

M. D. HELM, Chairman.

F. W. PRATT,	F. C. SOMES,
W. H. RAPLEY,	WARREN H. ORCUTT,
W. X. STEVENS,	AUGUST PETERSON,
B. R. CATLIN,	GEO. S. PRINDLE,
T. J. W. ROBERTSON,	EUGENE W. JOHNSON,
W. H. SINGLETON,	H. H. DOUBLEDAY,
HERVEY S. KNIGHT,	W. P. KENNEDY,
F. A. LEHMANN,	J. NOTA McGILL,
WM. E. BOULTER,	H. N. LOW.

The Committee on Badges and Medals.

This committee shall cause designs for badges and medals and the cost thereof to be submitted to the Executive Committee for approval, and, when authorized, secure and deliver the same to the chairman of the several committees or officers for appropriate distribution.

SCHUYLER DURYEE, Chairman.

V. D. STOCKBRIDGE,	W. H. DOOLITTLE,
W. A. BARTLETT,	F. L. BROWNE,
ALEX. S. STEWART,	LLOYD B. WIGHT,
P. G. RUSSELL,	A. S. BROWNE,
G. P. WHITTLESEY,	WALLACE GREENE.
J. R. LITTELL,	P. MAURO,
C. H. FOWLER,	DR. F. W. RITTER,

C. L. STURTEVANT.

COMMITTEE ON PRESS.

The Committee on Press will make arrangements for the collection and dissemination of news, and for the accommodation of the Press, extending to them all necessary facilities.

S. H. KAUFFMANN, Chairman, *Evening Star.*

FRANK HATTON, *Post.*	F. A. RICHARDSON, *Baltimore Sun.*
D. R. MCKEE, *Associated Press.*	RICHARD NIXON, *N. O. Times.*
H. V. BOYNTON, *Commercial Gazette.*	H. W. SPOFFORD, *Scranton Republican.*
JEROME J. WILBER, *Associated Press.*	W. B. STEVENS, *St. Louis Globe-Democrat.*
J. H. SOULÉ, *Sunday Herald.*	F. A. G. HANDY, *Chicago Tribune.*
EDWARD W. BRADY, *Critic.*	O. O. STEALEY, *Louisville Courier-Journal.*
JOHN M. CARSON, *Philadelphia Ledger.*	M. G. SECKENDORF, *N. Y. Tribune.*
JOHN MCELROY, *National Tribune.*	JULES GUTHRIDGE, *N. Y. Herald.*
W. L. CROUNSE, *N. Y. World.*	PAUL WOLFF, *Staats-Zeitung.*
W. E. CURTIS, *Chicago News.*	W. G. STERRETT, *Galveston News.*
P. V. DEGRAW, *United Press.*	RICHARD WEIGHTMAN, *Age-Herald,* Birmingham, Ala.
E. G. DUNNELL, *N. Y. Times.*	O. P. AUSTIN, *Press News Association.*
J. J. NOAH, *Kansas City Times.*	E. B. WIGHT, *Boston Journal.*
LUTHER B. LITTLE, *St. Paul Pioneer Press.*	E. C. HOWLAND, *Philadelphia Press.*
DEB. RANDOLPH KEIM, *Philadelphia Inquirer.*	LOUIS J. LANG, *N. Y. Press.*

WILLIAM C. FOX.

Committee on Music.

The Committee on Music will be charged with the duty of providing such instrumental and vocal music as may be determined upon for the sessions of the convention, excursions, receptions and parades, subject to the approval of the Executive Committee.

W. R. LAPHAM, Chairman.

W. D. McFARLAND,	W. R. B. ATKINSON,
H. O. SIMONS,	J. C. PENNIE,
J. R. EDSON,	J. R. NOTTINGHAM,
GEORGE R. BYINGTON,	F. D. JOHNS,
L. S. BACON,	FRANK L. MIDDLETON.
F. H. HOUGH,	WILL E. DYRE,
FRANK L. DYER,	H. J. ENNIS.

Committee on Carriages.

The Committee on Carriages will make arrangements with the livery stables to provide sufficient and suitable carriages for the use of the members of the convention while in the city at reasonable and uniform rates, to be furnished upon telephonic call of the committee or a request by its authority.

A representative of the committee will be on duty at headquarters, 811 G street, during the time of the convention.

O. E. DUFFY, Chairman.

A. E. H. JOHNSON,	ALLEN S. PATTISON,
HENRY ORTH,	HERBERT E. PECK,
CHAS. S. JONES,	W. E. AUGHINBAUGH,
W. N. MOORE,	GEORGE W. STOKES,
HARRY F. SLOCUM,	FREDERICK A. HOLTON,
SHIPLEY BRASHEARS,	WALTER ALLEN,
CHAS. J. STOCKMAN,	JAMES L. SKIDMORE.
EDSON S. DENSMORE,	

Committee on Parade and Military Organizations.

Returning from the excursion to Mount Vernon on Friday, April 10th, by invitation of the Secretary of the Navy the boat will land at the Navy Yard, and an opportunity will be given the inventors and their friends to inspect the ordnance shops, after which a military parade from that point through the city is contemplated. The Secretary of War has already given favorable consideration to the matter, and it is expected that the Regular Army and the District National Guard and the High School Cadets will participate. The arrangements are under the charge of the following committee :

GEN. ALBERT ORDWAY, Chairman.

GEN. CECIL CLAY, MAJ. W. C. McINTIRE,
COL. W. G. MOORE, MAJ. T. M. GALE,
F. N. LANE.

COMMITTEE ON BANQUET.

If it be determined to hold a banquet during or at the close of the Convention, the arrangements therefor will be placed in the hands of the following committee, who will make due announcement of the time, place, etc.:

LAWRENCE GARDNER, Chairman.

A. B. BROWNE,	RHESA G. DUBOIS,
WALTER JOHNSON,	FRED. W. PRATT,
JOHN JOY EDSON,	H. L. BISCOE,
JOHN W. BOTELER,	WM. J. STEPHENSON,
JOHN C. EDWARDS,	R. G. MONROE,
WM. R. SINGLETON,	E. W. ANDERSON,
C. S. WHITMAN,	A. A. CONNOLLY.

SPECIAL COMMITTEE FOR THE RECEPTION OF FOREIGN OFFICIALS AND GUESTS.

As it is desirable to pay special attention to official and other foreign guests who may be present in response to invitations sent to the Patent Offices, Societies, and distinguished citizens of other countries, that duty has been devolved upon a special committee, consisting of

GEN. CYRUS BUSSEY, Chairman.

HON. ROBERT P. PORTER,	EUGENE M. JOHNSON,
A. S. SOLOMONS,	ANTHONY POLLOCK,
HON. THOMAS WILSON,	HENRY ORTH,
HON. N. L. FROTHINGHAM,	LOUIS BAGGER,
EDWIN B. HAY,	GUSTAV BISSING,
ALVA S. TABOR,	FRANCIS R. FAVER, JR.
GEN. L. T. MICHENOR,	JOSÉ M. YZNAGA,
M. L. MORRIS,	WILLIAM H. BECK,

JOSÉ J. RODRIGUEZ.

PROCEEDINGS OF THE CONGRESS.

FIRST MEETING.

The Congress of Inventors and Manufacturers of Inventions to celebrate the Beginning of the Second Century of the American Patent System convened at the Academy of Music (formerly Lincoln Music Hall) in Washington, D. C., Wednesday, April 8, 1891, at 2:30 p. m. The first meeting was presided over by the President of the United States, and among other distinguished guests upon the stage were Hon. John W. Noble, Secretary of the Interior; Hon. John Wanamaker, Postmaster-General; Prof. S. P. Langley, Secretary of the Smithsonian Institution; General Cyrus Bussey, Assistant Secretary of the Interior; Hon. Edwin Willits, Assistant Secretary of Agriculture; Senators O. H. Platt and J. W. Daniel; Hon. John H. Pope, Minister of Agriculture, Canada; Mr. Wm. J. Lynch, Cashier, and Mr. J. McCabe, Chief Examiner of the Patent Office, Ottawa, Canada; Hon. Charles E. Mitchell, Commissioner of Patents; Hon. Carroll D. Wright, Commissioner of Labor; Mr. E. W. Halford, and the Commissioners of the District of Columbia.

The boxes were occupied by Prof. Alexander Graham Bell, the inventor of the telephone, Hon. Gardiner G. Hubbard, and their families. Mrs. Amanda Vail, the widow of Alfred Vail, who designed and constructed the first complete magneto-electric telegraph instrument, and who was associated with Prof. Morse in the invention of the electric telegraph, was an honored guest upon the stage. In the audience were seated many distinguished inventors, among them being Dr. Gatling, General Berdan, George W. Maynard (son of Dr. Edward Maynard), inventor of guns, rifles and ammunition; Frederick E. Sickles, inventor of the Sickles engine cut-off and the steam steering apparatus; E. Berliner, of telephone and phonograph fame; D. G. Weems, inventor of the fast-speed electrical locomotive and railway; Colonel Price, of Scranton, Pa., inventor of appliances to utilize coal dust; Thomas Shaw, of Philadelphia, inventor of apparatus to purify and regulate the ventilation of coal mines; John Y. Smith, of Doylestown, Pa., whose patented air-brakes are in use on many European railways. There were also many other distinguished men present who have aided in the world's progress by their inventive genius.

After an overture by the orchestra, Hon. John Lynch, Chairman of the Executive Committee of the Patent Celebration, announced the following officers of the "Congress of Inventors and Manufacturers of the United States assembled to celebrate the Beginning of the Second Century of the American Patent System"—

President—The President of the United States.

Vice-Presidents—Hon. John W. Noble, Secretary of the Interior; Hon. Frederick Fraley, President National Board of Trade; Prof. Samuel P. Langley, Secretary of the Smithsonian Institution, and Prof. Alexander Graham Bell, Washington, D. C.

Honorary Vice-Presidents—General Russell A. Alger, Detroit, Mich.; Prof. W. A. Anthony, Manchester, Conn., President of the Institute of Electrical Engineers; John Birkinbine, Philadelphia, President of the Institute of Mining Engineers; Mr. Justice Bradley, United States Supreme Court; Hon. B. K. Bruce, Washington, D. C.; Charles F. Brush, Cleveland, Ohio; General Thomas L. Casey, Chief of Engineers, U. S. A.; Octave Chanute, Chicago, President of the American Society of Civil Engineers; George W. Childs, editor and publisher, Philadelphia; Thomas A. Edison, Menlo Park, N. J.; Norvin Green, President of the Western Union Telegraph Company, New York; Hon. Abram S. Hewitt, New York; Hon. Gardiner G. Hubbard, President National Geographical Society, Washington, D. C.; Hon. John Jay, President of the American Historical Association; Charles F. Mayer, President of the Baltimore and Ohio Railroad Company, Baltimore; Prof. T. C. Mendenhall, Washington, D. C.; Oberlin Smith, President of the Society of Mechanical Engineers, Bridgeton, N. J.; Elihu Thomson, Lynn, Mass.; Frank Thomson, Esq., Pennsylvania Railroad Company, Philadelphia, and Joseph M. Wilson, Philadelphia, President of the Franklin Institute.

The President being introduced by Chairman Lynch, addressed the Congress, as follows:

OPENING ADDRESS BY THE PRESIDENT OF THE UNITED STATES.

My fellow-citizens, members of this first convention of Inventors and Manufacturers, assembled to observe the Centennial of the Patent System of the United States: My connection with this meeting must necessarily be very brief, and may seem to be quite formal. Other engagements will prevent the enjoyment by me of the treat that is in store for you in the addresses which will be delivered by the distinguished men whose names are upon the programme. I can only by my presence here, and these few introductory words, opening and constituting this Congress, express my appreciation of the importance of this occasion, and my hope that your gathering may be promotive of those branches of science and art in which you are respectively interested.

It distinctly marked, I think, a great step in the progress of civilization when the law took notice of property in the fruit of the mind. (Applause.)

Ownership in the clumsy device which savage hands fashioned from wood and stone, was obvious to the savage mind; but it required a long period to bring the public to a realization of the fact that it was quite as essential that invention, taking shapes useful to men, should be recognized and secured as property. That is the work of the patent system as it has been established in this country. It cannot be doubted by any, I think, that the security of property in inventions has been highly promotive of the advance our country has made in the arts and sciences. (Applause.) Nothing more stimulates effort than security in the results of effort. (Applause.)

Rev. Byron Sunderland, Pastor of the First Presbyterian Church, then invoked the divine blessing upon the deliberations of the Congress, and gave thanks to the Supreme Being for the benefits which have accrued to the world "through the genius of men, inspired from on high."

After the invocation the President placed the Congress in charge of the first Vice-President, Hon. John W. Noble, Secretary of the Interior, who introduced Hon. Charles E. Mitchell, U. S. Commissioner of Patents, to address the Congress on "The Birth and Growth of the American Patent System."*

This address was followed by Senator O. H. Platt, of Connecticut, whose theme was "Invention and Advancement," a scholarly production, which was received with applause.

"The Relation of Invention to Labor," was discussed by Hon. Carroll D. Wright, Commissioner of Labor. During this address the Justices of the Supreme Court, headed by Chief Justice Fuller, entered in a body amid applause and were shown to seats upon the stage. This courtesy to their distinguished colleague, Hon. Samuel Blatchford, who was the next speaker, was a most pleasing incident of the celebration. The Executive and Legislative branches of the government had already paid their tribute to the long continued efficiency of the American Patent System, and this action by the representatives of the highest judicial branch was only needed to render the recognition complete.

Justice Blatchford, who enjoys a high reputation as a jurist versed in patent law, then addressed the Congress on "A Century of Patent Law."

The last address of the afternoon was delivered by Hon. Robert S. Taylor, of Fort Wayne, Indiana, upon "The Epoch-Making Inventions of America," and upon its conclusion the meeting was adjourned until 7:30 P. M.

SECOND MEETING.

The second meeting was called to order at 7:30 P. M., Wednesday, April 8, 1891, by Hon. John W. Noble, Secretary of the Interior, who delivered a timely address, wherein he

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*The addresses are published in full, and, as far as practicable, in the order in which they were delivered. See index.

referred to the growth of the Interior Department, the importance of the Patent Office, the necessity for increasing its facilities, and spoke enthusiastically of its future usefulness as a factor of civilization.

Secretary Noble then presented Hon. John W. Daniel, U. S. Senator from Virginia, who spoke of "The New South as an Outgrowth of Invention and the American Patent Law," his remarks being received with applause.

The programme concluded with a paper from Hon. Edwin Willits, Assistant Secretary of Agriculture, on "The Relation of Invention to Agriculture."

THE RECEPTION AT THE PATENT OFFICE.

After adjournment, the members of the Congress and the ladies accompanying them repaired to the Patent Office to attend the reception tendered in their honor by the Secretary of the Interior and the Commissioner of Patents. The invitation, which was accepted by several thousand persons, read as follows:

"Congress of Inventors and Manufacturers of Patented Inventions for the Celebration of the beginning of the Second Century of the American Patent System.

"The Executive Committee requests the presence of yourself and ladies at a reception by the Secretary of the Interior and Commissioner of Patents in honor of inventors and manufacturers, at the Patent Office Building, Washington, Wednesday, April 8th, 1891, at 9:30 P. M.

"JOHN LYNCH, GEORGE C. MAYNARD,
"J. W. BABSON, MARVIN C. STONE,
"J. E. WATKINS.

"Present this card at the Seventh-street entrance."

The scene in the interior of the Patent Office was a brilliant one. The walls of the broad corridor on the F street side of the building were hung with flags, among which were introduced countless electric lights. The rotunda in which the receiving party stood was ablaze with light and color. At the opposite end of the corridor, the large space behind the columns was furnished with rugs and divans as a resting place for those who did not desire to participate in the promenade. Mr. Wm. Cranch McIntire made the introductions to Secretary Noble, who in turn presented each guest to Mrs. Noble and the receiving party, consisting of Commissioner and Mrs. Mitchell, Mrs. Frothingham, wife of the Assistant Commissioner of Patents; Mrs. Lyman, wife of the Civil Service Commissioner; the Misses Halstead, the Misses McIntire, Mrs. Woodruff, of New York; Mrs. George Bartlett and Mrs. T. S. Bishop, of New Britain, Conn., and others.

Among the guests present were Assistant Commissioner Frothingham, Mr. Robert Mitchell, Mrs. Coston, Mrs. Randolph Keim, Miss Sarah C. Deen, of Reading; Prof. and Mrs. A. Graham Bell, Dr. Teunis S. Hamlin, Dr. and Mrs. G. Brown Goode, Senator Manderson, Postmaster-General Wanamaker, Gen. Berdan, Gen. Butterfield, Hon. Robert P. Porter, Superintendent of the Census; Maj. J. W. Powell, Hon. John H. Oberly, Mr. William C. Fox, Mr. E. H. Fox, Prof. W. D. Cabell, with a number of young ladies; Prof. and Mrs. Woodward, Mr. and Mrs. William Lapham, Dr. Luce, Mrs. Kuehling, Mrs. H. L. King, Mr. and Mrs. Byrne, Dr. Gatling, Mr. Matthew G. Emery, Mr. H. E. Ogden, Dr. J. B. Hamilton, Surgeon General, Marine Hospital Service; Col. E. B. Hay, Rev. Dr. Corey, Senator Daniel, Commissioner Lyman, Mr. and Mrs. Powell, Hon. Carroll D. Wright, Mr. O. L. Pruden, Mr. Sevellon A. Brown, Mr. F. W. Smith, Mr. F. W. Flowers, Maj. Benjamin F. Pike, Mr. Thomas S. Chappell, Mr. J. G. Howland, Mr. W. D. Swan, Mr. O. B. Brown, Maj. J. P. Sanger, Mr. J. N. Morrison, Capt. W. S. Patten, Mr. A. C. Towner, Mr. William R. Lapham, Mr. William R. Ryan, Mr. James J. McDonald, Mr. Henry G. Potter, Mr. Edmond Mallet, Mr. Manning M. Rose, Mr. H. H. Bates, Mr. Roger Welles, Mr. William Burke, Mr. W. G. Perry, Miss C. M. Richter, Mr. R. M. Layden, Mrs. D. W. Lewis, Mr. Charles P. Lincoln, Mr. W. W. Barker, Dr. M. F. Gallaher, Mr. Frank H. Allen, Mr. and Mrs. A. H. Clark, Mr. Geo. C. Maynard, Mr. and Mrs.

Marvin C. Stone, Hon. John Lynch, Prof. and Mrs. J. Elfreth Watkins and Miss Ruth Hannah, Mr. William B. Shaw, Mr. John W. Babson, Mr. E. R. Tyler, Mr. J. W. Jayne, Mr. George M. Holtzman, Mr. Frank R. Williams, Mr. John Hyde, Mr. Wiliam C. Hunt, and nearly every official connected with the Interior and the other Departments of the government.

THIRD PUBLIC MEETING.

Hon. Frederick Fraley, President of the National Board of Trade and of the American Philosophical Society, who was expected to preside over the third public meeting, held at 2 P. M., Thursday, April 9th, 1891, was deterred from this duty by illness. His place was filled by Mr. Oberlin Smith, Past President of the Society of Mechanical Engineers, and Honorary Vice-President of the Congress.

Hon. Benjamin Butterworth, who was announced to address the Congress on "The Effect of Our Patent System on the Material Development of the United States," was unavoidably delayed in Chicago, rendering a change in the programme necessary.

Hon. A. R. Spofford, Librarian of Congress, who has administered the affairs of our great national library for twenty-seven years, then read the first paper of the session, entitled "The Copyright System of the United States: its Origin and its Growth."

Owing to the illness of Prof. Octave Chanute, President of the American Society of Civil Engineers, his paper, next in order upon the programme, "The Effect of Invention upon the Railroad and Other Means of Intercommunication," was read by Prof. J. Howard Gore, of the Columbian University, Washington.

"The Inventors of the Telegraph and the Telephone" was the title of an address delivered by Prof. Thomas Gray, of Rose Polytechnic Institute, Terre Haute, Indiana. This address attracted additional attention from the fact that Professor Gray is the author of the articles on the "Telegraph" and

"Telephone" in the last edition of the Encyclopædia Britannica. A further coincidence in connection with this address was the presence in the audience of Mrs. Alfred Vail, widow of one of the inventors of the telegraph; Prof. Alexander Graham Bell, the inventor of the telephone, and Mr. Emilie Berliner, of telephone fame.

Col. F. A. Seely, a Principal Examiner in the Patent Office, contributed a paper on "International Protection of Industrial Property." The fact that Colonel Seely had only recently been called upon to represent the United States in a conference relating to International Patent Laws at Madrid, Spain, made it possible for him to utilize the results of these deliberations in his discussion of this important subject.

The last paper of the afternoon session, "Invention in its Effect upon Household Economy," prepared by Dr. Edward Atkinson, of Boston, Massachusetts, who was unable to be present, was read by Prof. G. K. Gilbert, of the United States Geological Survey. The theory of this address was, that we pay many penalties for the progress of invention, but these penalties are being gradually removed by further improvements in the same line.

The meeting then adjourned until 7:30 P. M., April 9th, 1891.

FOURTH PUBLIC MEETING.

Prof. S. P. Langley, Secretary of the Smithsonian Institution, presided over the fourth public meeting, which was called to order at 7:30 P. M., April 9th. He delivered a short address, and called attention to the fact that the Smithsonian Institution in its early days was the inheritor of many of the treasures of the Patent Office.

The presiding officer then introduced Prof. William P. Trowbridge, of the School of Mines, Columbia College, New York, who spoke of the "Effect of Technological Schools upon the Progress of Invention," his remarks being frequently applauded.

Dr. Robert H. Thurston, Director of Sibley College, Cornell University, New York, followed Professor Trowbridge with an able address on "The Invention of the Steam Engine," replete with interesting facts and conclusions regarding steam.

The third paper of the evening, "The Effect of Invention upon the Progress of Electrical Science," was read by Prof. Cyrus F. Brackett, of Princeton College. The fact that Professor Brackett occupies the chair founded to commemorate the life work of Professor Henry, the great discoverer of the laws of electro-magnetism, rendered his selection to speak upon this subject peculiarly appropriate.

Maj. Clarence E. Dutton, of the Ordnance Department, U. S. A., who was to address the Congress on "The Influence of Invention upon the Implements and Munitions of Modern Warfare," being unavoidably absent in Mexico, his paper was read by Capt. Rogers Birnie, U. S. A.

The last address of the evening was delivered by Prof. F. W. Clarke, Chief Chemist of the U. S. Geological Survey, on "The Relations of Abstract Scientific Research to Practical Invention, with Special Reference to Chemistry and Physics."

The meeting then adjourned.

ANNIVERSARY DAY.

EXCURSION TO MOUNT VERNON.

One hundred and one years ago—upon April 10, 1791, the first American Patent Law, "An Act to Promote the Progress of the Useful Arts," was signed by George Washington. It was therefore especially appropriate that this annversary should be celebrated by an excursion to Washington's tomb, at Mount Vernon. At 11 A. M. the steamer Excelsior left her wharf, carrying six hundred people. The Naval Band from Annapolis accompanied the excursionists by permission of the Secretary of the Navy, a courtesy which was greatly appreciated. On arriving at Mount Vernon the Annapolis Band headed the procession, and a solemn march was made up the hill to the tomb, where, with uncovered heads, the visitors viewed the crypt containing the marble sarcophagus of Washington. The excursionists then proceeded to the lawn in front of the mansion, where the large group was photographed; the mansion house and its interesting historical relics were then visited and examined, after which Dr. J. M. Toner, the orator of the day, was introduced by Mr. Watkins, Secretary of the Executive Committee, who said:

"It seems eminently proper that upon this important anniversary you should be addressed by one, a large portion of whose long life has been devoted to preserving the history of the Father of our Country. As a son of Virginia, standing upon this historic ground, it is indeed an honor to be permitted to introduce the orator of the day, Dr. Toner, of Washington."

Dr. Toner then delivered an address upon "Washington as an Inventor and Promoter of Useful Arts."

Upon the conclusion of the exercises the party proceeded to the steamboat, where a felicitous address was delivered on the return trip by ex-Commissioner of Patents Hon. Benjamin Butterworth, upon "The Influence of the Patent System on the Prosperity of the Country." At the close of Mr. Butterworth's stirring address, the Canadian Commissioner of Patents spoke briefly, congratulating the government and the various committees on the success of the celebration, and the inventors of the United States upon their patent system and individual achievements. He further stated that Canada was trying to model her patent system after that of the United States, this remark being received with gratifying applause.

The excursionists reached Washington at 4 P. M., and immediately repaired to the Executive Mansion to witness the military parade in the White Lot, and to attend the reception tendered them by the President.

The Military Parade and Reception at the White House.

A special and impressive feature of the Centennial Celebration was the military review and parade in honor of the visitors. This imposing spectacle occurred in the White Lot, south of the Executive Mansion, where the military was reviewed by the President, all the U. S. troops from the Arsenal and Fort Myer, the militia of the District of Columbia, and the High School Cadets being in line. The Third Artillery Band, the National Guard Band and the Naval Academy Band and Drum Corps furnished the music. After being reviewed by the President, the companies continued their march along Pennsylvania Avenue to the Capitol. The battalion of six companies of the High School Cadets was one of the most interesting parts of the parade, their precision in marching being especially commended by the visitors.

The military display was pronounced by competent judges to be perfect in every detail, the discipline manifested being worthy of special mention.

With the President upon the reviewing stand were a number of prominent inventors, army and navy officers and government officials. After the review the members of the Congress proceeded in a body to the White House, where they were formally presented to the President by Hon. John Lynch, Chairman of the Executive Committee. This was a most pleasant feature in the programme of entertainment, and the courtesy was greatly appreciated by the visitors.

FIFTH PUBLIC MEETING.

In opening the fifth and last public meeting of the Congress, Friday, April 10th, at 8 P. M., Hon. John Lynch, the Chairman of the Executive Committee, introduced the presiding officer in the following words:

"I have the pleasure of introducing as President of this concluding session of the Congress a man of world-wide fame, whose name is at this moment literally ringing throughout the civilized world, Professor Alexander Graham Bell."

Professor Bell, upon taking the chair, delivered a thoughtful and interesting address.

The first regular address of the evening was delivered by Hon. William T. Harris, Commissioner of Education, on "The Relation of Invention to the Communication of Intelligence and the Diffusion of Knowledge by Newspaper and Book."

This was followed by a paper on "The Birth of Invention," by Prof. Otis T. Mason, Curator of the Department of Ethnology, U. S. National Museum, showing the growth of inventive ideas.

"American Inventions and Discoveries in Medicine, Surgery and Practical Sanitation" was the title of the last paper, which was read by Dr. J. S. Billings, Curator, U. S. Army Medical Museum.

Secretary J. Elfreth Watkins then read a number of telegrams and communications from the officials of European Patent Offices and several scientific societies. Among them were the following:

OFFICE OF THE PRESIDENT OF THE
IMPERIAL GERMAN PATENT OFFICE,
BERLIN, March 23, 1891.

HONORED SIR: I have the honor to herewith respectfully acknowledge the receipt of your valued communication of the 2d instant. It is with great interest that I see from it the worthy manner in which the citizens of the United States of America intend to celebrate the one hundredth anniversary of the day on which the patent system was established. Allow me to express to you my congratulations upon this resolution, no less, however, upon the manner in which you hope to carry it out.

It is with great propriety that you and those seconding your efforts in the arrangement of the celebration point to the important part which the patent system has had in the growth, development and prosperity of your home industries. Did nothing else speak for the high value of the patent law, the one circumstance would be of sufficient proof that the American people, as a whole, are bringing to the celebration the heartiest sympathy, and that you will have the honor and the pleasure to greet as participants men of science as well as those of practical experience, whose names are held in high honor far beyond the boundaries of your own land.

I join with you in recognizing in the protection of invention a practical means of increasing the prosperity of the people, and praise with you the deed which was performed one hundred years ago, and rejoice with you at the fruits which have obtained to your citizens, and with them the cultured nations of the earth, to the nurturing of inventive genius in America.

With these sentiments I beg you to consider me, though not present, as with you on the 8th of April and the following days, and look upon me as a participant in the celebration. I greatly regret that circumstances will prevent my leaving Berlin at this time, where official matters require my attention, and further, the conclusion of arrangements necessary for a journey at this time would be impossible, even if the time necessary for them was shorter than it is.

I beg you to accept these lines as an expression of my most hearty thanks for your remembrance of me and to excuse my absence. With the assurance of my most respectful consideration, I have the honor to remain

Your most obedient servant,

BOJANOWSKI,

HON. JOHN LYNCH, etc. *President.*

FRANKFORT-ON-MAIN,

GERMANY, April 10, 1891.

Secretary of the Patent Centenary Celebration, Washington, D.C.:

The undersigned beg to congratulate the United States upon the beginning of the second century of the American patent system which has contributed so much to the development and promotion of electrical science and art.

ELECTRO TECHNICAL SOCIETY,

Frankfort-on-Main.

25, SOUTHAMPTON BUILDINGS,
CHANCERY LANE,
LONDON, W. C., 19th March, 1891.

SIR: I have the honor to acknowledge the receipt of your letter of the 2d inst., and in reply to ask you to be good enough to convey to the chairman of the Executive Committee my best thanks for the courteous invitation to attend the celebration of the beginning of the second century of the American patent system, and at the same time to express to him my regret that it will not be possible for me to be absent from England at the date fixed for holding the celebration.

I have the honor to be, sir,

Your obedident servant,

H. READER LACK,
Comptroller-General.

J. ELFRETH WATKINS, Esqre.

BUREAU FÉDÉRAL
DE LA PROPRIÉTÉ INTELLECTUELLE,
BERNE, le 18 May, 1891.

To the Hon. John Lynch, Chairman of the Executive Committee of the Celebration of the Beginning of the Second Century of the American Patent System, Washington, U. S.

DEAR SIR: In expressing to you our thanks for the invitation with which you have honored us, we are compelled to decline it on account of the distance from Washington.

With our best wishes for the full success of the celebration of the beginning of the second century of the American patent system, we have the honor to be, my dear sir, with assurances of high regard,

BUREAU FÉDÉRALDE LA PROPRIÉTÉ INTELLECTUELLE
LE DIRECTEUR, HALLER.

DEN KONGELIGE NORSKE REGERINGS,
DEPARTEMENT FOR DET INDRE,
DEPARTEMENT-SCHEFEN.
CHRISTIANIA, den 18 April, 1891.

SIR: While having the honor to offer my thanks for the invitation received to take part in the celebration in Washington, on the 8th, 9th and 10th inst., of the beginning of the second century of the American patent system, I regret very much to be prevented by circumstances from uniting in this celebration.

I am, sir, respectfully yours,

W. KONOW.

To HON. JOHN LYNCH,
Washington.

The Swedish Commissioner of Patents sent the following cablegram from Stockholm:

"On your Centennial the Royal Patent Office sends cordial greetings, with best wishes for continued success."

The French Commissioner of Patents recognized the importance of the occasion, and sent cordial greetings.

The reading of these communications having been completed the following resolution was offered by H. T. Simons, of Ohio:

Resolved, That the thanks of this Congress of Inventors and Manufacturers of Patented Inventions here assembled be extended to the President of the United States, the members of the Cabinet and the Judges of the United States Supreme Court for their honored presence at our meetings; to the learned and distinguished gentlemen who presided over and addressed the Congress of Inventors at the several public meetings; to the Hon. John W. Noble, Secretary of the Interior; Hon. Charles E. Mitchell, Commissioner of Patents, and the ladies assisting them in the brilliant reception tendered this Congress at the Patent Office; to the Washington Centennial Committee for the enjoyable excursion to Mount Vernon and the magnificent military review; to Hon. John Lynch and Professor J. E. Watkins, for their arduous labors in behalf of the Congress of Inventors and Centennial Celebration; to the Executive Committee, the several sub-committees, and the citizens of Washington for their kind and courteous efforts for our comfort and entertainment, and finally to the several newspapers and reporters for their fair and honorable reports of the proceedings of our meetings.

The resolution was unanimously adopted amid applause, and Professor Bell then declared the Congress adjourned for one hundred years.

Badges worn by Committees, Members and Guests during the Patent Centennial Celebration.

The following badges were worn by committees, members and guests during the celebration :

COMMITTEES.	BADGES.		
	Bows.	Ribbons.	
1. Central	Purple	Gold	Gold
2. Advisory	Gold	Purple	Purple
3. Executive	Red	Red	Red
4. Literature	Blue	White	White
5. Finance	White	Red	Red
6. Public Comfort	Red	White	White
7. Reception	White	White	White
8. Transportation	Blue	Blue	Blue
9. Halls	Red	Blue	Blue
10. Badges and Medals	Blue	Red	Red
11. Press	Gold	White	White
12. Music	White	Blue	Blue
13. Carriages	Purple	White	White
14. Parade and Military Organizations,	Purple	Purple	Purple
15. Banquet	White	Purple	Purple
16. Members (Button)	Blue	Red	White
17. Guests "	White	Red	Blue
18. Foreign Reception "	Gold	Gold	Gold
19. National Committee "	U.S. flag	Red	White
20. Auxiliary State Committee "	Red	White	White

A handsome medal of pure aluminum bearing the seal of the patent office and the inscription "Patent Centennial Celebration, Washington, April 10, 1891," was one of the souvenirs of the celebration.

The National Association of Inventors and Manufacturers.

The expectation that one of the outcomes of the celebration would be the establishment of an association of inventors and manufacturers of patented inventions was realized.

The first meeting of the National Committee from the different States, and representing various industries, met according to call in Parlor 10 of Willards Hotel at 10 A. M. on Wednesday, April 8.

Hon. Gardiner G. Hubbard, of Washington, was chosen Chairman and J. Elfreth Watkins, Secretary.

A sub-committee was appointed, to whom was referred the question of the advisability of establishing an association. This committee was requested to examine all of the correspondence relating to the formation of an association which had been received by the Executive Committee of the Patent Celebration, with directions to report at a general meeting to be held at 10 A. M. the following day.

At the meeting on Thursday morning this sub-committee made a brief report.

The questions as to the advisability of forming an association at once, or of leaving the matter in the hands of a committee to get into touch with inventors and manufacturers throughout the country before definite steps were taken, were earnestly and thoroughly discussed.

As those who favored the former course were in the majority, the committee was requested to submit a form of constitution and by-laws to the meeting which was to be held on Friday, on the steamboat *en route* for Mount Vernon.

As the committee to whom the matter was referred was unable to complete its deliberations in time, no meeting was held until 6 P. M. on Friday, April 10, at Lincoln Hall, when a constitution and by-laws were adopted.

OFFICERS.

At the meeting of the members of the American Association of Inventors and Manufacturers held after the adjournment of the Congress at Lincoln Hall, at 10 P. M. on Friday, April 10th, 1891, the following officers were elected for the ensuing year :

President—DR. R. J. GATLING, of Hartford, Connecticut.
First Vice-President—GARDINER G. HUBBARD, of Washington, D.C.
Second Vice-President—THOMAS SHAW, of Philadelphia, Pa.
Third Vice-President—PROF. W. A. ANTHONY, of Manchester, Conn.
Fourth Vice-President—BENJAMIN BUTTERWORTH, of Cincinnati, O.
Secretary—J. ELFRETH WATKINS, of Washington, D. C.
Treasurer—MARVIN C. STONE, of Washington, D. C.

The following Board of Directors "were separately voted for" and unanimously elected to serve during the periods prescribed by the Constitution :

CHAS. F. BRUSH, Cleveland, Ohio.
OTIS T. MASON, Washington, D. C.
R. B. MUNGER, Birmingham, Ala.
F. E. SICKLES, Kansas City, Mo.
JOHN Y. SMITH, Doylestown, Pa.
OBERLIN SMITH, Bridgeton, N. J.
D. M. SMYTH, Northwood, N. H.
ROBERT H. THURSTON, Ithaca, N. Y.
DAVID G. WEEMS, Baltimore, Md.

THE BANQUET OF THE WASHINGTON BOARD OF TRADE.

The closing feature of the Congress, and one which will be remembered with pleasure by the participants, was the banquet given on Friday evening, April 10th, by the Washington Board of Trade at the Arlington Hotel, to celebrate at one and the same time the centenary of the American Patent System and that of the District of Columbia. The company numbered over two hundred guests, comprising members of the Cabinet and other distinguished government officials, noted men who attended the Patent Centennial celebration, besides many prominent and representative citizens of the District. The spacious dining-hall was tastefully decorated and the table was artistically arranged with flowers. In the menu, decorations, and general appointments the banquet was a memorable one, even in Washington, where the art of giving dinners has grown to be a science. At each plate was placed a menu card artistic in design, bearing a representation of the genius of invention and containing the seal of the Patent Office in gold.

MENU.

Blue Points

Clear Turtle Soup

Anchovies — Olives — Radishes

Striped Bass, a la Chambord.

Cucumbers — Bermuda Potatoes

Chicken Croquettes
Green Peas

Filet of Beef, with Mushrooms
Asparagus

Lobster, a la Newbourg

Punch, Lalla Rookh

Grouse, Roasted

Lettuce and Tomato Salad — Currant Jelly

Ice Cream Napolitaine

Fancy Cakes.

Coffee — Cigars.

Wines:

Haut Sauterne — Sherry — Claret

G. H. Mumm's Extra Dry

The banquet will be long remembered on account of the distinguished men present, every department of the government being represented, and for the character of the speeches delivered. The beauties of the city of Washington and the great benefits of the patent system were exploited in eloquent words by those who responded to the toasts.

Mr. Myron M. Parker, President of the Board of Trade, presided. By his side was Justice Harlan of the Supreme Court, and near him were Hon. Charles Foster, Secretary of the Treasury ; Hon. John W. Noble, Secretary of the Interior ; Hon. Lewis A. Grant, Assistant Secretary of War ; Hon. J. R. Soley, Assistant Secretary of the Navy ; Hon. S. A. Whitfield, First Assistant Postmaster-General ; Hon. C. E. Mitchell, Commissioner of Patents; Hon. Benj. Butterworth, ex-Commissioner, and Mr. E. D. Anderson, Secretary Board of Trade.

At the close of the dinner President Parker delivered an address of welcome, which, with such of the responses to the following toasts as have direct reference to the American patent system, will be found in the subsequent pages.

1. Address of Welcome, Mr. M. M. Parker, President Board of Trade. 2. The President of the United States. 3. The Supreme Court of the United States, Mr. Justice Harlan. 4. The Future of the American Patent System, Hon. John W. Noble, Secretary of the Interior. 5. American Patents from the Financial Standpoint, Hon. Charles Foster, Secretary of the Treasury. 6. The Relation of Patents to the Law, Hon. W. H. H. Miller, Attorney-General. 7. The Centenary of Washington City, T. W. Noyes, Esq., editor Evening Star 8. The District of Columbia, Hon. John W. Douglass, President Board of District Commissioners. 9. American Patents from an International Standpoint, Hon. F. O. St. Clair, Department of State. 10. The Capital of the Foremost Republic, Hon. J. L. M. Curry. 11. American Patents in the Army, General Lewis A. Grant, Assistant Secretary of War. 12. Washington, the Educational Centre of America, Rt. Rev. Bishop Keane. 13. American Patents in the Navy, Hon. J. R. Soley, Assistant Secretary of the Navy. 14. The First Century of the American Patent System, Hon. C. E. Mitchell, Commissioner of Patents. 15. American Patents in the Postal Service, Hon. S. A. Whitfield, First Assistant Postmaster-General. 16. Ameri-

can Patents in Agriculture, Hon. Edwin Willits, Assistant Secretary of Agriculture. 17. American Patents at the World's Exposition, Hon. Benjamin Butterworth, Secretary World's Columbian Exposition.

THE GUESTS.

The following is a partial list of those present at the banquet:

Hon. Charles Foster, Secretary of the Treasury; Hon. John W. Noble, Secretary of the Interior; Hon. Lewis A. Grant, Assistant Secretary of War; Hon. James R. Soley, Assistant Secretary of the Navy; Hon. Charles E. Mitchell, Commissioner of Patents; Bishop Keane, Hon. J. L. M. Curry, Archbishop Ireland, Dr. Gatling, Hon. A. M. Soteldo, Prof. Harry King, M. D. Leggett, Hon Richard Pope, Commissioner of Patents Dominion of Canada; Hon. W. J. Lynch, Cashier Commissioner, and Hon. Thos. McCabe, Chief Examiner of the Canadian Patent Office; District Commissioners Douglass, Ross and Robert, Ethan Allen, Prof. Henry Morton, H. E. Parsons, Henry W. Smith, W. H. Bagley, C. F. Z. Caracristi, E. W. Halford, C. C. Chase, Marshal D. M. Ransdell, Controller of the Currency E. S. Lacey, H. B. F. Macfarland, C. M. Hendley, W. E. Aughinbaugh, D. B. Ainger, E. M. Dawson, J. G, Beckham, M. B. Harlow, E. E. Downham, Hon. W. H. Arnoux and Capt. P. H. McLaughlin, Prof. Alexander Graham Bell, Dr. J. M. Toner, Dr. John S. Billings, Prof. Cyrus W. Brackett, ex-Representative Butterworth, Prof. F. W. Clarke, Maj. C. E. Dutton, Prof. Thomas Gray, Col. F. A. Seely, Hon. Robert S. Taylor, Prof. R. H. Thurston, Prof. W. P. Trowbridge, Hon. Carroll D. Wright, Commissioner of Labor, and Hon. W. T. Harris, Commissioner of Education.

Of the Central Committee: Messrs. J. W. Babson, B. H. Warner, O. T. Mason, George C. Maynard, M. C. Stone, J. E. Watkins, John Lynch, J. T. Dubois and R. W. Fenwick.

Of the National Committee: John H. Bartlett, Mendes Cohen, T. N. Ely, G. G. Hubbard, R. J. Howard, W. J. Johnson, J. A. Price, Oberlin Smith, George F. Simonds, D. M. Smyth, D. J. Weems, Eli Whitney and George Westinghouse.

Chairmen of the local committees: Schuyler Duryee, Hon. Cyrus Bussey, Lawrence Gardner, W. C. McIntire, W. B.

Thompson, J. K. McCammon, M. D. Helm, W. R. Lapham, O. E. Duffey and S. H. Kauffmann.

Of the Advisory Committee: Hon George Gray, H. E. Paine, Ellis Spear, Prof. J.W. Powell, Col. Marshall McDonald, Dr. J. C. Welling, Rev. J. E. Rankin, N. L. Frothingham, Dr. G. Brown Goode, M. V. Montgomery and Thomas Wilson.

In addition to the above about two hundred and fifty members of the Board of Trade participated in the banquet.

THE ENGINEERS' BANQUET.

On Thursday evening, April 9th, the Washington and Baltimore members of the American Society of Civil Engineers gave a banquet at Welcker's Hotel. It was originally intended as a compliment to Prof. Octave Chanute, the President of the Society of Civil Engineers, who was unfortunately prevented by illness from delivering his address at the patent celebration. The members of the Society attending the banquet were:

Horatio G. Wright, Mendes Cohen, William S. Rosecrans, Henry T. Douglas, Francis H. Hambleton, Andrew Rosewater, John A. Partridge, Channing M. Bolton, Bernard R. Green, Alonzo T. Mosman, Henry L. Marindin, David E. McComb, Mordecai T. Endicott, Frederick H. Smith, Herbert M. Wilson, James L. Lusk, Julien A. Hall, George B. Hazlehurst, Conway B. Hunt, Francis R. Fava, Jr., Charles B. Ball, J. Elfreth Watkins, Owen L. Ingalls and David S. Carll.

As invited guests there were present Oberlin Smith, Past President of the American Society of Mechanical Engineers, and Prof. R. H. Thurston, of Cornell University.

A permanent organization for the purpose of occasional social meetings was effected by the election of Bernard R. Green, of Washington, D. C., as President, and Charles B. Ball as Secretary, for one year.

THE LOAN EXHIBITION.

In connection with the regular programme of the Congress a loan collection was installed in the lecture hall of the National Museum, where machines of antique design, models, early inventions and patents were inspected and studied by many visitors, drawn to Washington by their interest in the Patent Centennial. A description of this collection in detail will be found in the Appendix.

BIRTH AND GROWTH OF THE AMERICAN PATENT SYSTEM.

BY HON. CHARLES ELIOT MITCHELL, COMMISSIONER OF PATENTS.

The patent system had its birth in a statute against monopolies. That statute was enacted by a British parliament to restrain the British throne. From the earliest times the right to grant exclusive privileges had been asserted as a royal prerogative. Sometimes the power had been exercised beneficently. With vastly more frequency it was employed to bring in revenue to the royal coffers. More and more, as the sovereign struggled to govern without the aid of parliament, the power was abused and perverted until, in the days of Elizabeth, monopolies were conferred upon favorites of the court, extending to the most ordinary articles of commerce and consumption. In aid of these illegal monopolies arbitrary powers of search were granted, and heavy penalties were inflicted upon English merchants for engaging in occupations which had been of common right for centuries. Of course such tyranny could not continue, and in the year 1623 the famous statute of James was enacted, destroying all illegal monopolies by a single stroke, and declaring that in future all patents should be to inventors of new manufactures, and to them only for a limited time. It is to this statute that legal writers ascribe the modern patent system.

It is true that the statute of James was declaratory of the common law, as it was understood by the judges; it is true that after its enactment the king's pleasure was still, in theory, the source whence the grant proceeded; it is true that subsequent monarchs chafed under its restrictions, and at times even trampled them under foot; but, nevertheless, in a large way and in a very vital sense, the patent system had its birth in the remedial statute of 1623. In an hour of moral and political exaltation England had declared that odious monopolies should cease, and that patents for inventions should be granted. That declaration has been law to the present hour. And it should never be forgotten by the friends of industrial progress that the same great statute which restored the freedom of established industries to monopoly-ridden England, created also the modern patent system and placed it upon an enduring basis in justice and public policy.

But although the patent system is ascribed to the statute of 1623, its administration was long pervaded by a spirit hostile to inventors. The benefactor of the public had to crawl before the king as a suppliant for favor. If his cringing was successful his patent was granted, but he was dismissed with the poor privilege of proving the novelty of his invention as best he could. The patent was not even *prima facie* evidence that the patentee had made an invention. When it came into court it was construed in a technical spirit, a spirit which assumed everything in favor of the crown and nothing in favor of the subject, and it is hardly too much to say that some of the earlier decisions in patent causes betray a temper that would have better befitted a permit to sell gunpowder in the streets of London.

It is Coryton, the law-writer, who tells us that to the patentee alone "no margin was conceded for possible error. An unapt title to his invention, an ill-judged word in his description, an incautious experiment, the least disclosure of his secret before letters were sealed, and his privileges are at an end."

In view of this judicial hostility, which robbed the law of its beneficence and transformed the statute into an ambuscade, it is no wonder that for one hundred and fifty years scarcely more than one thousand patents were granted. It could make but little difference whether patents were denied, or having been granted were denied protection.

But a more enlightened sentiment developed. Watt had harnessed machinery to steam and Arkwright had harnessed spinning to machinery. The patent to Watt, granted in 1769, had been extended by an act of Parliament in 1775 and had run unscathed the gauntlet of the judges. Patents were granted with increasing frequency, and the useful arts received a mighty impetus. Powerful infringers sought to trample upon the rights of patentees, and law-suits followed that were fierce as battlefields. Judges began to regard inventors not as mere recipients of royal favor, but as public benefactors worthy of the world's great prizes. Then came those days, memorable in judicial annals, when jurists who were in touch with human progress discussed anew the relationship of the inventor to the public, and, as if they had foregleams of the new industrial era, laid down those broader and more generous principles which have become the foundation and framework of the patent law. The statute of James followed the Mayflower across the ocean. In the year 1641 the General Court of Massachusetts Bay granted a patent to Samuel Winslow for a method of making salt, and prohibited others "from making this article except in a manner different from his." In 1646 a patent was granted to Joseph Jenks for "an engine for the more speedy cutting of grass," the invention substituting for the short and clumsy English scythe a long slender blade supported by a rib along its back, a construction easily recognized as that of the modern scythe. The invention seems also to have extended to machinery for scythe-making.

The name of Joseph Jenks—how inconsiderable the place which it occupies in colonial history! The antiquarian stumbles upon it and makes a memorandum in his note-book, while the student of events that thrill and startle passes it without a thought or utterance. Nevertheless, a deep human interest invests it, and more and more it shall attract attention. Nor do we honor him the less because the mowing machine and the reaper have eclipsed in brilliancy his humble achievement, as there in the early wilderness he appeals to the General Court for protection, so that, as he quaintly says, "his study and cost may not be in vayne or lost."

The colony of Connecticut was far-sighted and liberal in encouraging inventors. Between 1663 and 1785 many acts were passed granting exclusive privileges in inventions relating to nearly all branches of industry practiced in the colony. Indeed, Connecticut passed a general law, which appeared in the revision of 1672, declaring that "there shall be no monopoly granted or allowed amongst us of but such inventions as shall be adjudged profitable to the country, and for such time as the General Court shall deem meet." This statute, by implication, held out inducements to inventors, and it is reasonable to associate with its enactment, a hundred years before the Revolutionary War, the fact that the people of Connecticut have taken out more patents *per capita* from year to year, down to the present time, than those of any other State.

In 1785 Maryland granted protection to James Rumsey for making and selling "new invented boats" on a model made by him; also, in 1787 to Oliver Evans for making and selling "two machines for the use of merchant mills," and "one other machine, denominated a steam carriage," the right of recovery against infringers being upon condition that the grantee should not "be proven not to be the original inventor." It will be noticed that this proviso reversed the burden of proof, as it stood under the English law, making the grant evidence of novelty unless the contrary should be shown as matter of defense.

In 1787 New York granted to John Fitch "the sole right and advantage of making and employing for a limited time the steamboat by him lately invented." During the next year New Jersey, Pennsylvania and Delaware granted to the same John Fitch the exclusive privilege "to navigate their waters with vessels propelled by steam."

I have thus alluded to some of the patents granted before the adoption of the Federal Constitution, because they show how deep-seated was the understanding, wherever the law of England had been inherited, that it was a just and beneficent exercise of the power of governments to protect inventions by patents for limited periods. I have done so, too, because the spectacle of John Fitch and James Rumsey and Oliver Evans applying to the several States for the limited protection which they could furnish will prepare us to expect that the constitutional convention will not overlook the subject in the midst of its important duties. We shall also expect to find that when a patent system common to all the States has been developed it will follow in the line of American precedent, and to a corresponding extent depart from the English system, by causing an examination before the patent is granted, in analogy to the legislative methods practiced by the colonial and State assemblies.

The constitutional convention in Philadelphia had been in session nearly three months before its attention was directed to patents and copyrights. On the 16th of August, 1787, Madison submitted for the consideration of the Committee on Detail two propositions for powers to be exercised by Congress, one of them "to secure to literary authors their copyrights for a limited time;" the other "to encourage by premiums and provisions the advancement of useful knowledge and discoveries." On the same day similar provisions were submitted by Charles Pinckney, one of them "to grant patents for useful inventions," another, "to secure to authors exclusive rights for a certain time." On the 31st of August such propositions as had not been acted upon were referred to a committee composed of one member from each State, and on the 5th of September this committee recommended that Congress have the power "to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries." In the final revision this clause became paragraph 8 of section 8 of Article I of the Federal Constitution.

Wise and illustrious men were they, those Constitution framers, but they had no conception of the importance of what they did, when, just before the curtain fell upon their labors, they decreed that the exclusive rights of inventors should be secured. They thought they were applying finishing strokes and touches to an edifice which was otherwise complete, when they were really at work upon its broad foundations. For who is bold enough to say that the Constitution could have overspread a continent if the growth of invention and of inventive achievement had not kept pace with territorial expansion. It is invention which has brought the Pacific Ocean to the Alleghanies. It is invention which, fostered by a single sentence of their immortal work, has made it possible for the flag of one republic to carry more than forty symbolic stars.

On the 23d of June, soon after the first Congress assembled in New York, Benjamin Huntington, of Connecticut, reported a bill to carry into effect the constitutional powers for promoting the progress of science and the useful arts. In this bill, for the first time in history, appeared the idea of a general law providing affirmatively for the granting of letters patent. For some reason, which does not appear, its consideration was postponed until the next session. On the 4th day of January, 1790, Congress having again assembled, a committee was appointed to report upon unfinished business brought over from the previous session. Before this committee could report, President Washington, clad in a broadcloth suit, made by Col. Jeremiah Wadsworth, of Hartford, addressed for the first time the assembled Houses of Congress. In that address he said: "I cannot forbear intimating to you the expediency of giving effectual encouragement, as well to the introduction of new and useful inventions from abroad as to the exertions of skill and genius at home." Three days later the committee which had been appointed made a report, in which they said: "It also appears that there was postponed for further consideration until this session a bill to promote science and the useful arts." This bill was thereupon referred to a committee consisting of Edward Burke, of South Carolina; Benjamin Huntington, of Connecticut, and Lambert Cadwallader, of New Jersey, who made a report on the 16th day of February, 1790. The bill thus reported, after discussion and amendment, was duly passed, and receiving the signature of the President, April 10, became the celebrated statute of 1790. The enactment of that statute this audience, unprecedented in its character in all history, now joyfully celebrates.

The law of 1790 was brief and simple. The applicant was required to describe his invention, but no claim or oath was called for. No discrimination was made between citizen and alien. A drawing was to be furnished and, in certain cases, a model also. In two respects the statute embodied a radical departure from English methods. It required an examination, and it made the patent *prima facie* evidence that the invention was truly described and the patentee the first inventor. The Secretary of State, the Secretary of War and the Attorney-General were to determine in each case whether a patent should be granted. From April to July they awaited a successful applicant. He comes at last, and three Cabinet officers—Jefferson, Knox and Randolph—sitting in solemn dignity, determine that Samuel Hopkins is entitled to a patent for his new method of making pot and pearl ashes.

Does any one say that the office then discharged was unworthy of such a tribunal? Let him then remember that that patent of July 31, 1790, was the first of four hundred and fifty thousand patents. Let him ask himself what adequate reason exists for the wizzard-like transformations of a century, excepting the stimulus afforded by patent legislation. Let him compare the saddle and the pillion with the parlor car, the tallow-dip with the electric light, the post-boy with the lightning mail, the telegraph and the speaking telephone. Let him make a corresponding comparison in every department of life, along every line of development, and he will see in the signing of that patent to Samuel Hopkins an act of historic grandeur.

Fifty-seven patents in all were granted under the statute of 1790, one of them being to our old friend John Fitch, whom we have met in the State assemblies. On October 24, 1791, we find James Rumsey presenting a petition to Congress that the act of 1790 might be amended and rendered more effective. A year later, November 7, 1792, he presented another petition, this time praying for the revision of the act.

It is familiar to all that a new act was passed on the 21st of February, 1793; but it is a fact not usually known that Mr. Williamson, of North Carolina, chairman of the committee having the measure in charge, in advocating the principles of the bill said that it was "an imitation of the patent system of Great Britain, and that its provisions were such as would circumscribe the duties of the presiding officer within very narrow limits." An oath was required to the application, and the patent was still to be *prima facie* evidence; the fees were increased to thirty dollars, aliens were cut off from receiving patents, provision was made for determining the rights of competing applicants by arbitration, the assignability of inventions was recognized and provided for, and the duty of granting patents was conferred upon the Secretary of State alone.

It would give me pleasure to speak with some detail of the history of the patent office between 1793 and 1836. But the patent system, and not the patent office, is my subject, and I must pass on to consider the great act of 1836, remarking, meanwhile, that in 1800 the right of obtaining patents was partially restored to foreigners, and in 1819 power was conferred upon the circuit courts to prevent the violation of the rights of authors and inventors by granting injunctions according to the principles and practice of courts of equity.

The act of 1836 created an epoch. An eminent statesman has pronounced it the most important event from the Constitution to the civil war. Less than 10,000 patents preceded it; more than 450,000 have followed in its train. Under it the Patent Office was established; under it the first Commissioner of Patents was appointed, and hardly had the approving signature of Andrew Jackson been affixed before the walls of yonder Doric temple, already completed in design, began to rise.

The most important change brought about by the act of 1836 was the restoration of the examination system and the establishment of an examining corps of experts. The English system, developed on executive lines, relegated all investigation to the courts; the American plan, developed on legislative lines, made the investigation precede the grant. The law of 1790 followed the American trend developed in the colonies, and Jefferson and his associates formed an examining board. Then came the act of 1793, which avowedly imitated the English system, and permitted a patent to be issued to any one who should allege that he had made an invention and should make oath that he believed himself to be the true inventor. Its workings are described in 1837 by Mr. Ellsworth, the first Commissioner under the new act. "The Patent Office," said he, "only examined names and dates, and granted all applications presented in proper form. Of course duplicates and triplicates were issued for the same invention. The rights of parties were referred to legal tribunals, and in the meantime spurious claims were selling throughout the United States."

The act of 1836 restored the American system. The Patent Office was vested with quasi-judicial as well as with executive functions, the patent being adjudicated upon in advance, and possessing, as soon as it was granted, the attributes of a patent which under the old system had been tested by expensive litigation. The importance to inventors of the system of preliminary examination has been declared to be inestimable. It places at the service of the humblest inventors the services of trained experts in law and mechanics. It makes the patent something more than an assertion of right, something more than a challenge to the world to show that the patentee was not the true inventor. It bears testimony that it has been compared with prior patents and publications, domestic and foreign, and with all that has been done in the United States, so far as known, and that the device or process claimed is what it professes to be—a new departure in the arts. Thus the patent acquires an immediate commercial value—a value which is enhanced just in proportion as means are supplied by the government for making an inquiry as complete and exhaustive as it is in human power to make it.

Another important feature of the act of 1836 was the distinction drawn between the description of the invention and the claim. It would be a mistake, however, to ascribe the first appearance of the claim to the act of 1836. Its history shows that it was evolved in practice before it emerged in law. The first American patent which contained anything like a claim, so far as the restored records of the Patent Office indicate, was that of Isaiah Jennings, November 20, 1807, for manufacturing thimbles for sails of ships. In the Franklin Journal for 1828 appears an article prepared by Dr. Jones, then Superintendent of the Patent Office, which contains the suggestion that, although it is perfectly proper to describe an entire machine, "after doing this the applicant should distinctly set forth what he claims as new, and this is best done in a paragraph at the end of the specification."

The requirement of a claim added greatly to the value of patents. It set definite walls and fences about the rights of the patentee, which were not less effective because they were incorporeal. A fruitful source of contention was done away with, and the chances lessened of being obliged to resort to the courts of law.

Time will not allow me to dwell upon the other changes wrought by the act of 1836, but I must introduce its author and champion, that "unaccredited hero," John Ruggles, Senator from Maine. Elected to the Senate in 1835, he signalized the beginning of his senatorial career by his conspicuous service as chairman of the committee in charge of the new measure, which he seems to have largely originated as well as championed. He received substantial aid from Henry L. Ellsworth, afterward the first Commissioner of Patents; and, if tradition is to be relied upon, Charles M. Keller, afterward a renowned advocate in patent causes, rendered invaluable assistance.

Subsequent laws, passed in 1837 and 1839, provided that where the patentee had made his claims too broad, through inadvertence, accident or mistake, he might file a disclaimer of the excess of claim, to become in effect a part of the original specification, and also prevented the forfeiture of the right to a patent by any use or sale of the newly-invented article prior to application, unless such prior use or sale covered a period of more than two years. The latter provision gave the inventor an opportunity to actually use his invention for a sufficient period to demonstrate its practicability and usefulness before applying for a patent. In 1842 the patenting of ornamental designs was authorized. In 1861 the term of a patent was extended from fourteen years to seventeen, and the right to obtain an extension, which had been conferred by an act of 1838, was abolished. In 1870 the patent law was revised, but the revision was in the nature of a consolidation of the statutes then in force. When the laws of the United States were generally revised in 1875 the act of 1870 was re-enacted without substantial change.

All the statutes since the law of 1836 have been in substantial accord with the policy inaugurated by that act, and have had for their object to carry that policy into effect, with such modifications as experience has shown to be necessary.

In 1790 three patents were granted; in 1890 the number was twenty-six thousand two hundred and ninety-two. In 1790 the receipts were about $15; in 1890 they were $1,340,372.60, an excess over all expenses of $241,094.72. In 1790 the work could only have required the infrequent services of a single clerk; in 1890 the number of employes, including the examining, clerical and laboring force, was five hundred and ninety men and women.

In order to distribute and dispatch the work the office is divided into thirty examining divisions, and inventions are divided according to subject-matter into two hundred classes and four thousand two hundred and ninety-five sub-classes. All applications as they are received are assigned to the assistant who has in charge the proper sub-class of invention. It is only by careful classification and division of labor that it is possible to conduct successfully the enormous amount of work which now, at the close of the century, is devolved upon the Patent Office.

The growth of the patent system has been brought about by the friendly laws which I have mentioned exercising their influence for the most part in four different channels:

1. The patent system has stimulated inventive thought. Benjamin Franklin, a man of science, stood by the side of the old hand lever printing press for a generation, and left it where it was left three centuries before by Guttenberg. It remained for Hoe and other inventors, who worked under the stimulus of the patent laws and patented their inventions, to produce that marvelous machine for disseminating knowledge that has made the world a university. A century ago the apprentice learned the skill and secrets of his craft and jogged along contented with his acquirements. To-day no workman expects to leave his craft or calling without lifting it to a higher plane and providing it with better instrumentalities. A new power of achievement has come into human thinking. Men of all callings seem to have acquired the faculty, and no explanation of the change is plausible which ignores the stimulating influence of a century of patent law.

2. The patent system has stimulated men to transform their thinking into things. It is a long and toilsome road from the first fugitive suggestion, through failure and discouragement and temporary defeat, to an invention in a form perfected. If men were not induced by the rewards of a patent system to cling to their new ideas through all the vicissitudes of an inventor's experience their hands would drop in discouragement. The story of the lost arts has never been told, even by Wendell Phillips, and decades and centuries of possible progress have been wrapped up in inventions which have dawned upon the human consciousness only to disappear and be forgotten.

3. The patent system encourages men to disclose their inventions. The duty of men to disclose their discoveries is one which, if it exists at all, has never been recognized. It is not so, however, when patent laws prevail, and for a hundred years men have hastened to share with the public their newly acquired ideas because of the invitation contained in the patent system, and the phenomenon of rediscovery is now a very rare experience.

4. The patent system enables inventors to make their efforts fruitful, and saves them from the folly of misdirected labor. The Official Gazette of the Patent Office publishes to the world the claims and one or more drawings of each patent. Each number of the Gazette may be likened to a series of maps, exhibiting that borderland adjacent to the illimitable unknown upon which the sun of human invention has shed its radiance, while clocks and watches have registered a week of time. Inventors need not and do not, as formerly, delve in exhausted mines.

It is a gratifying feature of this centennial era that the patent system is now at peace with all the world. Voices are heard in favor of amendatory statutes, opinions differ as to methods of administration, but no audible utterance, the wide-world over, challenges the policy of patent laws. In 1868 Count Bismarck in Germany and Lord Stanley in England declared, the former that patent laws should be abolished, the latter that he was ready to vote against them. But the Centennial Exposition at Philadelphia, that second declaration of independence, startled the nation with its splendid demonstration of the results of a liberal policy toward inventors. Sir William Thompson, in reporting upon the Centennial Exposition, said: "If England does not amend its patent laws America will speedily become the nursery of useful inventions for the world." Mr. Hulse, the English judge of textiles at the Exposition, in reporting to Parliament, said: "The extraordinary extent of ingenuity and invention existing in the United States, and manifested throughout the Exposition, I attribute to the natural aptitude of the people, fostered and stimulated by an admirable patent law system." Similar reports were made by the representatives of other nations.

The effect of these reports was speedily manifest. England, which had been discussing seriously whether or not the patent system should be abolished, passed a new act in 1883 upon a basis more liberal and popular in its character. Germany revised its law in 1877, and in a further and more radical revision, to take effect in October, 1891, European traditions have been largely disregarded, and to a considerable extent the American system has been imitated; and Switzerland, long cited as a state prospering without a patent system, in 1887 threw aside all its ancient traditions and enacted a wise and generous patent law. It is true that in our country congressional indifference has thwarted every forward movement in recent years, but nowhere in the popular mind does there seem to be a spirit hostile to the inventor's recompense. The demonstrations everywhere of the usefulness and importance of patent laws have been so overwhelming, and upon such a conspicuous scale, that upon no other subject relating to the internal policy of nations is there such profound repose.

Let us hope that the United States, whose place in the vanguard of progress is so largely due to its great inventors, may not now, through indifference to its patent system, fall back in the procession of the nations. Let us hope that an aroused public sentiment, set in motion by this celebration of the achievements of a century, may demand for the patent system, and for the office which administers its functions, just recognition of its mighty influence and of its rights and needs as it enters upon the second century of its usefulness.

INVENTION AND ADVANCEMENT.

BY HON. O. H. PLATT, LL.D., OF CONNECTICUT, U. S. SENATOR.

Neither the genius of Irving nor the exquisite acting of Jefferson was required to give the legend of Sleepy Hollow a lasting hold upon the popular heart. It was not wholly the miraculous flavor in the story of the Seven Sleepers of Ephesus that preserved that early Christian myth. In all such tales the mutual astonishment of the awakened sleeper and the wondering beholders is largely due to the fact that the changes which have occurred during the lethargic sleep are suddenly and sharply forced upon the attention. But in all of them it is the domestic, the political, or the social revolution that is thus outlined.

The legend in which the awaking dazed sleeper and the bewildered witnesses shall realize and feel the material, intellectual, and humanitarian development of the last century has yet to be given shape and skillful touch. The marvel is transcendent, but the story will never be wrought. Genius cannot describe nor the public mind appreciate what of human progress has occurred, what of human development has taken place in the United States during the last hundred years. I know of no place where it may be more fitly illustrated or more sharply forced on the attention than in this city of Washington. Imagine, if you can, an individual who witnessed the laying of the corner-stone of the Capitol, now nearly one hundred years ago, to have been suddenly withdrawn from the associations of men, and with the scenes of that day vivid in his mind permitted to stand again upon the spot graced by the completed building, but which to him had been a rural waste. We would appear to him like the inhabitants of a new world, while he would seem as strange a being to us as a visitor from some other planet. The Potomac flowing as before, the outline of the hills, the dip of the valley, the sun and the sky above would be the only features of what to him was the scene of yesterday. The city, with its noble avenues, its architectural structures, and the residences of its people, would have grown as if by magic in a night. These things he might with wonder dimly comprehend. But the steamboat on the river would startle him as the ships of Columbus startled the natives whom they approached. The wavy lines of black smoke and white vapor escaping from chimneys and steam-pipes would be as incomprehensible and awesome as the aurora borealis. The incoming and outgoing locomotives with their trains; street railroads and vehicles moving thereon apparently without propulsive force; the tick of the telegraph, transmitting thought from the ends of the earth; the voice of man sounding through half the continent in his ears, would be as truly miraculous to him as the raising of Lazarus from the dead. The light that illumines our nightly darkness to him would be as truly a miracle as was to Moses that bush which burned with fire and was not consumed. He would find the people engaged in occupations and pursuits of which he had no knowledge. Machinery would have no meaning to him; the thought of his fellow-men and their language in large part would be incomprehensible. Doubtless he would regard us all as crazy, and would probably repeat to himself the old familiar nursery rhyme, as true now as in his childhood:

> There was a mad man,
> And he had a mad wife,
> And the children were mad beside;
> So on a mad horse,
> They all of them got,
> And madly away did ride.

As the miraculous change began to dawn upon his mind, and he began by degrees to understand that it was real—that he had returned after an absence of a hundred years, and that during the century a thousand years of growth and development and increase of human knowledge and comfort and happiness had occurred—his first question of the bystanders would be: "What has done all this? Is this enchantment? What magician has transformed nature and changed mankind? What force, what power has been at work?" And the answer, if truly given, would be, "The spirit of invention has accomplished this; the creative faculty in man hath wrought these wonders."

How little we have realized the progress of the century; how silent its footsteps have been, and how little we have stopped to analyze or appreciate its cause. How barren of suggestion are the standard works on political economy and sociology as to the real underlying cause of the great transformation. Change, improvement, advancement have come to be so large a part of our history that we should the rather wonder if they ceased to go forward with accelerated motion. We are satisfied with nothing else. The world would be slow and dull and intolerable to us if in every decade we did not outstrip the performance of a century. We seem to care as little about the cause of it all as we do about sunlight and air, and health and strength. We enjoy it as our right. We write and speak of the incidents of progress, the new phases of our existence, of visible results, and magnify them in our minds above the invisible force which has produced the results. Away out in the busy world, if my thought shall ever reach it, men will receive my statement, that invention is to be accredited with this great progress, with a sceptical sneer. But you who are workers in the field, who are planning and devising methods by which still greater progress is to be achieved, will understand me.

Books without number have been written, showing how man emerged from savagery to barbarism, from barbarism to civilization. The whole world has been explored for relics by which to measure the progress of man on the long and toilsome way from his prehistoric condition to the period of civilization. Audiences gather to hear it explained, and go away satisfied that the weapon, the tool, or the implement dug up from its buried resting place unerringly proves how much progress mankind had made at the time it was used. Science divides the periods of human progress into ages, and calls them the stone age, the iron age, the bronze age, but has failed to comprehend that there is another age, the age in which we are living—the machine age. The first tool that man invented that he might more easily satisfy his wants does not more truly mark his advancement than does the invention of the marvelous devices and contrivances by which his comfort and happiness are a thousandfold multiplied in the present time. Savagery, barbarism, civilization—have we reached the end of human growth and development? Shall we not the rather understand that a new name must be given to the condition of human society upon which we are about to enter, if we have not already entered it; that we are reaching or have reached in our progress the age of spirituality. I do not use the word in its religious sense, but as meaning that, in the future of human achievement, mind is to triumph over matter, brain over muscle; that man is entering that period in which he is to subjugate all forces of nature and make them his servants.

Time will not permit me to paint the picture of our progress in detail; a few striking outlines must suffice. I must leave realistic touches to others. Nor can I closely analyze causes; I can merely suggest and generalize.

The establishment of constitutional liberty, the granting of patents for inventions, and the introduction and use of Webster's Spelling Book were practically coincident with the opening of the century, the closing of which we celebrate. Freedom, invention, popular intelligence were thus inaugurated. Who can fail to appreciate their intimate relation? During the century and a-half that preceded the year 1791 we had only succeeded in obtaining a permanent lodgment on the continent. We occupied only what has been called the selvedge of a great country. Our growth and progress had been slow. When the patent system was established we were less than four millions of people, differing little in character, ability, and pursuits from the men who settled at Jamestown and Plymouth. To-day we are more than sixty-three millions, so different in character and civilization that the traces of the Cavalier and Puritan are scarcely discernible. Then our westernmost States were Pennsylvania, Virginia, Kentucky, and Georgia; now the line of Commonwealths is unbroken from the Atlantic to the Pacific. Then the Mississippi River marked the western boundary of our possessions, and we had just passed an ordinance for the government of the unoccupied territory northwest of the Ohio River; now we are asking the nations of the world to join us in the Columbian Exposition on the shores of Lake Michigan. Our coal mines, with a present out-put of more than one hundred and thirty million tons per annum, were then practically unknown; our iron mines, with a present annual production of fourteen million tons of ore, were mainly unworked. The railroad was undreamed of; now our railroad trackage would encompass the earth six and one-half times. The steamboat was but an expectation; now we are using six thousand with an aggregate carrying capacity of two million tons. The telegraph then lay in the realm of the miraculous; to-day our telegraphic wires would reach from the earth to the moon, return to earth and again to the moon, with enough spare wire to girdle the earth three times. We had in those days about nineteen hundred miles of post-routes, over which the mail was carried at intervals and deposited in about seventy-five offices; now our post-routes cover more than four hundred and twenty-five thousand miles, and our post-offices number more than sixty thousand. The mail matter carried during the past year weighed more than one hundred and eighty-two thousand tons, and the persons engaged in carrying it (not including "free-delivery" carriers) traveled three hundred and twenty-seven million miles. Then we had a depreciated and really worthless currency, little of private wealth, and no public credit. Our sound currency now exceeds two billions of dollars; our national credit stands highest among the nations of the earth; and the aggregate wealth of our people is estimated to be more than sixty billions of dollars. Then a few weekly, semi-weekly or tri-weekly newspapers, scarcely larger than a sheet of foolscap, supplied and satisfied the popular demand for news. There were no reporters or editors then. These words are new, as are the professions they signify. It was the "printer" whom the public knew in connection with the newspapers of those days. The entire newspaper publication of 1791 is now surpassed in the weakest of our Territories; and a single newspaper of our day, The New York World, has circulated nearly six hundred thousand copies in a single day, requiring for their printing ninety-four tons of paper.

Manufactures, except in the household, were practically unknown. There were no "mechanics" in the meaning of the word as now used. Men knew how to sow and plow, hoe and chop, reap and mow and cradle, break flax and hackle it, thrash with the flail, winnow with the blanket or fan, and to shell corn by hand; the women knew how to spin, card, weave, and knit. Mechanical knowledge was monopolized by the blacksmith, the carpenter, the millwright, and the village tinker. Production was a toilsome, weary matter, limited by the capacity for muscular endurance. In the absence of reliable statistics we only know that in 1790 the value of our manufactures was but a few millions of dollars, the larger part of which consisted of linen and woolen cloth made in households. The value of our manufactured products in 1880 was between five and six billions. Statistics for 1890 are not at hand, but the sum total of our manufactured products within the census year can hardly be less than eight billions. But I must forbear; our material advancement surpasses the wildest dream of the most vivid imagination. Neither philosopher nor mad man could have predicted it. It is incomprehensible; the mind does not and cannot grasp it. We know that it is great; we try to realize it as in our feeble way we try to comprehend the infinite.

If you would in a measure form a conception of how large a factor invention has been in this progress, try to imagine what our social, financial, educational, and commercial condition would be with an absolute ignorance of how steam and electricity can be used in the daily production of things for our sustenance and comfort; with an absolute ignorance of the steamboat, the railroad, the telegraph, the telephone, the modern printing press, and the machinery in common daily use. Men who acknowledge that the development of invention and national progress have kept even pace in all that makes the people great and happy are yet slow to comprehend that invention has contributed in any large degree to such progress.

To satisfy the doubts of such, a little careful thought is needed. We may well inquire what it is that marks the superiority of our people. And to answer this we need to read the lesson which history teaches—that the people which has known most of the laws of nature, and has had with that knowledge the greatest capacity to apply natural forces in economic production, has always attained the highest point in human development. Human superiority consists in superior capacity to know and superior ability to do. If I understand how it is that invention has promoted the progress of our people, it is because it has enabled them to know more, and has given them the power to do more than any other people.

Invention needs a new definition; it has outgrown that given in the dictionary; we must inquire what it really is. To say that it is merely the act of "finding out," the "hitting upon," the "coming upon" something new, feebly expresses the meaning of the word. A recent law writer* more happily conveys to our mind its real force. He says: "Invention means the finding out, the contriving, the *creating* of something which did not exist, and which can be made useful and advantageous in the pursuits of life, or which can add to the enjoyment of mankind."

Mr. Justice Matthews felicitously expressed the same idea when he said it was "that intuitive faculty of the mind put forth in the search for new results or new methods, *creating* what had not before existed, or bringing to light what had lain hidden from vision."

We must understand that to invent is to create, and that the thing created must be beneficial to mankind. We are wont to say that we live in an environment of invention—that everything we touch, taste, handle, or see, is the result of an invention. We might more properly say that we live in a new creation. Literally, the old things have passed away and all things have become new. Human society is full of creators. Formerly we ascribed creative faculty or force to the Divine Being alone; our commonest thought of God was that He was the Infinite Creator. We said as we gazed on the forms, animate

*Prof. W. C. Robinson.

and inanimate, which surrounded us and which we believed contributed to our happiness, "Behold the expressed thought of the Creator—God!" and we were lost in wonder, love, and praise. Now, when we look upon the wondrous contrivances and inventions everywhere contributing to our life wants and adding to our life enjoyments, we are forced to exclaim: "Behold the expressed thought of the creator—man!" Inventions have given us a new and higher idea of the capacity of man. We begin to see how nearly he is related to Divinity; we have found a new meaning in the phrase, "So God created man in His own image." Shakespeare's words—the highest and noblest uninspired estimate of man seem real to us at last—"How infinite in faculty * * * * In apprehension, how like a god."

Let me illustrate. Men have often wondered and adored the Infinite Creator as they have dwelt upon the words—"And God said, 'Let there be light,' and there was light." But the hours are not all light; there is the night and darkness as well as the day and light. Now, if you will think as you come to this place this evening how the thought of man has transformed black coal and viewless electricity into the agents which light your pathway, you will feel it scarcely irreverent to exclaim: "And man said, 'Let there be light,' and there was light."

If you will let your mind dwell steadily on the development during the century of the creative faculty in man, you will discover one prominent reason for the advancement of mankind. You will see that the creative faculty is no longer limited to a few great souls, but that it is possessed by the many. You will see that the gap between the scientific discoverer and the practical workman is slowly but surely being closed. When we survey the field of invention our eyes rest inevitably on the figure of Watt. He stands out before us as the great leader in the inventive world. We give him highest place among those who have wrought for mankind. We put him above Alexander and Napoleon. They were destroyers; he was a creator; they devoured; he developed the world's capacity to produce. But do we realize that many greater than Watt are here? There are thousands of men in our midst whose praises are never sung, who pursue their intense work quietly and unnoticed, for whom the world erects no pedestal of fame, but each of whom knows more of the nature and power and adaptation of steam than Watt ever dreamed of. We sing the praises of Morse ; we write him down among our greatest ; we give him a conspicuous niche in our temple of fame ; the world pays tribute to his greatness, to his creative skill; he will go down in history as the first man who by his invention made it possible to crowd into a day's time transactions which would otherwise require a month's time for their accomplishment; who enabled every man who can buy a penny paper to behold as in a moving panorama the events transpiring throughout the whole world. But many greater than Morse are with us. There are thousands of girls in our country who know more of the laws of electricity, and better how to apply their knowledge of these laws in the transmission of human thought, than ever Morse imagined. Such men, such inventors, famous by right in the world's history, were after all but prospectors, locating the rich mine of human invention. They thought out, or by accident discovered, a limited possibility in the application of new forces to the supply of human wants. Then the world's thought became focused like a great burning lense on that possibility, and other men wrought the possible into the actual.

Thus it is with every invention. Watt, in a crude way, was the first to use that force which we call steam to move engines and machines, and for that he will ever stand in the first rank of inventors. But will you tell me who first used that greater force which we call electricity, and which some day will supersede steam as a motor power and add to the number of the marvels of our civilization ? For aught I know he may sit before me, but to me he is unknown. In that he first made application of that more subtle and potential force of nature in the working out of productive results beneficial to mankind, he is doubtless a greater inventor than Watt ; but the world has no crown for him. And why ? Possibly, because man has so advanced in capacity to know and do that the achievement of to-day must outrank the achievements of the past in order to confer great distinction on the doer; possibly, because there are now so many capable ones seeking the same result that the discovery of the germinal idea is no longer the work of one man.

So we see that each invention, great or small, by its own inherent force and power wonderfully stimulates and increases the inventive or creative faculty of man. Reduction to practice requires knowledge and skill equal to that of the man who conceives the idea, and the use of the invention necessitates knowledge akin to that of the inventor. The woman who uses the sewing machine must have knowledge in kind, at least, if not in degree, equal to that of Howe. The field laborer who uses the harvester must know as much of the operation, if not of the principle, of the machine as McCormick. What an advancement in average human knowledge this signifies in the country where we live and move and have our being among inventions! And if, as Bacon said, knowledge is power, how greatly have we advanced in power!

Another thought in this line. Our library shelves are filled with books, written to prove the ennobling influence of the fine arts upon mankind. Painting, sculpture, and music are lauded because they educate and refine society, because they improve and elevate men and women, and advance them in the scale of being. But, is the contemplation of a painting more inspiring than the intelligent study of an engine? Is a statue more beautiful than a machine? The one copies nature, the other compels nature; in the one there is repose and inaction, the other is instinct with life and energy. Are the waves of song more rythmic than the undulations which fall on the ear from the movement of myriad inventions? The one touches sentiment, the other sings to us of human peace and plenty.

Again. There are books without number which tell us how man grows by the contemplation of nature, of the subtle influence exercised upon the character of man by the scenes in which he dwells, by mountain and forest, by brook and river and ocean, by clear sky and fleecy clouds, by the rare tints of sunset and dawn, by breaking billow and roaring blasts. All this has been portrayed since books were first written—by poet, philosopher, and moralist alike. But who has written, who shall write, of that greater and subtler molding influence exercised upon the character of man by his subjection of the forces of nature to become his ministering spirits? Compare the man who muses on nature, who drinks in the influence of the mountain from afar, with the man who pierces that mountain to make a highway for the distribution of the world's products, or digs out from their dungeon the imprisoned metals, to be wrought into implements for his use, and tell me which man grows most or best. Which is the more a man, he who gazes with awe on the dark storm-cloud and sees in the lightning only the manifestation of the wrath of an angry God, or he who subdues the lightning and makes it his servant, and sends it to and fro on missions of mercy and sympathy to his fellow-man?

Thus far I have spoken of the indirect influence of invention on the progress of mankind, on human advancement. Let me for a moment be more specific and direct. Man is ever wanting something. He may be said to be the creature who wants; and the greater his attainment the more numerous his wants. The man who wants least in the world is of the least use to the world. Sometimes we call this craving, unceasing want of man, aspiration. Our fathers called it the pursuit of happiness, and declared it an "inalienable right." Whatever we may call it, this is true: The more numerous and complex the wants of man (provided they are not born of vicious desire) and the more easily they are satisfied, the better, abler, happier, and nobler mankind becomes. Every human want involves production; something must be produced to satisfy it, and production is useless and objectless except to satisfy human wants. Man's first want is to appease hunger and quench thirst; his next, to be protected from the extremes of cold and heat. If these are all, we call him a savage, and production stands at its minimum. With every step of advancement toward civilization and spirituality his wants multiply, and production must increase. His comfort and happiness, his present and future, depend upon the ease with which he can obtain wherewith to satisfy and gratify these wants.

Now, the true problem of invention—its only purpose and object, indeed—is, first, to enable man to satisfy his present wants with less of effort and cost than before; and, second, to create in him the new wants incident to his higher plane of existence, and the means of supplying those wants, so that as the years go on man can have more of comfort with less of personal effort than ever before. If this does not constitute human advancement, I do not know what does.

Is it true that invention does this? It is the test by which the patentability of every invention is tried. It is the test applied by the inventor, the Patent Office, the courts, to determine whether the machine, or process, or product is really an invention. The machine or process must be "new and useful," (what pregnant words); that is, it must produce things adapted to the existence and comfort of man, cheaper and better than they can be produced by any known process. If the invention be of a new product, the same law defines and limits it. The new product must be "useful;" it must be one that man can use, and, from its use, be benefited. If the inventor does not believe this capability resides in his invention, he abandons his effort. If the Commissioner of Patents cannot find this quality in the supposed invention, he rejects it. If courts cannot discover this essential characteristic, they say it is not entitled to be called property. That man must be blind and deaf and dull to the degree of stupidity who does not see that in this country during the last century inventions have laid their magic fingers upon every means and source of production, have improved and cheapened every product, have multiplied new products until now our entire population has more of comfort and less of want, more of happiness and less of misery, more of pleasure and less of pain, than any people that now exists or has ever existed—and all these with less of weary, wearing toil, with less of anxiety and less of hardship.

When and why we began to count the world's life by centuries, as men count human life by years, we hardly know. There are years in almost every individual life during which a man's character, habits, and effort undergo radical change—some forceful cause makes him a new man. So in a short hundred years the spirit of invention has changed the current of human thought and purpose and enterprise in our country— it has made a new world. The America of to-day is radically different from the America of 1791. We call our improvement the development of Christian civilization; and I would not for a moment forget nor disparage the great influence of Christianity in molding our institutions and directing our pursuits. But what kind of a Christian civilization would it be with the spirit of invention still dormant? Improved printing presses, telegraphs, and the means of rapid communication have given us a different Christianity, and taught us the lessons of the Master more correctly. The religious polemics of a former century interest men no longer. Reasoning

> Of providence, fore-knowledge, will and fate,
> Fixed fate, free-will, fore-knowledge absolute,

is as obsolete now as the argument to prove witchcraft a reality and of satanic origin. Men no longer wander in the mazes of abstract speculation; they seek for practical truths and practical results. The clergyman who should preach the sermon of a hundred years ago would speak to empty pews. The present religion is one that seeks to better man's physical and social condition. We care less for doctrine, and more for human improvement; and we have come at last to dwell with intense satisfaction upon the thought that our Saviour went about "doing good."

Thus we see how the inventive spirit of the age has been working this change; how the very essence of an invention is to do good to man, to minister to the comfort, the happiness, and the higher intelligence of the people; how it works hand in hand with the spirit of a true religion. For the first time in the history of the world we seem to be making real headway against superstition and bigotry. We no longer count the mysterious as miraculous. What seemed miraculous has in our day too often come to be commonplace to let us sit down in wonder before it. For the first time we have come to learn that true rivalry in manly achievement is the struggle to accomplish most for the benefit of mankind, and that the only real happiness consists in enabling others to become happy.

Nor is the change in the method and system of our education less radical than that in religious thought and effort. The college president of a hundred years ago would bring financial ruin to any college in a twelve-month. We more and more demand that our children shall study the present, and that their expansive powers shall not be imprisoned in the dungeons of a dead past. Roman and Grecian manners, customs, literature and art are no longer the only models upon which we seek to develop the character of our sons. They must be fitted to explore the storehouse of nature and to bring out therefrom unseen treasures for a true enrichment of their fellows. Nothing more strikingly illustrates this change than the public demand for scientific, industrial, and manual training schools. Consider for a moment how impossible such schools would have been when our Constitution was framed, and how their felt necessity is now changing all our educational methods. No education is complete to-day that does not fit the student to deal with the great problems of applied science, the solution of which is still more to enrich and bless mankind. Education is not finished now in the college or professional school; it goes on in the workshop, in the laboratory, by the lathe, in the field, in the mine, in the forest, wherever and so long as man is called upon to wrestle with these great problems. And how intense life has become in consequence! Slow and toilsome processes of thought are now no longer possible by the side of the swiftly-moving machine; thought has been wedded to intuition. Evidence is not wanting that invention and discovery have resulted in lengthening the average of human life. But whether this be so or not, if we count life by its action and experience and what we gain in it and by it, our term of life has been wonderfully lengthened.

The change in human enterprise may be illustrated by contrasting what were once the Seven Wonders of the world with the seven wonders of American invention. The old wonders of the world were: The Pyramids, the Hanging Gardens of Babylon, the Phidian Statue of Jupiter, the Mausoleum, the Temple of Diana at Ephesus, the Colossus of Rhodes, and the Pharos of Alexandria. Two were tombs of kings, one was the playground of a petted queen; one was the habitat of the world's darkest superstition ; one the shrine of a heathen god ; another was a crude attempt to produce a work of art solely to excite wonder, and one only, the light-house at Alexandria, was of the slightest benefit to mankind. They were erected mainly by tyrants ; most of them by the unrequited toil of degraded and enslaved laborers. In them was neither improvement nor advancement for the people.

Let me enumerate the seven wonders of American invention : The cotton-gin ; the adaptation of steam to methods of transportation ; the application of electricity in business pursuits ; the harvester ; the modern printing press ; the ocean cable, and the sewing machine. How wonderful in conception, in construction, in purpose, these great inventions ; how they dwarf the Pyramids and all the wonders of antiquity ; what a train of blessings each brought with its entrance into social life ; how wide, direct, and far-reaching their benefits! Each was the herald of a social revoluion ; each was a human benefactor ; each was a new Goddess of Liberty ; each was a great emancipator of man from the bondage of labor ; each was a new teacher come upon earth ; each was a moral force.

I should not do justice to this subject if I omitted to speak of one thing, which, however, it will hardly be thought necessary in this gathering to urge as a defence of the patent system. Our patent system needs no defence. When our fathers asserted constitutional authority for Congress to promote the useful arts, by granting to inventors for a limited time the exclusive control of their inventions, they builded better than they knew. But it may be said that without the stimulus afforded by the prospective reward of the inventor this development of invention would never have occurred—that the inventor is spurred and lured on by the expectation of a fortune. I do not deny that every inventor expects and hopes for pecuniary gain to be derived from his invention, and that if there were no gain the spirit of invention might be checked. It is right that the man who benefits mankind should be rewarded. Our instinct of justice revolts at the short-sighted policy which has ever sought to stifle inventions, and we rejoice at the liberal policy founded upon the good judgment of mankind which has sought to encourage them.

The world has nothing but contempt for the Emperor Tiberius who, when approached by a skillful workman who had discovered the secret of making glass malleable, inquired of him whether he alone possessed the secret, and upon being assured that he was the only one, ordered his head to be struck off immediately, lest his invention should prove injurious to the workers in gold, silver, and other metals. I deny, however, that the hope of pecuniary gain is the only motive of invention, or indeed the most powerful motive. Two others, at least, are more potent: The insatiable desire of man to see the invisible, to touch the intangible, to know the unknown, to conquer the unconquered, is one; to benefit the human race is the other. The prospect of money reward alone would never absorb and concentrate and intensify the faculties of the inventor. He is an enthusiast. Like prophet and poet, he seems possessed by a semi-madness. A passion to accomplish and achieve what seems impossible takes hold of him. He is a philanthropist, too; the desire to furnish his fellow-men with something new and useful absorbs him. There are men sitting before me, no doubt, whose waking and sleeping hours are given to the exploration of new fields, that they may discover, control, and apply new forces; who are striving to bring forth inventions more wonderful and beneficial than the world has yet known. Ask them, and see if they do not tell you that I am right, and if they do not scout the idea that the pecuniary profit which they may derive from their invention is the only, or indeed the principal, motive that impels them. If they can but discover the germs of new inventions which are to cheapen production, which are to minister to the present and prospective wants of mankind, they will be satisfied with their life-work and feel that they are entitled to a place among the world's great doers, though others shall enter in and reap more abundantly the money reward. There never yet was a true invention from which the public did not reap infinitely greater pecuniary reward than the inventor. However selfish his purpose may be, it is an inevitable law of invention that it holds greater benefits in store for the masses than for the inventor.

I must not fail to notice at this point a more or less prevalent idea that the result of invention is to enrich the few at the expense of the many—that capital is assisted while labor is injured. I have little patience with this belief. It is the wail of the pessimist rather than the opinion of the intelligent. Men who give utterance to it forget that in social economy man always builds on the ruins of the past. The first effect of every useful invention is to destroy capital. In the inventive realm the fittest only survives. No invention answers its purpose that does not either supersede the old methods of production or bring forth a new product. If some new motive power should be discovered which would enable us to produce those things which men must have for their sustenance and happiness better and more cheaply than water power, air power, steam power, and electrical power, the capital thus invested would be gradually but surely destroyed; whereas all experience teaches us that there would be no injury to labor—there would simply be a readjustment of labor and an increased demand for it. There would be a demand for more intelligent labor, more skillful labor, more brain labor, as well as a greater demand in new fields for what we term muscular labor.

An illustration or two conclusively proves this. In the beginning of the century there were no railroads; all transportation was by wagons, carts, horses, and oxen. The railroads of the country last year, in railroad parlance, moved sixty-eight billion tons of freight one mile. To have accomplished the same work would have required more horses than there are in the United States, and two-thirds of the able-bodied men of the country to drive them. But all the horses in the country were needed for other work—work which, except for the railroads, would not have been done. With the introduction of the railroad the men who had driven horses found that their services were in demand at prices which teamsters never expected to receive. There would be no such carrying trade as we now have if it had not been developed by the railroads. People who think that invention lessens the demand for labor should remember that millions of people find profitable employment in localities where Indians would now be hunting the buffalo were it not for the inventions which go to make up that vast system of railroads, which is itself one great conglomerate machine acting with the precision of mechanical law. They should remember, too, that to operate the railroads of this country nearly a million persons are employed to fill places that have been created by the railroad, in which intelligence and skill of a high order are required. They should take account, too, of the men who have worked in mines and forests, who have built furnaces and mills, who have produced the rails for one hundred and sixty thousand miles of railroad track, and the necessary equipment of locomotives and cars; of the men who have leveled and graded the roads—who have pierced the mountains and filled up the valleys; of the men who have found employment in supplying all these laborers and artisans with food and comforts and luxuries. That man is sadly deficient in the intelligence of the age who cannot see that every true invention greatly increases the demand for labor, improves the quality of labor, and thereby enhances its price.

About thirty-five years ago men discovered a natural product unknown before; they called it petroleum. Invention seized upon it and began to work it into useful forms for the production of useful results and to supply unquestioned needs. It was a timely discovery. Without it, we can hardly conceive how it would be possible to light the homes of our people. In every stage of its treatment invention has been called into use. By the aid of those inventions the crude article has been resolved into more than one hundred and fifty separate products, each one of which has its commercial designation, its beneficial use—many of them supplying wants unfelt and unknown before. All this has created an army of workmen engaged in employments unheard and unthought of but for the discovery, and for the inventions which have so multifariously utilized the product. What labor has been displaced or injured thereby? So with every invention since the creation of man. Not one of them but has made life more to be desired by the toiler; not one but has made his station more honorable, his environment more agreeable. I count it one of the chief benefits of our unrivaled inventions that labor in the United States has become more intelligent, more skillful, and therefore commands the highest price. I count the advancement of our laborers as the chief wealth of our people. A people may have gold and not be rich, may have lands and be indigent; but a people with intelligence and skill and energy is truly rich and truly great. It is brain power that constitutes real wealth. The old poet of the sixteenth century who sang, "My mind to me a kingdom is," had a better conception of the true nature of wealth than the man who counts only the millionaire as the wealthy man.

One other thought I commend to the pessimist. If, as he believes, invention has augmented and concentrated capital and clothed it with power which is used to the public detriment, it has also made possible the organization and association of labor. Without the railroad, the telegraph, and the press, associated labor could not exist; without these children of invention, no labor combination or organization would extend beyond the city or town in which it was organized. By adding to the intelligence of the masses, by the opportunity which it gives for association, invention has wonderfully increased the power of the masses. The laborer is no longer an isolated toiler. Invention has clothed him with strength as a garment. God grant that he may use it wisely.

We stand in the doorway of a new century. What of the future? Has invention reached its zenith; has man attained his highest development; has he already reached the goal of human progress; can he advance no farther? I ask these questions because I firmly believe that the limit of human invention is also the limit of human advancement; that he who writes the history of invention will write the history of mankind; that if invention has already done its perfect work, man is all he can ever hope to be in this life.

For one, I cannot entertain the gloomy thought that we have come to that century in the world's life in which new and grander achievements are impossible. For one, I am persuaded that we have but just entered the era of improvement; that at no period in his existence has man been so well equipped, so well fitted by his ability, knowledge, and high resolve, to grapple with the problems of life and to make new conquests in the field of invention. Invention is a prolific mother ; every inventive triumph stimulates new effort. Man never is and never will be content with success, and the great secrets of nature are as yet largely undiscovered. Though we seem to have accomplished much, we really know but little. Who knows what electricity is? Who understands the properties of any material substance? Who has solved the mysteries of the atom and the germ? Who knows what forces men have passed by in their search for motive power? Who has even catalogued the forces of nature? What wondrous possibilities are yet locked in her storehouse? But, after all, the real wonder of the earth is man; never so wonderful as when he boldly challenges nature to unlock her doors and reveal her mysteries that he may use them for the improvement and advancement of his kind.

THE RELATION OF INVENTION TO LABOR.

BY HON. CARROLL D. WRIGHT, OF MASSACHUSETTS,
COMMISSIONER OF LABOR.

The lines of industrial history are dimly drawn. The writers of civil history have been too thoroughly engrossed with political events and with wars to give much attention to the development of the industries of different peoples. Here and there a paragraph or a page may give some hint of the state of the industrial arts during different periods and in different countries; but the necessity of giving connected and extended accounts of industrial progress has not yet seemed to possess them. The beginning of the history is, of course, as nebulous as the beginning of all history. It runs back into the ages, beyond tradition, even, for we cannot conceive of the first step in civilization having been taken without the assistance of the industrial arts. When the Greek could find no trace of his own origin, it is unreasonable to suppose that the historian can give the origin of those arts which have been potent in developing civilization. The history of the development of the mechanic arts must be largely the history of civilization; at least each reflects the history of the other, for it is true that as advancing civilization has begotten higher and finer types of production, the higher type of artisan has been the productive element in social progress. It is impossible, with this condition of things historically, to treat of the relation of invention to labor, or, more broadly, of the influence which invention has had upon labor during the earlier historical stages.

The civil historian finds it convenient to make three great divisions of history — ancient, medieval, and modern. The historian of the industrial arts can make use of but the first and the last of these periods, the two great divisions, ancient and modern—the ancient extending almost to our own time, the modern finding its birth in that wonderful period of invention practically beginning with the year 1760. We are, then, actually living in the early generations of the modern history of manufactures, for the whole ancient period saw but little change and but little invention, beyond the few contrivances by which people met their simple wants. Certainly invention had not been prolific in processes of production. The period of ancient history, as defined, has not even ceased for a great proportion of the inhabitants of the world.

The grand divisions which the archæologist finds essential are far more applicable to manufactures than those of the civil historian. He takes three great ages—the stone age, the bronze age, and the iron age—and these divisions more accurately mark the progress of manufactures, for in them we find the peculiar changes which mark the growth of the inventive genius of the world. The limits of these ages, however, are not found to be contemporaneous, so far as beginning and ending are concerned, for while the stone age may have ended in one country and the bronze age been evolved from it, the stone age may have lingered for centuries longer in another country, or the bronze age may have continued far beyond the birth of the iron age among an adjacent people, or it may have been omitted because of the conquest of a people still living in the stone age by a people who had reached the iron age. These great distinctions of ages, which the archæologist finds so convenient, are not continuous steps in the development of natural history, except in a philosophical sense. Logically they are true divisions, and so far as nearly all the peoples of the world are concerned they are true divisions chronologically. The history of civilization is not that of successive steps, except as we view great cycles of time; so the various industrial systems which have prevailed in the world—the slave system, the feudal system, and the wage system—are not successive universally, but only successive in individual nations. Even in the case of special nations, one or the other of these systems may have been omitted through the circumstances growing out of conquest, or, it may be, treaty, though in the growth or evolution of industrial events the steps are quite regular. The natural division of industrial history really involves two great features—hand-production and machine-production. Hand-production prevailed until the last half of the eighteenth century, and, as already remarked, inventive genius had not been applied in this direction, except in the simplest way. During the last half of the eighteenth century the history of machine-production, or of the age of mechanical invention, really began; it is with this age that I have to deal, for it is only since invention has been applied to productive processes that it has had any specific influence upon the labor of man, either in an economic or an ethical sense.

The age of invention found its birth in the development of spinning and weaving, and as these two arts lay at the very foundation of the industrial arts of the ancients, so they are the basic arts of the modern system of industry. Until the decade of years beginning with 1760, the machines in use for weaving, as well as for spinning, were nearly as simple as those in use among the ancients. The principles adopted by the ancients, of course, are those still in force. The processes of spinning and weaving were generally performed under the same roof, the weaver continually pressing upon the spinner for a supply of weft or warp; but the weaver's own family could not respond with a sufficient quantity, and he had much difficulty in collecting it from neighboring spinsters. The first influence of invention, paradoxical as it may seem, aggravated this difficulty by a device for facilitating the progress of weaving. This occurred by the use of the fly-shuttle, invented in 1738, by one John Kay, by which device one man alone was enabled to weave the widest cloth, while prior to Kay's invention two persons were required. One can readily see how this increased the difficulty of obtaining a supply of yarn; for the one-thread wheel, though turning from morning till night in thousands of cottages, could not keep pace either with the weaver's shuttle or with the demand of the merchant. In the same year, 1738, John Wyatt invented an elementary mechanical contrivance whereby he expected that a single pair of hands could spin twenty, a hundred, or, on a perfected mechanical construction, even one thousand threads. This invention of Wyatt's, patented by royal letters-patent in 1738, in the name of Lewis Paul, really embodied the method of spinning by rollers, for Wyatt's specification describes the very principle of spinning by rollers which distinguished the spinning machine brought into use thirty years later by Sir Richard Arkwright, and which was universally adopted, and of which Sir Richard is generally supposed, even at the present day, to have been the inventor. Wyatt did not succeed, either in making his fortune, or in introducing his machine into use. He lacked the pecuniary means, and could not hold out long enough to realize the success his genius merited; but, more than all, as often happens with many advanced inventions—inventions made in advance of the times—he lacked the time and attendant circumstances, with all their subtle influences, which accompanied the train of inventions relating to spinning and weaving which came into use a generation or so after Wyatt's time. His invention slumbered for thirty years, until it was rediscovered, or, what is just as probable, until its principles came accidentally to the knowledge of Arkwright, who, previous to 1769, had been a barber at Preston. These primitive efforts—that of John Kay, in the invention of the fly-shuttle, and that of John Wyatt, in the invention of spinning machines where rollers were used—formed the germs from which sprang that great line of inventions which has revolutionized industry, and whose influence upon labor has been so widely marked in every direction.

The invention of the spinning jenny came just in time to have its usefulness adopted. One day while a spinner of England was at work with his single wheel, in what poetry has called a "cottage," but what history denominates a "hut," surrounded by his children, they accidentally overturned the wheel, and while it lay on the earthen floor in a horizontal position, the wheel, which was revolving at the time it was overturned, continued to revolve, and of course the spindle revolved through the power conveyed to it. This little accident suggested to the intelligence of James Hargreaves the idea that a spindle could be run in a position perpendicular to the motive-power, as well as horizontal, and that the same power might be carried to two or more spindles. He therefore set himself to work and constructed, between 1764 and 1767, a crude machine, subsequently called a spinning jenny, which had several spindles driven by cords or belts from the same wheel. He was thus enabled to multiply his production of yarn. This result brought him increased wages, and made him the envy of his neighbors, who, fearing that the machine would ultimately affect them injuriously, became excited, broke into Hargreave's house, and destroyed not only the machine but nearly all of his furniture. The inventor was so severely persecuted that he left his native county and went to Nottingham, at which place he was furnished with means and was enabled to perfect his invention, taking out royal letters-patent in 1770. But the year previous, 1769, Richard Arkwright, of whom I have spoken, took out a patent for his invention of spinning by rollers. These two men, therefore, can be called contemporaneous inventors, and, so far as practical results are concerned, the original inventors who gave to the world the birth of the age of invention.

The mule-spinning machine, which Samuel Crompton invented in 1776, was a combination of the principles of the jenny and the water-frame of Arkwright, and entirely superceded the use of the jenny; but the machines of Hargreaves and Arkwright broke down the barrier which had so long obstructed the advance of the cotton manufacture, and the breaking down of this barrier inaugurated the factory system, which really dates from their period.

In 1785 Dr. Edward Cartwright invented the first power-loom. This was improved upon by various inventors till 1806, when power-looms began to be used in factories. Prior to this invention all the yarn spun by power-machines had been woven into cotton by hand-loom weavers, and of course the introduction of the power-loom caused a repetition of the scenes of riot which followed the introduction of the spinning machine. The power-loom closed the catalogue of inventions necessary to the inauguration of the era of mechanical supremacy.

To give in detail an account of the invention of the great processes in all departments which have affected civilization or which have constituted, or marked, practical epochs in industrial evolution, is not my province. Others who speak to you will give you this information. But the influence upon the labor of man, of the age which was born when the spinning and weaving machinery of England was perfected, constitutes a theme to which I am called upon to address myself. This influence has been great, and has been felt along two principal lines or directions, those of economics and of ethics. Economically speaking, the influence has been felt in two directions also, but in diametrically opposite ways. These ways are what are called, in popular speech, "the displacement of labor" and "the expansion of labor." By the displacement of labor is meant what would be expressed more specifically by another term, the contraction of labor; that is, where a machine has been invented by which one man can do the work, with the aid of the machine, of several men working without its aid; and by the expansion of labor is meant where, through invention, more men are called into remunerative employment than would have been employed had not such invention been made. In considering these economic bearings or influences of inventions, we must deal with labor abstractly, while under the ethical influence we not only deal with labor abstractly, but with man as a social and a political factor. This, of course, leads at once to the remark that the ethical influence, or the ethics of the question, becomes the most prominent feature of any treatment of the relation of invention to labor. Before touching this, however, I desire to call your attention to some of the more marked economic disturbances which have taken place.

The Displacement or Contraction of Labor.

The facts relative to the so-called displacement of muscular labor by machinery have been drawn from the First Annual Report of the U. S. Commissioner of Labor.

That labor-saving machinery, so-called, but which more properly should be called labor-making or labor-assisting machinery, often displaces labor so far as men, individually, are concerned, and temporarily, cannot successfully be denied. All men of sound minds admit the permanent good effects of inventions; but the permanent good effects do not prevent the temporary displacement, which displacement, so far as the labor displaced is concerned, assists in crippling the consuming power of the community in which it takes place. It is, of course, exceedingly difficult to secure positive information illustrating a point so thoroughly apparent; yet from the source I have named a sufficient amount of information can be drawn to show clearly and positively the influence of inventions in bringing about what is called displacement.

In the manufacture of agricultural implements new machinery, during the past fifteen or twenty years, has, in the opinion of some of the best manufacturers of such implements, displaced fully fifty per cent. of the muscular labor formerly employed, as, for instance, hammers and dies have done away with the most particular labor on a plow. In one of the most extensive establishments engaged in the manufacture of agricultural implements in one of the Western States it is found that 600 men, with the use of machinery, are now doing the work that would require 2,145 men, without the aid of machinery, to perform; that is to say, there has been in this particular establishment a loss of labor to 1,545 men, the proportion of loss being as 3.57 to 1. In the manufacture of small arms, where one man, by manual labor, was formerly able to "turn" and "fit" one stock for a musket in one day of ten hours, three men now, by a division of labor and the use of power machinery, will turn out and fit from 125 to 150 stocks in ten hours. By this statement it is seen that one man individually turns out and fits the equivalent of 42 to 50 stocks in 10 hours, as against one stock in the same length of time under former conditions. In this particular calling, then, there is a displacement of 44 to 49 men in one operation.

Looking to a cruder industry, that of brick-making, improved devices have displaced 10 per cent. of labor, while in making fire-brick 40 per cent. of the labor formerly employed is now dispensed with, and yet in many brick-making concerns no displacement whatever has taken place.

The manufacture of boots and shoes offers some very wonderful facts in this connection. In one large and long-established manufactory in one of the Eastern States the proprietors testify that it would require 500 persons, working by hand processes and in the old way in the shops by the roadside, to make as many women's boots and shoes as 100 persons now make with the aid of machinery and by congregated labor, a contraction of 80 per cent. in this particular case. In another division of the same industry the number of men required to produce a given quantity of boots and shoes has been reduced one-half, while, in still another locality, and on another quality of boots, being entirely for women's wear, where formerly a first-class workman could turn out six pairs in one week, he will now turn out eighteen pairs. A well-known firm in the West engaged in the manufacture of boots and shoes finds that it would take 120 persons, working by hand, to produce the amount of work done in its factory by 60 employes, and that the hand-work would not compare in workmanship and appearance by 50 per cent. By the use of Goodyears' sewing machine for turned shoes one man will sew 250 pairs in one day. It would require eight men, working by hand, to sew the same number in the same time. By the use of a heel-shaver or trimmer one man will trim 300 pairs of shoes a day, while formerly three men would have been required to do the same work; and with the McKay machine one operator will handle 300 pairs of shoes in one day, while without the machine he could handle but five pairs in the same time. So, in nailing on heels, one man, with the aid of machinery, can heel 300 pairs of shoes per day, while five men would have to work all day to accomplish this by hand. A large Philadelphia house, which makes boys and children's shoes entirely, has learned that the introduction of new machinery within the past thirty years has displaced about six times the amount of hand-labor formerly required, and that the cost of the product has been reduced one-half.

The broom industry, which would not seem to offer a large field for speculation in reference to displacement, has felt the influence of invention, for the broom sewing machine facilitates the work to such an extent that each machine displaces three men. A large broom-manufacturing concern which a few years ago employed seventeen skilled men to manufacture 500 dozen brooms per week, now, with nine men, aided by invention, turns out 1,200 dozen brooms weekly; so in this case, while the force is reduced nearly one-half, the quantity of product is more than doubled.

To look at a carriage or a wagon, one would not suppose that in its manufacture machinery could perform very much of an office, and yet a foreman of fifty years' experience has informed me that the length of time it took a given number of skilled workmen, working entirely by hand, to produce a carriage of a certain style and quality was equal to thirty-five days of one man's labor, while now one man produces substantially the same style of carriage in twelve days. Machinery has been employed in making the parts necessary to the construction of a carriage or a wagon, and thus has simplified the work and reduced the time essential for the production of the completed product.

In the manufacture of carpets there has been a displacement, taking all the processes together, of from ten to twenty times the number of persons now necessary. In the spinning of carpet material alone it would take, by the old methods, from seventy-five to one hundred times the number of operatives now employed to turn out the same amount of work, while in weaving there would be required at least ten times the present number. A carpet-measuring machine has been invented which brushes and measures the product at the same time, and by its use one operator will accomplish what formerly required fifteen men.

Very many people would say that in the manufacture of clothing there has been no improvement, except so far as the use of the sewing machine has facilitated the manufacture; yet in the ready-made clothing trade, where cutting was formerly done by hand, much of it is now done by the use of dies, many thicknesses of the same size and style being cut at one operation. So in cutting out hats and caps with improved cutters, one man is enabled to cut out a great many thicknesses at the same time, and he does six times the amount of work with such devices as could formerly be done by one man in the old way.

While the age of machinery began with improvements for the manufacture of textiles, so the manufacture of textiles, and especially cotton goods, offers perhaps as striking an illustration as any of the apparent displacement of labor. With a hand-loom a weaver used to weave from sixty to eighty picks per minute in weaving a cloth of good quality, with twenty threads of twist to each one-quarter square inch. With a power loom he now weaves one hundred and eighty picks per minute of the same kind of cloth. Even in power machinery, a weaver formerly tended but one loom. Now one weaver minds all the way from two to ten looms, according to the grade of goods. In a large establishment in New Hampshire, improved machinery, even within ten years, has reduced muscular labor 50 per cent. in the production of the same quality of goods. This, of course, is true in other localities given to the manufacture of cotton goods. In another line labor has been displaced to such an extent that one-third the number of operatives formerly required is now in employment. In the days of the single-spindle hand-wheel, one spinner, working fifty-six hours continuously, could spin five hanks of number thirty-two twist. At the present time, with one pair of self-acting mule-spinning machines, having 2,124 spindles, one spinner, with the assistance of two small boys, can produce 55,098 hanks of number thirty-two twist in the same time. It is quite generally agreed that there has been a displacement, taking all processes of cotton manufacture into consideration, in the proportion of three to one. The average number of spindles per operative in the cotton mills of this country in 1831 was 25.2 ; it is now over 72, an increase of more than 185 per cent.; and along with this increase of the number of spindles per operative there has been an increase of product per operative of over 145 per cent., so far as spinning alone is concerned. In weaving in the olden time, in this country, a fair adult hand-loom weaver wove from forty-two to forty-eight yards of common shirting per week. Now a weaver, tending six power-looms in a cotton factory, will produce 1,500 yards in a single week.

Marvelous as these facts appear, when we examine the influence of invention as applied in the newspaper publishing business we perceive the magic of inventive genius. One of the latest quadruple-stereotype perfecting presses manufactured by R. Hoe & Co., of New York, has an aggregate running capacity of 48,000 eight-page papers per hour ; that is to say, one of these perfected presses, run by one pressman and four skilled laborers, will print, cut at the top, fold, paste and count (with supplement inserted if desired) 48,000 eight-page papers in one hour. To do the press-work alone for this number of papers would take, on the old plan, a man and a boy working ten hours per day one hundred days. A paper now published in the morning, printed, folded, cut and pasted before breakfast, would, before the edition was completed under the old system, become a quarterly.

And so illustrations might be accumulated in very many directions—in the manufacture of furniture, in the glass industry, in leather-making, in sawing lumber, in the manufacture of machines and machinery, in the production of metals and metallic goods of all kinds, or of woodenware, in the manufacture of musical instruments, in mining, in the oil industry, in the manufacture of paper, in pottery, in the production of railroad supplies, in the manufacture of rubber boots, of saws, of silk goods, of soap, of tobacco, of trunks, in building vessels, in making wine, and in the production of woolen goods.

It is impossible to arrive at an accurate statement as to the number of persons it would require under the old system to produce the goods made by the present industrial system with the aid of invention and power-machinery. Any computation would be a rough estimate. In some branches of work such a rough estimate would indicate that each employe at the present represents, on an average, fifty employes under the old system. In many other branches the estimate would involve the employment of one now where three were employed. Looking at this question without any desire to be mathematically accurate, it is fair to say, perhaps, that it would require from 50,000,000 to 100,000,000 persons in this country, working under the old system, to produce the goods made and do the work performed by the workers of to-day with the aid of machinery. This computation may, of course, be very wide of the truth, but any computation is equally startling, and when it is considered that in spinning alone 1,100 threads are easily spun now at one time where one was spun under the old system, no estimate can be successfully disputed.

All these facts and illustrations simply show that there has been, economically speaking, a great displacement of labor by the use of inventions; power machinery has come in as a magical assistant to the power of muscle and mind, and it is this side of the question that usually causes alarm. As in the early day, when Hargreaves and Arkwright were struggling to supply the weaver with a sufficient quantity of yarn, and the spinners looked only to the immediate effect upon themselves, so now, no good answer can be made to the man who finds his labor a superfluity in a market overstocked with labor. Enlightenment has taught the wage-receiver some of the advantages of the introduction of inventions as his assistants, but he is not yet fully instructed as to their influence in all directions. He does see the displacement; he does see the difficulty of turning his hand to other employment or of finding employment in the same direction. These are tangible influences which present themselves squarely in the face of the man involved, and to him no philosophical, economic or ethical answer is sufficient. It is therefore impossible to treat of the influence of inventions, so far as the displacement of labor is concerned, as one of the leading influences, on the individual basis. We must take labor, as I have said, abstractly. So, having shown the powerful influence of the use of ingenious devices in the displacement or contraction of labor, as such, it is proper to show how such devices have influenced the expansion of labor or created employments and opportunities for employment which did not exist before their inception and application.

The Expansion of Labor.

As incredible as the facts I have given might appear to one who has not studied them, the ability to crystalize in individual cases and show the fairly exact displacement of labor exists. An examination of the opposite influence of inventions, that of the expansion or creation of employments not before existing, reveals a more encouraging state or condition of things, but one in which the statistician can make but very little headway. The influences under the expansion of labor have various ramifications. The people at large, and especially those who work for wages, have experienced these influences in several directions, and contemporaneous with the introduction and use of inventions, the chief economic influence being in the direction of expansion, the other influences being more thoroughly ethical, and these should be considered under that broad title. The science of statistics helps us in some respects in studying the expansive power of inventions, and especially in the direction of great staples used as raw material in manufacturing processes and in the increase of the number of people employed relative to the number of the population. If there has been a great increase in the consumption per capita of great staples for manufacturing purposes, there must have been a corresponding expansion of labor necessary for the production of goods in like directions. Taking up some of the leading staples, the facts show that the per capita consumption of cotton in this country in 1830 was 5.9 pounds; in 1880, 13.91 pounds, while in 1890 the per capita consumption had increased to nearly 19 pounds. These figures are for cotton consumed in our own country, and clearly and positively indicate that the labor necessary for such consumption has been kept up to the standard, if not beyond the standard, of the olden time—I mean as to the number of people employed. In iron the increase has been as great proportionately. In 1870 the per capita consumption of iron in the United States was 105.64 pounds, in 1880 it had arisen to 204.99 pounds, and in 1890 to 283.38. While processes in manufacturing iron have been improved, and labor displaced to a certain extent by such processes, this great increase in the consumption of iron is a most encouraging fact, and proves that there has been an offset to the displacement. The consumption of steel shows like results. In 1880 it was 46 pounds per capita, and in 1890, 144 pounds. The application of iron and steel in all directions, in the building trades, as well as in the mechanic arts, in great engineering undertakings, and in a multitude of directions, only indicates that labor must be actively employed, or such extensions could not take place. But a more conclusive offset to the displacement of labor, considered abstractly, is shown by the statistics of persons engaged in all occupations. From 1860 to 1880, a period of twenty years, and the most prolific period in this country of inventions, and therefore of the most intensified influence in all directions of their introduction, the population increased 59.51 per cent., while during the same period the number of persons employed in all occupations—manufacturing, agriculture, domestic service, everything—increased 109.87 per cent. In the decade of years, 1870 to 1880, the population increased 30.08 per cent., while the number of persons in all occupations increased 39 per cent. An analysis of these statements shows that the increase of the number of those engaged in manufacturing, mechanical, and mining industries, those in which the influence of inventions is most keenly felt, for the period from 1860 to 1880, was 92.28 per cent., as against 59.51 per cent. increase in the total population. If statistics could be as forcibly applied to show the new occupations brought into existence by inventions, I believe the result would be still more emphatic. If we could examine scientifically the number of created occupations, the claim that inventions have displaced labor on the whole would be conclusively and emphatically refuted. Taking some of the great industries that now exist, and which did not exist prior to the inventions which made them, we must acknowledge the power of the answer. In telegraphy thousands and thousands of people are employed where no one has ever been displaced. The construction of the lines, the manufacture of the instruments, the operation of the lines—all these divisions and sub-divisions of a great industry have brought thousands of intelligent men and women into remunerative employment where no one had ever been employed before. The telephone has only added to this accumulation and expansion, and the whole field of electricity, in providing for the employment of many thousands of skilled workers, has not trenched upon the privileges of the past. Electro-plating, a modern device, has not only added wonderfully to the employed list by its direct influence, but indirectly by the introduction of a class of goods which can be secured by all persons. Silverware is no longer the luxury of the rich. Through the invention of electro-plating, excellent ware, with most artistic design, can be found in almost every habitation in America. The application of electro-plating to nickel furnished a subsidiary industry to that of electro-plating generally, and nickel-plating had not been known half a dozen years before more than thirty thousand people were employed in the industry, where no one had ever been employed prior to the invention.

The railroads offer another grand illustration of the expansion of labor. It now requires three-quarters of a million of people to operate our railroads, and this means a population of nearly four millions, or one-sixteenth of the whole population of the country. The displacement of the stage-coach and the stage-driver was nothing compared to the expansion of labor which the railroad systems of the country have created. The construction of the road-bed and its equipment constantly involve the employment of thousands and thousands of mechanics, while the operation of the roads themselves, as I have said, secures employment to more than three-quarters of a million of people. All this work of the railroads has not, in all probability, displaced a single coachman ; on the other hand, it has created the demand for drivers and workers with horses and wagons through the great expansion of the express business, of cab-driving, of connecting lines and in other directions, which could not have taken place under the old stage-coach *regime*.

When the sewing machine was invented it was thought that the sewing girl's day was over. So it was in a certain respect. She can now earn more money with less physical exhaustion than under the old system. Abominably poor as are the results of her efforts now, they are far better than they would have been without this invention. But as a means of the expansion of labor the sewing machine is a striking illustration. It has displaced no one ; it has increased demand, and it has been the means of establishing great workshops to supply the thousands of machines that are sold throughout the world.

The inventions of Goodyear, whereby rubber gum could be so treated as to be made into articles of wearing apparel, have resulted in the establishment of great industries as new creations. We need not in this place consider the great benefits through the use of water-proof clothing. The mere fact that great industries have arisen where none existed before is sufficient for our purpose. I might take up much time in simply accumulating illustrations showing the expansive force of inventions in the direction of creating new opportunities for remunerative employment. The facts I have given show conclusively that displacement has been more than offset by expansion. Yet, if the question be asked, Has the wage-earner received his just and equitable share of the economic benefits derived from the introduction of machinery? the answer must be, No. I mean by this his relative share, compared with that going to capital. In the struggle for supremacy, in the great countries devoted to mechanical production it probably has been impossible for him to share equitably in such benefits. Notwithstanding this, his share has been enormous, and the gain to him such as to change his whole relation to society and the state, such changes affecting his moral position.

It is certainly true—and the statement is simply cumulative evidence of the truth of the view that expansion of labor through inventions has been equal or superior to any displacement that has taken place—that in those countries given to the development and use of machinery there is found the greatest proportion of employed persons, and that in those countries where machinery has been developed to little or no purpose poverty reigns, ignorance is the prevailing condition, and civilization consequently far in the rear.

The Ethical Influence of Inventions.

According to Mr. Herbert Spencer, ethics comprehends the laws of right living; and that, beyond the conduct commonly approved or reprobated as right or wrong, it includes all conduct which furthers or hinders, in direct or in indirect ways, the welfare of self or others; that justice, which formulates the range of conduct and limitations to conduct hence arising, is at once the most important division of ethics; that it has to define the equitable relations among individuals who limit one another's spheres of action by co-existing, and who achieve their ends by coöperation; and that, beyond justice between man and man, justice between each man and the aggregate of men has to be dealt with by it.

This constitutes a very broad definition of ethics, and the propositions laid down by Mr. Spencer, taken by themselves, are such as no moral philosopher can for a moment reject, nor should they be rejected by economists, for a moment's reflection upon their bearing shows conclusively that material prosperity is best subserved by their incorporation as chapters in the laws of trade, commerce, and production. So the relation of the wage receiver to his fellow-man and to society becomes ethical, purely so; but it is certainly ethico-economical, and his wages, the standard of his living; his working time, the cost of his living; his education, his interest in religious and literary matters, in art, and in all that adorns life, are features surrounding him which must be contemplated from the ethical point of view. This thought is all the more emphatic when it is considered that invention has brought with it a new school of ethics. It is the type and representative of the civilization of this period, because it embodies, so far as physics and economics are concerned, the concentrated, clearly wrought-out thought of the age. Books may represent thought; machinery or invention is the embodiment of thought. From an intellectual point of view, then, it becomes perfectly legitimate to speak of the ethical influence of inventions, and no consideration of the relation of inventions to labor would be complete without showing in a more deeply philosophical sense the ethical influence upon the individual laborer.

We are living at the beginning of the age of mind, as illustrated by the results of inventive genius. It is the age of intellect, of brain—for brain is king, and machinery is the king's prime minister. Wealth of mind and wealth of purse may struggle for the mastery, but the former usually wins, and gives the crown to the Huxleys, Darwins, Tyndalls, Proctors, Woolseys, and Drapers, rather than to the men who accumulate great fortunes. It is natural and logical that under such a sovereignty inventions should not only typify the progress of the race, but that they should also have a clearly marked influence upon the morals of peoples, a mixed influence, to be sure, as men are what we call good or evil, but on the whole with the good vastly predominant.

The philosopher of the pessimistic school usually finds in the economic influence of inventions a great displacement of labor or back-work, and he calls the attention of the thinkers of the present day to the supposed glories of the past. He calls up for consideration what he designates the peaceful and happy days of labor under the domestic system ; he sees in the growing importance of inventions what he is pleased to call the destruction of the individuality of men and their retrogression to mere puppets, without the intelligence of the machinery he deplores ; he sees in the division of labor what is to him a sure corollary of invention, the degradation of labor, the dwarfing and narrowing of the mind, and the complete subjugation of all manly qualities ; he fails to comprehend work as anything more than mere manual labor, the expenditure of muscle, and never realizes that work means employment—occupation—the means by which all sane people secure happiness for themselves and for those whom they love, and that whatever is done in the name of service to mankind is work, and that the work which calls out the highest faculties of the worker, whether of endeavor or aspiration, is for him the highest employment. He also fails to comprehend, or, at least, he overlooks the fact, that under the domestic system of labor displaced by invention the most demoralizing conditions prevailed. He finds something exceedingly poetic in the idea of the weaver of old England, before the spinning machinery was invented, working at his loom in his cottage, with his family about him, some carding, others spinning the wool or the cotton for the weaver, and so falls into the idyllic sentiment that the domestic system surpassed the present. This idyllic sentiment has done much to create false impressions as to the results or influence of inventions. Goldsmith's Auburn and Crabbe's Village do not reflect the truest picture of their country's home life under the domestic system of labor, for the domestic laborer's home, instead of being the poetic one, was very far from the character poetry has given it. Huddled together in his hut, not a cottage, the weaver's family lived and worked, without comfort, convenience, good air, good food, and without much intelligence. Drunkenness and theft made each home the scene of crime and want and disorder. Superstition ruled, and envy swayed the workers. If the members of a family, endowed with more virtue and intelligence than the common herd, tried to so conduct themselves as to secure at least self-respect, they were either abused or ostracized by their neighbors. The ignorance under the old system added to the squalor of the homes under it, and what all these elements failed to produce in making the hut an actual den was faithfully performed, in too many instances, by the swine of the family. The reports of the Poor Laws Commissioners of England are truer exponents of conditions than poetry, and show more faithfully the demoralizing agency of pauperism and of all the other evils which were so prolific under the hand-system of work.

The influence of invention at this particular time in the history of mankind is usually overlooked by the philosopher with a pessimistic turn of mind, and he also overlooks the fact that if there is any one thing in individuals that this age insists upon more than any preceding age, it is work—employment of some kind. Once it was enough to be good; now one must prove himself valuable or he becomes, if not an actual, a social and a moral tramp. St. Paul said: "To him that worketh, reward is reckoned not of grace, but of debt." Yet when a man is employed to the extent of the support of himself and his own, the reward must be reckoned of grace; and he is capable of a better and purer religion, for a poverty-stricken people cannot well be a religious people. Ethics and pure religion most assuredly have much to do with everything that affects the conduct of life; they constitute the art of living well, not merely of dying well, and they are the science of being and of doing. The aim of the modern Christ would be to raise the whole platform of society, says an ethical writer * of our day. The modern Christ would not try to make the poor contented with a lot in which they cannot be much better than savages or brutes, and he would not content himself with denouncing sin as merely spiritual evil. On the other hand, he would go into the economic causes of sin and destroy the flower by cutting at the very roots, which are poverty and ignorance; and the lowest, the most harmful and the most expensive ignorance of to-day is ignorance of work—the want of some technical knowledge which enables a man to earn his own living outside of penal institutions. Poverty and pure religion cannot exist among the same people, for such a religion cannot prevail unless the people are engaged in that

* Dr. C. C. Everett.

class of employment which tends to broaden all their faculties, to awaken not only their sense of duty to their kind, but also to develop their love of beauty, of art, and of all that adorns and ennobles life; and such employment cannot be maintained without the vitalizing use of inventions as the enduring, working and perfect embodiment of human ingenuity. We are hardly aware of the silent working influence of machinery upon the morals of the world; it is recognized in this thought I have outlined, that poverty and religion are not now, as once, twin virtues. Christianity only prevails in industrious communities. The people of America, with all their faults and foibles, are more religious in the truest sense than any other people; and this, I am sure, is because amongst a democratic people, where there is no hereditary wealth, every man works to earn a living, or has worked, or is the son of parents who have worked, the notion of labor therefore being presented to the mind on every side as the necessary, natural and honest condition of human existence. A wealthy man even thinks he owes it to public opinion to devote his leisure to some kind of industrial or commercial pursuit, or to public business. He would think himself in bad repute if he employed his life solely in living (*a*). This idea of life or of active living is stimulated by all the elements which make up the essential characteristics of our period.

Professor Everett, of the Harvard Divinity School, in an admirable paper entitled "The new Ethics," gives an excellent illustration of this truth. "The time has been," he says, "when poverty was felt to be to some extent a mark of sanctity. Your tramp would lack little of being regarded, if not as a saint, at least as a very good representative of one. Poverty was regarded as, in a double sense, a means of grace. The poor themselves were not far from the Kingdom of Heaven; at the same time they furnished one of the readiest means of salvation to their rich neighbors. It was the poor who carried the souls of the rich to heaven. Thus poverty was to be comforted and solaced. It was to be in some way ameliorated. The poor were at any event to be kept alive. But the idea of doing away with poverty would have been

a. Democracy in America, by De Tocqueville.

considered if not sacrilegious, at least hardly desirable. This life of poverty was, indeed, the ideal life." This ideal life of poverty continued to be the leading thought so long as the domestic system of labor prevailed. The age of machinery, of invention, of active mental competition, as set over against purely muscular competition, has changed this whole state of things; for now it is considered that poverty is not the blessing, but the curse of society, and the whole social effort is not so much to ameliorate as to abolish it. Charity, instead of being regarded as the ideal virtue, is, at least under its old form, regarded as a weakness, if not as a vice. To help men, we must now help them to help themselves. We must give work—employment, mental or muscular occupation, and in it find not the cure-all, not the panacea for all of the evils that threaten society, but a great uplifting influence, which in time will become a panacea for some of the evils; but in order to have this great influence induce the very best conditions for the reception and growth and home of a high state of morals, the prerequisite of religious advancement, the employment or work should be of the very highest grade. If the lowest grade of employment leads to self-respect, and the dignity and repose even, which come of self-support (a proposition which cannot be denied), how ennobling must be that employment which not only stimulates the highest faculties, but also excites admiration for the perfect and love for the beautiful! A man cannot superintend the movements of a complicated piece of machinery and not feel this silent working influence, and, maybe, become the better for his experience. His mind intuitively takes on the harmony of action and finds itself running in tune to something which represents embodied thought. Any man witnessing the operations of the wonderful mechanism of the needle machine feels a continued influence from his observations. There is something peculiarly educational in the very presence of the working of mechanical powers. The witnessing of the automatic movements of a machine stimulates thought, and, coupled with necessity or desire, makes the beholder not only the inventor of other movements, but also brings him to a higher respect for the inventions of the world and creates in him a mental activity which places him on a higher standard than that on which he lived prior to his invention. In the first steam engines a boy was constantly employed to open and shut alternately the communication between the boiler and the cylinder, according as the pistons either ascended or descended. One of these boys, who, like most boys, loved to play with his companions, observed that by tying a string from the handle of a valve which opened this communication to another part of the machine, the valve would open and shut without his assistance and leave him at liberty to divert himself with his fellows. Probably there was a displacement of labor, for one of the greatest improvements that has been made upon the steam engine since it was first invented was the discovery of a boy who wanted to save his own labor. And so it has been that very many of the machines made use of in manufactures have been invented by workmen who, being employed in some simple operation, have turned their thoughts toward finding out easier and readier methods of performing it (*b*).

These things stimulate industry, and, as I have said, industry and poverty are not hand-maidens; and so as poverty is lessened, good morals thrive. If labor—employment of the mind—is an essential to good morals, then the highest kind of employment—that requiring the most application, the best intellectual effort—means the best religion and the best morals. If it were not so, then the continued employment at the crudest muscular labor would be the best for mankind. But the condition I have named, I take courage to assert, is superinduced eventually by the employment of so-called labor-saving machinery and the division of labor, and the reverse of this condition is superinduced by the continued and exhausting application of much muscle and the use of little intellect.

In the early history of political economy we find that progress was supposed to be the result of the division of labor; to-day it is very often the *bête noir* of a class of philosophers who do not look beyond the apparent displacement of muscular labor by the use of improved machinery. These philosophers make out a most excellent *prima facie* case, as I have shown by the facts cited relative to the displacement or contraction of

b. Adam Smith: Wealth of Nations.

labor. The error lies in taking the *prima facie* case for the conclusive evidence, which is found in joining the facts pertaining to the expansion of labor. Now the optimist sees in the division of labor what may well be called the emancipation of labor, and instead of the dwarfing of minds, the undue stimulation of industrial enterprises and moral retrogression, he sees the fuller development, in every direction, of minds, of industries, of moral relations; and he sees in the clouds created by the modern philosophers the warm showers which will sprout the germs of the solution of some of the vexed questions of labor. Communism, which means the destruction of labor, cannot co-exist with machinery. It must be true that without machinery the world would retrograde to superstition and consequent irreligion, and that without machinery the ingenuity of man must assume its old place among the unused faculties of the mind.

These truths, or what to my mind are truths, are easily and conclusively illustrated by many every-day observations. In some of the Spanish localities of New Mexico the plow of to-day is the bent stick of the Egyptians; but as the railroad cuts through the land and through the ignorance of New Mexico, it straightens out the plows as it straightens out the streets of that country—by the sheer influence of parallel lines. When a railroad is run through a straggling town, with houses thrown together as a child leaves its toys upon the floor, the first thing is to set it to streets running parallel with and at right angles to the railroad. The whistle of the locomotive has shrieked out a vast amount of civilization during the past fifty or sixty years, for with its shriek and as its cinders fell to the ground, the spelling-book and the New Testament have been lodged as fixtures in the new country.

All such illustrations are common-place, indeed, but they are necessary in a discussion of the influence of inventions upon labor.

The division of labor has grown finer and finer as machinery has grown more and more essential to the production of goods. The consequence is that trades are hardly essential now, and the mechanic of a generation ago feels grieved because the artisan of to-day is not obliged to spend from three to seven years in learning a trade, and thereby be robbed to a great extent of the results of his labor. The apprentice boy, if bright, could learn his trade in less than the time required, but he could not become a journeyman until he had been pronounced such by the time spent at learning a trade ; and after he had become skillful his wages were exploited to the extent of his skill, and he was obliged to contribute more in the way of actual earnings than he received. But this was not the worst. Finding that he was robbed by the system, he finally undertook to earn no more than he was paid, and so acquired habits of unthrift which would follow him through life. The apprentice boy has disappeared from the industrial world, but the old-school workman, instead of glorying in the fact that he has disappeared and that the time has come, or is coming, when the years spent in learning a trade are considered as partially lost time, feels the absence of the apprentice as a menace. But the intelligent workman, I am happy to know, has changed his views in this respect, and finds that through manual training and the results of the trade school, a boy can utilize his whole time, and as soon as accomplished or equipped in his trade, can command the wages legitimately his due ; and the boy who has had the experience of good training schools has the advantage over the old apprentice, for he discovers that instead of one trade at which he can secure a living, he may seek remunerative employment through his handy skill in other trades when the chosen one does not furnish sufficient employment. This enables the world to go on in the diversity of employment or development, or the versatility of talent, which is the secret of that future distribution of labor so much to be desired before the full results of the readjustment of industrial forces from the domestic system to the age of machinery shall be complete.

With this diversity of employment will come still shorter hours of labor and, consequently, increased opportunities for mental and moral improvement. This age has already brought greatly increased wages, a greatly reduced working time and a largely reduced cost of the principal articles of consumption.

I cannot analyze in the space and time allotted me the deductions of statistics which emphatically prove these things ;

nor is it essential. Such statistics exist. Wages have been increased, and one illustration must suffice, and I will draw this illustration from the cotton industry of this country, the first to feel the effects of invention. The ratio of wages for 1828 and 1880, in producing common cotton cloth, was as 2.62 in the former year to 4.84 in the latter year, while in the cost of production the ratio was reversed, it being as 6.77 in 1828 to 3.31 in 1880. The hours of labor have been reduced from twelve or thirteen per day in the same industry to nine and one-half in England and ten generally in this country. An examination of statistical tables will convince anyone that for most divisions of labor in cotton factories wages have very nearly doubled during the past sixty years, not only in Great Britain but in this country, and an examination of the wage statistics of very many industries shows the same results with, however, a varying percentage of increase.

As to production, the facts given in the earlier part of this address must suffice. There can be no question in regard to this feature of the influence of inventions.

With inventions there came the discussions and agitations of England for the amelioration of the condition of operatives, resulting in less hours of labor, machinery guarded against accident and all the beneficent laws for the elevation of the British factory workers to the plane of men and women. This work is still incomplete, but is progressive.

The inevitable result of machinery to enable man to secure a livelihood in less time than of old is grand in itself if none other had been secured. But this is not so much the effect of legislation as of changed conditions brought about by the use of inventions. It must be considered that as the time required to earn a living grows shorter civilization grows up, and that that system which demands of a man all his time, or a great portion of it, for the earning of mere subsistence is demoralizing in all respects.

It cannot be successfully denied that the direct influence of inventions has been felt in these three ways I have just outlined—the increase in wages (and I mean by this the increase in actual earnings in a given time), the reduction of working time, and the decreased cost of articles of consumption, whereby wages are made more efficient.

Another exceedingly important influence which has grown from the division of labor by the use of machinery in production relates to the length of life and to the means of comfortable living. We are told that in the good old times so many sick or feeble people were not seen as now. This is true, because they died. The feeble could not live under the old conditions; only the most robust and sturdiest physical natures could survive, and none others were seen. To-day the presence of feeble men and women of advancing years does not show degeneracy of the race; they must be looked upon as a living glory of our civilization, which enables them to exist. It shows elevation of the race, and that now, under the conditions of life, the result of all the various inventions which look to the comfortable existence of people, the comparatively feeble cannot only live, but can, if they choose, support themselves in a great measure, for feeble and dainty hands can perform work to which, in the good old time, only a giant would have been assigned. I need not specify the lines on which invention has perfected or established these conditions. They are too familiar to every one. In warm and comfortable clothing, in water-proof material, in heating and lighting, in a thousand ways, invention has carried with it comfortable conditions, increased health and an increased longevity; for now the average life is at least ten per cent. higher than in the olden time.

The beauty, the art, the enthusiasm, which belong to good morals can only grow to the wage receiver with a high order of employment and the division of labor, and with a high order of employment not only for profit, but for recreation—for art even. The age of inventions, or periods given to the development and practical adaptation of natural laws, raises all people coming under their influence to a higher intellectual level, to a more comprehensive understanding of the world's great march of progress.

Low grades of labor are constantly giving place to educated labor. The man who used to do the most detestable form of work is being displaced by the professional who superintends some device brought into use by invention, and the constant promotion of luxuries to the grade of necessaries of life also marks the forward steps of civilization and positively demands the fullest play of the ingenuity of man to place them within reach. By invention, what were luxuries to one class are now the necessaries of life to a class that might be considered below the first. The manufacturer often finds that he is obliged to sell for old metal the grand mechanical construction of a decade ago. Old successes are constantly giving place to the new, which make old mechanical perfections bungling in our present sight, and they must be destroyed to give place to the new. An examination carried on in any direction demonstrates the proposition that all progress, every step in advance, is over apparent destruction, and, like every pioneer who has ever startled the world with his discoveries and by them benefitted his kind, is over the graves of men individually or over their aspirations. Ignorance in men, as well as the men of ignorance, is in the way of progress, and must give way to intelligence.

As space and time have been overcome, inordinate differences in values have been overcome ; the markets of the world have been equalized, sectional resources have become cosmopolitan in their character, as peoples of all the world have become acquainted. All these influences have disarranged trade, upset old principles ; and we of the present time are living in a transition period of readjustment, or rather adjustment, that is like the early days of convalescence from fever—painful from lingering weakness, but joyous in the full knowledge of progress. In this adjustment individuals go down. The divine plan to perfect all the creations which make up the universe takes no notice of individuals, and is apparently profligate of human life ; but goes on with the work, crushing if need be, killing if it must, but always polishing, always purifying, always perfecting.

The wheel of progress rolls on, destroying the old as it rolls, crushing out ignorance ; but it rolls all the time, and man is often obliged to give way before it, as the old machine is thrown aside for the new. Educated labor, as the pioneer, must step over human graves, over buried ambitions and lost opportunities ; the law is infallible, even if in our short-sightedness we call it cruel.

All the benefits of the division of labor and the application of invention, like the reduction of working time, corresponding increase of wages, the decreased cost of production, etc., are benefits particularly marked during the past century, and they have given to man a wonderfully enhanced power to command what rulers a century ago, with all the appointments of war and the adjuncts of unlimited exchequers, could not command. The individual profits, as well as his kind, which claims the reward of improved conditions. We can hardly realize that there should have ever been a time when a linen sheet was worth thirty-two days of common labor, and when a gridiron cost from four to twelve days labor. Nor can we fully comprehend the moral influence which has come in other directions. It is hard to understand that even within the memory of men now living the first change in the way of speed in transportation or in the interchange of intelligence came to the world. Prior to the generation which precedes the present the fastest time that could be made was through the speed of man, or of horses, or of sailing vessels, except, perhaps, in the occasional transmission of intelligence by signals. So, as oddly as the purely economic changes seem to us, they strike with much less marvel then the reflection that Cyrus, when he had turned the river Euphrates from its channel and captured the city of Babylon, could inform his associates at home of his feat as quickly as could Washington the American Congress of the defeat of Cornwallis; or that Alexander after the battle at Arbela could send the news of his great victory for civilization to his capital in the same time it took Jackson to inform the Government of the United States that the British army had surrendered to him at New Orleans, and so won the already granted peace for this country.

It has been reserved for the age of machinery, and for machinery itself, to cure the difficulties in the way of national and grand movements which beset the governments existing back of this epoch, and now the great engineering enterprises of the day are being developed, and are thus solving the problem of how to relieve congested cities and of how to give to the wage-worker, who must save time as between his lodging and his work, the benefits of healthful surroundings in the country.

Rapid transit, through the application of electricity to street cars in the city of Boston within a few months, has added one-half hour of the day to the workingman's available time. This is the influence of invention, and a moral influence, for it betters his condition, helps him to a higher plane, facilitates social intercourse, and in every way gives him better opportunities for enjoying all that belongs to his environment.

These grand movements are the movements of great communities, but by inventive skill, by the application of ingenuity, the gain to the individual has been exceedingly marked, and perhaps in a more specific way than to communities at large.

To create is the province of the Omnipotent. The second great attribute, through the agencies established by Omnipotence, is to develop, and this allies man to his Creator. Can such a thought be illustrated by figures? Most surely; for educated labor, with applied natural forces, has developed a pound of cotton costing 13 cents into muslin which sells for 80 cents; into chintz which sells for $4. It has developed 75 cents' worth of common iron ore into $5 worth of bar iron, $10 worth of horse shoes, $180 worth of table knives, $6,800 worth of fine needles, $29,480 worth of shirt buttons, $200,000 worth of watch springs, $400,000 worth of hair springs, and $2,500,000 worth of pallet arbors (*c*). Intelligent, skilled labor, with its product of mind has accomplished this, and the individual, as well as the state, has profited by the development. Under such development a common man can ride to his work or upon his travels in palaces that would have been the envy of kings, and he can send the word of his arrival with a flash. He has learned that the wants of a free people increase as fast as there are means of supply, and that "contentment with one's lot is "the virtue of the subjects of a despotically governed and "non-progressive state, and self-denial the virtue of a poor "and unprosperous people;" and he has learned, too, that the ranks of the skilled and intelligent workmen are not thinned by the workhouse and the penitentiary, but that the ranks of ignorant labor are prolific in stocking such institutions. He will learn in the future that diversity of employment, and the consequent practical versatility of his talents, will enable him

(*c*) Technical Education. By Geo. Woods, LL.D., Pittsburg, 1874.

to secure the essentials of life in a few hours, and that he can swell his income by artistic employment upon articles which may now be denied him.

The inevitable result, it seems to me to be, is, that while we shall always have the unfortunate with us, made so from a variety of causes, all this will be palliated to a large degree by the capacity to use inventions to not only employ one's time, when enfeebled, upon profitable work, but also to bring with such employment corresponding joy.

The common man has learned furthermore, or he will learn, that the sacredness of private property lies in the fundamental principle or interest of self-preservation—in fact, that private property finds its institution in this instinct; for property is the means by which not only is self preserved, but by which species may be perpetuated. His experience with inventions teaches him this, and that from a rude instrument of toil he has become an intelligent exponent of hidden laws; that he is not simply an animal, wanting an animal's contentment, but that he is something more, and wants the contentment which belongs to the best environments. To accomplish these things it is desirable to increase his ability to consume, and this is done by improving his physical and moral conditions. So the nearer we get to the point where a man shall have control of mechanical powers, thereby simplifying muscular motions, the quicker will his physical condition be improved—not his mere muscular strength developed, but his sound physical condition—for the higher will be the efficiency of his mere muscular labor, and it is certainly true that the higher physical condition begets the better moral condition.

Every machine that is invented marks some progress in a useful art; it accomplishes some useful end not before attained, or it does some old work better and cheaper. It makes more valuable the day's work of an operative. "The man who rides the mowing machine all day should get more than the man who swings the scythe, and the weaver in the cotton mill should get more than a weaver at a hand loom, partly because labor is a unit as well as capital, partly because some machinery must be very skillfully, and all of it very carefully, used, and partly because so much more grass is cut and so much more cloth is made. The advantage of machinery should not belong exclusively to capital,'' and civilization must see to it that the advantages of inventions are equitably adjusted.

The argument that the use of machinery brings into industrial work an ignorant class of workers is often made by men who see in machinery the arch enemy of the mechanic. The argument is entirely baseless. There is no more ignorance in the world on account of inventions, but by their perfections an ignorant class can often do perfectly what an intelligent class used to bungle over, and at the same time the intelligence of the ignorant is raised. The ignorant laborer of to-day is, in all that makes up condition, more than the peer of the skilled workman of a few generations ago; and the fact that as the country increases in wealth, the numbers employed in miscellaneous industries and what Mr. Wells calls incorporeal functions; that is, artists, teachers, and others who minister to taste and comfort in a way that can hardly be called material, increase disproportionately to those engaged in the production of the great staples, answers the idea that inventions foster ignorance in production. Inventions have, indeed, superinduced the congregation of ignorant laborers, and thereby given the appearance of creating ignorant labor.

Phillips Bevan, of England, writing in 1877 of the industrial classes of his country, remarked that "few people are aware of the immense development of the last twenty-five years found in the condition for the better of English operatives especially, whether in a monetary, social, educational, sanitary or legislative light. It is very doubtful whether the bulk of workingmen themselves take heed of the strides they have made, or of how little they have to lament that the 'good old times' are past and gone;" and Mr. Bevan might have added that in most of the directions named by him invention had been the cause, for it was not until the factory system was thoroughly fixed as the industrial system of England that the Parliament of England began to make changes looking to the education of the masses.

What a commentary is this hardly won development upon the fantastical and pernicious sentiment with which the pessimistic philosopher calls up ages and conditions from which it is the greatest of blessings that we have been wholly delivered.

In art directions the development has been as great as in the purely mechanical field, for, by the aid of mechanical powers, the work of our artisans is rapidly making the taste of the people artistic, for trained and inventive skill, as exhibited in machinery, puts art into wood and metal, showing "the highest discipline of the mental faculties, the direction and the subordination of all its manifestations for some clearly-defined purpose." Every step marks some progress in industrial art. The stove manufacturer, in order to meet the demands of the common people, in the production of his goods must secure the services of an artist, that the design of the kitchen or the parlor stove shall not offend the artistic eye.

The ethical influence of the more modern system has been marked indeed, and especially in our own country, for the American workman demands, as a necessity, the culture to be gained by reading, music, and the lyceum, and from his moral and educational standpoint he participates in the government, and has raised from his ranks some of our very best and most revered Chief Magistrates, State and National; and he will demand in the future general admission to the ranks of the aristocracy of mind, where his name even now occupies so bright a place.

The development resulting from the influence of inventions has reached the economic side of industry, and this economic side, as it is better understood by our workingmen, will bring about truer and happier industrial relations. At present the manufacturing world is often disturbed by a succession of strikes and labor controversies. Do not, I beg you, make the mistake of assigning the cause of such strikes and controversies to retrogression, or to supposed increasing antagonism, or to any anarchistic desire to destroy or in any way abridge the grand results of the past developments. On the other hand, think for a moment that the man who works for wages has been taught to realize the conditions of a higher civilization; has been taught to appreciate, understand and desire still greater mental, moral and social progress. He has been taught, and through invention enabled, to enjoy art and music and literature, to understand that he is one of the sovereigns of the land, that he is a political and a moral factor;

and with all this he finds he still keeps the position of a wage receiver in enterprises in which his skill, as well as his hand, is a necessity. The honest and the intelligent workman, so far as he is engaged in the controversies of the day, is the conservator of all the required forces of industry, but he seeks in this conversation to become more closely allied to the factor of capital, which without him is dead material. He begins to see that while he has outgrown, through the aid of inventions, the purely physiological relation which labor bears to production; that is, the position of the animal, he now furnishes the developed mental qualities of the man, and, seeing this, he sees that he vitalizes the material side of production, which is capital. He therefore asks that he may become more closely associated with capital in the great productive enterprises of the day, and also secure a more just share of the benefits arising from the use of machinery than now falls to him. How a new system shall be established, with perfect justice to capital and to labor, recognizing the moral forces at work contemporaneously with the industrial, is the problem of the age. I feel so sure that this problem will be solved on the broadest business basis through the practical application of the moral principles of coöperative work that I have little anxiety for the industrial future of the country. I know no one element can come in as a panacea for ills, but I feel morally certain that a combination of elements can be so applied, and will be so applied, as to relieve industry of the present apparent warfare. Progress has been so rapid that we fail to see the intelligence underlying the industrial controversies. Ignorance, selfishness and, maybe, dishonesty are all interwoven with intelligence, and sometimes so closely that it seems as if the unhappy conditions subordinated those of intelligence, and this leads many to think that mechanical development has reached such a point that it is safe, and they have the courage to declare that we have arrived at the end of the *regime* of machinery; so, indeed, we have, but it is the first end, and not the end they would have it, which to them means retrogression. The development must go on. The future of the achievements of inventive genius in the mechanical, chemical, and other sciences is bright indeed, and holds out to humanity its best boons and most munificent endowments, not only in moral and industrial directions, but in a better, and a greater, and a more equal diffusion of wealth, and all that wealth means. Machinery is young ; in fact, is only the forerunner of great undiscovered wonders which will make the inventions of the past seem like toys thrown away as childhood steps into manliness through growth, through strength, and through perfection, which in itself is weakness as compared with the perfection of the invisible power, the manifestation of whose presence constantly reminds us that the future holds the golden age, and not the past.

A CENTURY OF PATENT LAW.

BY HON. SAMUEL BLATCHFORD, ASSOCIATE JUSTICE OF THE SUPREME COURT OF THE UNITED STATES.

I have been requested by the committee which has charge of the ceremonies of this celebration of the beginning of the second century of the American patent system, to address you on the subject of "A Century of Patent Law."

As we derive the principles of our statutory and administrative patent law from England, it seems proper to regard the subject as covering English patent law, to a certain extent.

Prior to the English statute of 21 James I, chapter 3, passed in 1623, entitled "An act concerning monopolies and dispensations with penal laws and the forfeiture thereof," commonly called "the Statute of Monopolies," it was customary for the King, by virtue of his prerogative, to grant exclusive privileges or monopolies to individuals according to his pleasure, and not because of any invention or discovery which the individual had made, or had been the first to introduce into the kingdom. To such an extent was this carried, that Edward III granted to two persons a patent of privilege for the sole making of "the Philosopher's Stone;" and, by subsequent sovereigns, patents were granted for the sole manufacture of playing cards, and for an exclusive right to sell various necessaries of life.

By the Statute of Monopolies, all monopolies were abolished as contrary to law, excepting grants to the first inventor of any manner of new manufacture, of the sole privilege of working or making the same. The statute did not bring such grants into existence, but excepted them out of the grants of monopolies, and left them to depend upon the common law for their legality.

James I, in 1610, had made a public declaration that all grants of monopolies and of the benefit of any penal laws, or of power to dispense with the law, or to compound for the forfeiture, were contrary to the laws of the kingdom, and had commanded that no suitor should presume to move the King for matters of that nature.

Section 1 of the Statute of Monopolies declared that all monopolies theretofore granted, or thereafter to be granted, for the sole making or using of anything should be void. Section 6 of the act provided that the inhibition should not extend to a patent of privilege "of the sole working or making of any manner of new manufactures within this realm to the true and first inventor" thereof, which others at the time of making the grant "shall not use, so as also they be not contrary to the law, nor mischievous to the State, by raising prices of commodities at home, or hurt of trade, or generally inconvenient," their duration to be for twenty-one years from their date, in respect to patents theretofore granted for more than twenty-one years, and to be for fourteen years or under in respect to patents thereafter to be granted.

For many years after the passing of this statute, the arts and manufactures continued in a low state in England, and few of the inventions patented were of any value. Until the reign of George III, the law reports are almost entirely silent respecting patent privileges; and almost the only case reported during that period is that of *Edgeberry and Stephens* (2 *Salkeld*, 447), where it was held, construing the statute of 21 James I, that "if the invention be new in England a patent may be granted, though the thing was practiced beyond the sea before; for the statute speaks of new manufactures within this realm, so that if they be new here it is within the statute; for the act intended to encourage new devices useful to the kingdom, and whether learned by travel or by study it is the same thing."

Since that decision it has been the uniform practice in England to grant letters patent to a person who introduces an invention not used before within the kingdom; and Parliament has repeatedly recognized the principle, by granting exclusive privileges to such introducers.

The first case of importance respecting a patent was an action of *scire facias* brought against Sir Richard Arkwright (*The King* v. *Arkwright*, 1 *Webster*, 60) to repeal his patent for an invention of a machine for preparing material for spinning, which action was tried in June, 1785.

About ten years afterwards the important cases of *Boulton and Watt* v. *Bull* (2 *Hen. Black*, 463) and *Hornblower* v. *Boulton and Watt* (8 *Term R.*, 95) in regard to the great invention of James Watt in steam engines were tried, in which the patent law was much discussed and many of its difficulties and obscurities were cleared away. In the second of the above cases the patent granted to Watt in 1769 was held by the Court of King's Bench to be valid. Since that time the issue of patents for inventions has increased steadily, the interests involved in them have assumed immeasurable importance and magnitude, and the principles of law applicable to them have been developed and applied by judicial decisions of the highest value.

A few words may be added in regard to the invention of James Watt, which substantially created the steam engine and gave to it that usefulness and efficiency, the further development of which has revolutionized the trade and manufactures of the world. Watt was a Scotchman. He was born in 1736 and died in 1819. He learned the business of a philosophical instrument maker in London, and at the age of twenty-one became mathematical instrument maker to the University of Glasgow. At that time the most advanced type of steam engine was that of Newcomen, which was applied only to the pumping of water for draining mines; but it was so clumsy and wasteful of fuel that it was very little used. In 1764, Watt's attention was particularly directed to it. In Newcomen's engine the cylinder had a vertical position under one end of the beam, and was open at the top. Steam at a pressure scarcely greater than that of the atmosphere was admitted at the lower end of the cylinder, under the piston, and the piston was pulled up by a counterpoise at the other end of the beam. Communication with the boiler was then shut off, and the steam in the cylinder was condensed by injecting a jet of cold water. The pressure of the air on top of the piston then forced it down, and the counterpoise was raised; and the injection water and condensed steam were drawn out of the cylinder by a pipe.

The observation of Watt was, that the alternate heating and cooling of the cylinder caused the engine to work slowly and with an excessive consumption of steam. The metal having been chilled by contact with the condensed steam and the cold injection water, it required the use of a large quantity of steam to heat the chilled surfaces before the cylinder could be filled and the piston rise again. As in almost all efficient mechanical operations, there had to be a reconciliation of antagonisms; and, as in almost all important inventions, the genius was invested in first recognizing the existence of the antagonisms, and in then devising a method of reconciliation. Watt saw that the temperature of the condensed steam ought to be as low as possible, or the vacuum would not be good, and, to use his own words, "that the cylinder should be always as hot as the steam which entered it." In 1765 the idea occurred to him that if the steam were to be condensed in a vessel distinct from the cylinder, it would be practicable to obtain a low temperature of condensation, and still keep up the temperature of the cylinder. For that purpose, he provided a separate vessel into which the steam from the cylinder entered, which vessel was to be kept cold either by injecting cold water into it or by letting cold water fall over the outside of it, and so a vacuum could be maintained in a separate vessel. Thus the steam which passed over from the cylinder would be condensed, the pressure in the cylinder would be as low as the pressure in the condenser, and the temperature of the metal of the cylinder and piston would be kept up, since no cold injection water would come in contact with them. On putting the apparatus to a test, it operated as was expected; and, to maintain the vacuum in the separate condenser, Watt added an air-pump to remove the condensed steam and injection water, with any air that might gather in the condenser.

He added several subsidiary inventions, such as more tightly packing the piston; closing the upper end of the cylinder; enclosing the piston with a steam-tight stuffing-box on top of the cylinder; causing steam instead of air to press on top of the piston; casing the cylinder in a non-conducting material; and introducing a steam-jacket between the cylinder and an outer shell. All these features were specified in his first patent, which was obtained in January, 1769.

By an act of Parliament, passed in 1775, that patent was continued for twenty-five years, and Watt, in connection with Matthew Boulton, who owned some engineering works at Birmingham, entered upon the manufacture of steam engines. At first the only application of the engine was to pumping water from mines, but Watt soon made other inventions to fit the engine for other uses, and took out further patents in 1781, 1782 and 1784. These inventions covered the method of converting the reciprocating motion of the piston into a rotary motion, so that ordinary machinery could be driven; making the engine double-acting by putting both ends of the cylinder in communication, alternately, with the boiler and the condenser instead of only one end; introducing the system of the expansive working of the steam, instead of admitting it through the whole stroke of the piston; and the well-known parallel motion.

Watt's principal patent was sustained by the courts of England, and he enjoyed the fruits of it until it expired in the year 1800. To his great invention we owe the development of the steam engine as used now for traffic and transportation by water and land; for, without it, there could be no practical or efficient steam engine.

The statutes which now regulate the granting of patents in England are those of August 25, 1883, (46 & 47 *Vict. ch.* 57), and December 24, 1888, (51 & 52 *Vict. ch.* 50). It is not necessary that a person should be a British subject to apply for a patent. The application must state that the applicant is in possession of an invention, of which he claims to be the true and first inventor. The word "inventor" in these statutes covers an introducer. It is declared by the act of 1883 that the word "invention" means "any manner of new manufacture, the subject of letters-patent and grant of privilege," within section 6 of the act of 21 James I, chapter 3, and includes an alleged invention. There must be either a provisional or a complete specification. If there is only a provisional specification, there must be a complete specification within nine months after the application. There is a limited examination, which extends only to an inquiry whether the nature of the invention has been fairly described, and whether the application, specification, and drawings, if any, are in due form, and whether the title sufficiently indicates the subject-matter of the invention. The acceptance of the complete specification is to be advertised, and any person may, within two months thereafter, give notice at the Patent Office that he opposes the grant of the patent on the ground that the applicant obtained the invention from him or from a person of whom he is the legal representative, or on the ground that the invention was patented in England on an application of prior date, or on the ground that the complete specification describes or claims an invention other than that described in the provisional specification, and that such other invention forms the subject of an application made by the opponent in the interval between the making of the two specifications. The patent is to be granted for fourteen years, but is to cease if certain fees are not paid within specified times. Disclaimers and amendments of specifications are provided for, but no amendment is allowable which would make the specification, as amended, claim an invention substantially larger than, or substantially different from, the invention claimed by the specification as it stood before amendment. At least six months before the time limited for the expiration of the patent, the patentee may apply for an extension, which may be granted on a favorable report from the judicial committee of the Privy Council, for a further term not exceeding seven, or, in exceptional cases, fourteen years; and a patent may be vacated by a court on certain specified grounds.

Let us pass now to the patent statutes of the United States.

The Constitution, in article 1, section 8, declares that the Congress shall have power to promote the progress of science and useful arts by securing, for limited times, to inventors the exclusive right to their discoveries.

The first act of Congress on the subject was that of April 10, 1790, entitled "An act to promote the progress of useful arts." This provided for the granting of a patent to the inventor or discoverer of any "useful art, manufacture, engine, machine, or device, or any improvement therein, not before known or used." A written specification, with drawings, and, if admissible, a model, was required. No examination as to the novelty of the inventiou was provided for. On an application made to a judge of a District Court within one year after the grant of a patent, if it was obtained surreptitiously or upon false suggestion, or if it should appear that the patentee was not the first or true inventor or discoverer, the judge might repeal the patent.

Further acts in regard to patents were passed in 1793, 1794, 1800, and 1832.

On July 4, 1836, an act was passed reorganizing the patent system and repealing all prior acts. By that act patents were to be granted for fourteen years, with the privilege of an extension by the Commissioner, in a proper case, for seven years more. It was required that the applicant should have discovered or invented a new and useful art, machine, manufacture, or composition of matter, or a new and useful improvement thereon, not known or used by others before his discovery or invention, and not, at the time of the application, in public use or on sale, with his consent or allowance, as the inventor or discoverer. He was required to deliver a written description of his invention or discovery, and of the manner and process of making, constructing, using, and compounding the same, in such full, clear, and exact terms, avoiding unnecessary prolixity, as to enable any person skilled in the art or science to which it appertained, or with which it was most nearly connected, to make, construct, compound, and use the same; and, in case of a machine, to explain fully the principle and the several modes in which he had contemplated the application of that principle or character by which it might be distinguished from other inventions; and particularly to specify and point out the part, improvement, or combination, which he claimed as his own invention or discovery. Drawings were provided for, and specimens of ingredients of a composition of matter, and a model of machinery, where admissible. A system of examination was instituted, and the patent was to issue if it should not appear to the Commissioner that the alleged invention or discovery had been invented or discovered by any other person in this country, prior to the alleged invention or discovery by the applicant, or that it had been patented, or described in any printed publication, in this or any foreign country, or had been in public use or on sale with the applicant's consent or allowance, prior to the application, and if the Commissioner should deem it to be sufficiently useful and important. On the refusal of a patent, an appeal was provided for to a board of three examiners. An interference with another pending application, or with an unexpired patent, could be declared with an appeal to a like board. In case a patent should be inoperative or invalid by reason of a defective or insufficient description or specification, or by reason of the patentee claiming in the specification as his own invention more than he should have a right to claim as new, if the error arose by inadvertency, accident or mistake, and without any fraudulent or deceptive intention, the Commissioner, on the surrender of the patent, could cause a new patent to be issued to the inventor for the same invention, for the residue of the period then unexpired for which the original patent was granted, in accordance with the patentee's corrected description and specification. This was called "a reissue." Provision was made for special defenses in actions for damages for infringement, and for giving to the plaintiff thirty days' notice before the trial, of the defense of prior use; also for a remedy by bill in equity in the case of two interfering patents, or of the refusal to grant a patent on the ground of its interference with a previous unexpired patent. Equity jurisdiction by the Circuit Courts of the United States was created, with the power of granting injunctions against infringement. An extension of a patent for seven years was provided for, on its appearing that the patentee, without neglect or fault on his part, had failed to obtain reasonable remuneration.

The foregoing features of the patent system were substantially reënacted in the act of July 8, 1870, the provisions of which are embodied in the Revised Statutes; but by statute a patent is now granted for only seventeen years, and no provision is made for an extension.

In the administration of the patent laws by the courts of the United States, the proper rights of inventors have been firmly maintained, while the abuses which crept in, in consequence of improper reissues of patents, have been corrected. Patents for important and meritorious inventions have been sustained, notably in the case of Morse's telegraph, which was held valid in the case of *O'Reilly* v. *Morse*, (15 *Howard*, 62), the opinion being delivered by Chief Justice Taney.

Samuel F. B. Morse was a historical painter, and had gone to Europe in 1829 to perfect himself in his art. In October, 1832, on board the packet-ship "Sully," on her passage from Havre, in France, to New York, he conceived the invention which he afterward patented. Before he landed in the United States he sketched the form of an instrument for an electro-magnetic telegraph, and arranged and noted down a system of signs, composed of a combination of dots and spaces to represent figures, which were to indicate words to be found in a telegraphic dictionary, where each word was to have its number. He also conceived and drew out the mode of applying the electric or galvanic current so as to mark signs by the chemical effects. He persevered in his invention, and by the forepart of the year 1836 he had constructed an instrument which marked down intelligibly telegraphic signs, and demonstrated by actual operation its capacity to accomplish his purpose. Further experiments were made, and in the latter part of September, 1837, a caveat was drawn up and in the following month was filed in the Patent Office. In February, 1838, a new instrument was exhibited by Professor Morse in the Franklin Institute at Philadelphia, where it operated with success through a circuit of ten miles of wire; and a committee of the Institute made a report of its success. It was then removed to the city of Washington, and publicly exhibited in the hall of the House of Representatives. On the 3d of March, 1843, Congress appropriated $30,000 to test the capacity and usefulness of the telegraph by constructing a line, under the superintendence of Professor Morse, between the cities of Washington and Baltimore, which was done in the year 1844. The United States patent having been granted to him on June 20, 1840, it was reissued in January, 1846, and came before the Supreme Court of the United States at its December term, 1853. It was sustained after a vigorous opposition.

The principle on which the patent laws are based is to give an inventor an exclusive right, for a limited time, in consideration of his fully disclosing his invention, so that it may be made and used by the public after the limited term shall have expired. Under this stimulus there has come into existence the briliant succession of inventions which have contributed so greatly to the progress of science and the arts, and to the material welfare of nations and individuals. In this career our own country has played no small part, and it is quite certain that in the future American inventors will do their full share toward illustrating the beneficent operation of the patent laws, and that when, a hundred years hence, there shall be another centennial celebration like the one through which we are now passing, there will have occurred no diminution of the importance and value of American inventions.

THE EPOCH-MAKING INVENTIONS OF AMERICA.

BY HON. ROBERT S. TAYLOR, OF INDIANA.

The real and enduring wealth of the world is its thoughts. It is the capacity to originate, communicate and preserve thoughts that makes civilization possible.

Some great thoughts are like jewels—precious for their beauty; some are like seeds—precious for their fruits; some are like mines—yielding treasures of wealth to the world long after their discovery.

It is with the thoughts of the inventor that we have to do to-day, and with those productions of his thought which are of such scope and character that they can fitly be called epoch-making inventions. That phrase was itself a happy invention on the part of the committee — vividly descriptive of those creations of the inventor's brain which enter so widely and intimately into the lives of men and the course of events that they divide history into epochs.

It would matter little to the world that one man went barefoot all the year. But if all the world had been going barefoot and one tender-footed man should invent shoes, and all other men, seeing how comfortable they were, should take to wearing them, the race would enter upon a new epoch in its history, for which it would owe thanks to the inventive thought of one man.

The sum of human happiness is made up of little things affecting the life of individuals. All existence is an adjustment of forces. It requires only a slight readjustment to produce a new existence. It is estimated that a fall of eighteen degrees in the average temperature upon the earth's surface would bring on a glacial period. The addition of one daily comfort, the taking away of one item of daily drudgery, is enough to give a new complexion to life. To do that for all men in one particular is to make an epoch.

It wants now just a year of a century since there flashed across the mind of a young Georgia school teacher the thought that a machine could be made which would separate the cotton fibre from the seed by the action of saw teeth. I do not know that the circumstances which attended the birth of this idea in the brain of Eli Whitney have been preserved. It would be of dramatic interest to know, if we could, in what wakeful hour of night, or receptive mood of day, there came into the mind of one man the revelation of a thought so simple in itself, and yet so big with blessing to the world. If he could have foreseen at that moment in one prophetic glance all the consequences that would flow from it, he would have fallen down and turned his face away from the brightness of his own invention, as Moses turned his face from the glory of the Lord in the holy mountain. It was the beginning of the epoch of cheap cotton cloth. It was a distinct step in the evolution of the race. It marked an advance in industry, trade, comfort, health and morals. It touched the whole world like a new element in sunshine.

Forty-six years later Elias Howe patented his sewing machine. It would be foreign to my topic to discuss the claims of rival inventors, and I take Mr. Howe as the representative of the group of inventors, who, in quick succession, brought out the various inventions which have emancipated human fingers from the most monotonous, wearisome and slavish of all forms of labor. It is too soon yet to estimate the full effect of the sewing machine upon human life and destiny. It ushered in an epoch of cheap clothes, which means better clothes for the masses—more warmth, more cleanliness, more comfort. It is entirely true to say that the cotton gin and the sewing machine together have given the human body an improved skin. But the indirect consequences of the invention of the sewing machine reach furthest beyond our ken — time was when half the human race were occupied chiefly in making clothes. When the machines took that avocation away from them they turned to other employments. The invasion of all occupations by women, and the sweeping changes which have taken place in their relations to the law, and society, and business, can be ascribed in large measure to the sewing machine. Where the end will be needs a bold man to say.

Robert Fulton once said that the three men who had conferred the greatest good upon their fellows were Arkwright, Watt and Whitney. Speaking for the time when he lived I should be disposed to name him as the fourth. For what one other cause has so metamorphosed life in all of its interests—its business, its pleasures, its peace, its war, its society, its traffic—as the application of steam to transportation and travel? It has made the world so small that a man can go round it at his leisure four times a year. At the same time, measured by what we can see of it, and find on it and get from it, steam travel has made it ten times as large as it was to our forefathers.

Whither the great journey onward and upward which the race has begun on its steamboats and steamers will take us, is beyond conjecture. The epoch of travel has only begun. It means not merely the running to and fro of men, and interchange of commodities, but the opening of a training school wherein all mankind are pupils. To-day the armies of men who are making and managing the steam machinery used for transportation are the brainiest, widest-awake great body of men in the world. To that large extent to which the business makes the man, this business makes the best men.

Of course, the invention of Fulton was the barest beginning of this great epoch. But it is quite true that as the Clermont awkwardly steamed her way up the Hudson on her trial trip the border of a new age came into view, as the border of the new continent greeted the vision of Columbus three hundred years before. The discovery was made. To enumerate the inventors who have developed and perfected it would be as impossible as to enumerate the navigators and pioneers who completed the conquest of the New World.

Nor am I unmindful of the fact that the railroad and its locomotive are not conceded to the American inventor. But these are only an evolution from their aquatic congener. All life begins in the sea. And very like the evolution of birds from fishes was the evolution of the Chicago Limited from a paddle-wheel steamboat.

To recognize adequately in this connection the individual merits of inventors in this great field is impossible. But every one who has crossed the sea ought to pay tribute to the memory of Ericsson, and those of us who are here from distant homes, remembering how comfortably and safely we came, can afford a word of thanks to Pullman and Westinghouse.

It was entirely natural that in the progress of man's conquest over the forces of nature he should attack last the most mysterious, powerful and uncontrollable of them all—electricity. And it must ever be a source of pride to Americans that since Franklin drew the first submissive spark from heaven his countrymen have been foremost in this great field of discovery.

Electricity had had the faculty of speech in a thundering and unintelligible way long enough before Professor Morse's day. But to him was reserved the task of teaching it to write. With the invention of the telegraph the world entered upon a novel epoch. In the nature of things human progress is for the most part a course of improvement in known processes. But here was a new process. In this respect there was nothing preceding to be compared with it except the invention of the steam engine. To the breath of fire and muscles of iron which that gave the world, this added the nerves of the body politic, which to-day radiate from their ganglionic centers in the great cities to every part of the world. By these organs of sensation society feels the shock of a massacre at New Orleans as instantly as a man feels a burn on his hand, and by the same channels an impulsive government calls home its minister as a man strikes at an insect which has stung him. Next day the same messengers convey to the world the dignified utterances of a government so great and strong that it can afford not to get angry.

The revolutions in commerce, which the telegraph introduced, were of themselves sufficient to mark an epoch in history. But there is a deeper significance in the universality of information and action which it makes possible. Supplemented by the daily newspapers, the telegraph advises the whole world every morning of all that happened on the planet the day before. All public men and public bodies discharge their duties in the concentrated light of universal observation. Every notable event is followed immediately by criticism and discussion, and by some judgment of the general intelligence upon the merits of the case. And there is thus developed a force in society—a governing force—which knows neither form of government or lines of jurisdiction, but which powerfully affects the affairs of men. It is the force of enlightened, unified, world-wide public opinion.

In the production of the electric light the genius of man has come nearer to creation than in any other achievement. When the Almighty said "Let there be light" and there was light, it was, as I believe, electric light. I have no doubt that the light of the sun and all the self-luminous stars is produced by electricity transformed by processes substantially identical with those that produce lightning in our clouds and arc light upon our streets.

This epoch of artificial sunlight distributed in fragments has so recently burst upon us that we have hardly yet recovered from its first dazzling effects. But we may be sure that it is the beginning of an age of increasing enjoyment for mankind. It is one of the revolutions that will not go backwards. The human eye once charmed by a better light is never content to return to a poorer.

The electric light was the result of the work of a great many students and inventors through a long period of time. I know of no other invention to which so many persons have contributed. But we are justly proud of the fact that in the successful practical solution of the problem, our countrymen, Charles F. Brush and Thomas A. Edison, were clearly the pioneers—one in the field of arc lighting and the other in the incandescent light. It is incredible to think that it is little more than a decade since their inventions came into public use, so universal have they become.

When the Master said to those who stood about Him, "Which of you by taking thought can add a cubit to his stature?" no one held up his hand. But Professor Bell by taking thought has added, not a cubit, but miles to the length of our tongues and our ears. I think this is the most gratifying of all inventions. I can make no personal use of the telegraph. I go about a dynamo filled with wonder and admiration, but mindful not to become too familiar with it. But to have in my house an instrument which is ears and mouth for everybody, and which enables me to hold conversation with all my neighbors from my own back hall, gives me a sense of personal triumph over the impediments of matter and space every time I use it.

Time fails me to speak of the epoch of news which was made possible by Hoe's cylinder press, or the epoch of vertical growth in American cities which began with the Otis elevator, or the epoch of farming by machinery which began, I may say, with McCormick's reaper, and which opens the era of cheap and abundant food.

One more invention, recent, bright and beautiful, shall close this category. It is the typewriter—the sewing machine of thought—which takes up with nimble fingers the drudgery of writing as that of sewing, and clothes our ideas as that clothes our bodies. It introduces the epoch of legible manuscript, with all the saving of time, labor and profanity which that implies.

All that I have said points to one final thought. We look backward over a century of unparalleled progress. To this so many causes have contributed that it is impossible to measure exactly the effect of each. It is natural that we should think most of those that spring from political freedom, which, indeed, it is not easy to over-rate. But the essentials of human happiness are not found in mere form of government. Personal liberty, a fair chance in the race of life, under the protection of equal laws, are all that is fundamental. The wants of man—the animal, to be fed, clothed and housed; the higher wants of the man—homo, to learn, read, think, travel, communicate and receive—it is in the amplest supply of these to the largest number of individuals that the greatest sum total of human happiness is to be found. And in these this age and this country surpass all others.

We do not often stop to think how or whence our blessings come. We accept them with a dim sense of gratitude to somebody or something as a flower smiles its thanks to the sunshine. But in the light of the reflections which this occasion suggests we can realize faintly how vast is the obligation which we owe to the inventors of America. Not a garment that we wear, not a meal that we eat, not a paper that we read, not a tool that we use, not a journey that we take but makes us debtor to some American inventor's thought. Measured by what we can learn, see, do and enjoy in a lifetime, we live longer than Methuselah, we are wiser than Solomon, richer than Croesus, and greater than Alexander. Archimides has found his fulcrum; it is the brain of the inventor.

We can realize too, to-day, how wise the fathers were beyond anything they could have known in providing in the Constitution for the encouragement and reward of invention. On twenty-two words—only twenty-two words—in that great Charter the American patent system rests. What other twenty-two words ever spoken or penned have borne such fruit of blessing for mankind?

THE NEW SOUTH AS AN OUTGROWTH OF INVENTION AND THE AMERICAN PATENT LAW.

BY HON. JOHN W. DANIEL, L.L.D., OF VIRGINIA, U. S. SENATOR.

I deem it great honor to stand in this presence and to unite in paying tribute to the inventive genius of our countrymen. You, Mr. Secretary, are to be congratulated upon the admirable exhibit of the Bureau of Patents—under your charge. It fulfills our democratic-republican conceptions of good government in every aspect. It records great achievements of mind; it indicates our wonderful progress; it is utilitarian in a high degree, and it is more than self-supporting. But the reach of its usefulness far transcends the lines of its economic administration, and its dignity is not to be measured by figures.

The Romans of old assigned the highest place in the Elysian fields to him who had improved human life by the invention of arts, and surely our own race—the most inventive of men, and our own country the most inventive of nations—will not refuse the highest honors to those creative minds which have contributed so much to make it the foremost of mankind.

"The West Indies," says Lord Bacon, "had never been discovered without the discovery of the mariner's needle." All America is therefore an evolution of invention, and the inventor must be hailed as one who cried in the wilderness before the coming of the Great Columbus.

The inventive faculties are stimulated by mechanical pursuits. The North was early impelled to such pursuits by its hard climate and rugged soil. The development of its inventive faculties was instantaneous and progressive—greater than the like development in the South, which by favoring conditions of soil and climate was attracted to agriculture and the proprietorship of land. Connecticut, Massachusetts, Pennsylvania, New York, Rhode Island—these were the States that led, and won first honors.

If you ask me the cause of the Northern victory in the Civil War, I would look beyond the smoke of battle and point to its inventors, mechanics and manufacturers. For through them it accumulated its preponderating wealth, numbers and material forces.

The Southern people, however, have taken deep interest in the promotion of arts and sciences. They have applauded the achievements of Northern mechanical genius; they are not themselves deficient in inventive gifts, and many Southern names are companions in the list of inventors. Amongst them are Sibley, of Louisiana, and his conical tent; Gatling, of North Carolina, and his terrific gun; McCormick, of Virginia, and his reaper and mower; Gibbs, of Virginia, and his sewing machine; Janney, of Virginia, and his car coupler; Gorrie, of Louisiana, and his ice machine; McComb, of Louisiana, with his "arrow" cotton tie; Gaynor, of Kentucky, and his fire telegraph; Stone, of Missouri, and his grain roller-mill; Remberts, of Texas, with his roller cotton compress; Clarke, of the same State, with his envelope machine, and Campbell, with his cotton picker; Bonsack, of Virginia, with his cigarette machine; Coffee, of Virginia, with his tobacco stemmer; Stevens, of Florida, with his fruit wrapper; Law, of Georgia, with his cotton planter; Avery, of Kentucky, with his plow sulky, Watt & Starke, of Virginia, with their plows—these are some of the names that greet us in our history; Rumsey with his steamboat; Maury with his map of the sea, which has made his name the synonym of benefactor to the navigator and to commerce; McDonald, of our own day, with his fish ladders and hatcheries filling our streams with fish. These, from scores of Southern names, should remind us that the South has not been an idler in the vineyard. And when we read in the annals of the Patent Office that some three thousand patents were issued in 1890 to Southern inventors, we must realize that the South vies in generous rivalry in every branch of intellectual achievement.

Worthy it is of mention that the first native born American woman to get a patent was Agdalena S. Goodman, of Florida, for improvement in broom brushes. Were I to follow this suggestive fact a speech might be made on the inventions of women. They are varied—varying from straw hats to horseshoes, and from deep-sea telescopes to sewing machine attachments. Woman's intuitions are proverbial; when she turns them to mechanical invention the possibilities of achievement surpass the scope of prophecy.

Many notable events of progress have occurred on Southern soil.

James Rumsey, a native of Maryland and a Virginian by adoption, exhibited to Washington here on the Potomac in 1784 the model of a boat for navigating rivers against the current by the force of the stream acting on setting poles, and in 1789, the same year that Fitch made his experimental trip on the Delaware, Rumsey exhibited his steamer here on the Potomac, propelled by an engine and mechanism of his own invention.

Both Fitch and Rumsey received patents for their inventions. The conception of the steamboat seems to have occurred to them simultaneously, but Fitch's experiment was a little prior in time. Rumsey's patents were allowed by New York, Missouri and Virginia, and also by England, France and Holland. Benjamin Franklin was a member of the Rumsey Society, of Philadelphia, formed to aid him in his inventions. In 1792 he made a successful trip in England on the Thames, and in 1839 Congress voted to his son, James Rumsey, a gold medal, "commemorative of his father's services and high agency in giving to the world the benefit of the steamboat."

The first great American canal was proposed by Washington. It was begun in 1785 and was finished to Westham in 1789, and afterwards carried as far as Lexington and Buchanan at immense cost. Finally, in recent years it was superseded by a railroad.

The first telegraph line in the United States was established between Baltimore and Washington in 1844, and about the same time and place appeared the first electric locomotive.

The South was in the front rank of railroad projection and construction. Amongst the earliest experiments with a steam locomotive on a railroad in this country were those made by Peter Cooper on the Baltimore and Ohio in 1829 and 1830, contemporaneous with Stevenson's work on the Liverpool and Manchester, in England. About the same time at Honesdale, Penn., the "Stourbridge Lion," a locomotive engine imported from England, was making a trial trip on a mine railroad constructed of strap iron. This event occurred August 8, 1829, and was probably the first of its kind in the Western Hemisphere. Horatio Allen, who superintended the experiment, was living in 1888, and gave an account of it in a letter which appears in the proceedings of the National Museum for that year. But the South Carolina Railroad, from Charleston to Hamburg, was the first road commenced in this country with a view to the use of steam. It was chartered in 1825, begun in 1830, completed in 1833. For it was constructed the first locomotive; it was the first steam road that carried the United States mail, and when completed, in October, 1833, it was the longest railroad in the world.

The South Carolina Colony, as early as 1691, passed an act to encourage the making of engines for propagating "the staples of this Province," and in 1717 an act "for encouraging the making of potash and saltpeter." And in 1784 it passed a regular patent law for the encouragement of the arts and sciences giving inventors exclusive benefit of their labors for fourteen years.

The early settlers of the South—and they were the pioneers of our race in the United States—brought with them some knowledge of the useful arts and manufactures from the mother country, and while they were building block houses to defend against the savages, their rude establishments of industry were rising in the wilderness.

With Captain Newport there came to the Colony of Virginia in 1608, twelve years before the pilgrims landed at Plymouth Rock, a number of citizens to make glass, and others to make tar, pitch and soap-ashes. A mile from Jamestown was established the first manufactory in the United States—a factory for making glass bottles. A saw-mill, driven by water and used for cutting wainscoating and boards, soon followed this infant industry. Ere long boat-building began, salt works were established, and skillful vine-growers planted a vineyard in 1620. In 1623 the Virginia Legislature required settlers to plant mulberry trees, in order to raise silk-worms and produce silk; and, as the story goes, Charles II wore at his coronation in 1651 a robe and hose of Virginia silk, the art of weaving having been introduced into England in 1620.

In 1621 "the first cultivation of cotton in the United States deserves commemoration. This year the seeds were planted as an experiment, and their plentiful coming up was at that early day a subject of interest in America and England." So writes George Bancroft, the historian.

Not less notable is the fact that the first works for smelting in America were set up in 1619 on Falling creek, a tributary of the James river, which enters it some seven miles below Richmond. Here the brown ore was found lying on the surface, and good progress was made toward completing the works under Mr. John Berkley, who was in charge of them. But before the consummation Berkley and all his workmen were slain and the works destroyed in the Indian massacre of March 22, 1622. It is curious to note that about the same time that the Indians were scalping the pioneer iron-makers in Virginia an ignorant mob in England destroyed the works of Lord Edward Dudley, for smelting ore with pit coal by a new process of his invention. Savagery and ignorance go together.

McMasters, in his history of the people of the United States, ascribes to Thomas Jefferson the glory of the American patent system, and declares that he inspired it and took so deep an interest in its workings that he is entitled to be called its founder. This view consists with the traditions of the Patent Office. Certain it is that the subject was congenial to the practical scientific mind of Mr. Jefferson, and certain it is that he took deep interest in the development of the system and in all that concerns the useful arts and scientific methods.

Amongst the powers conferred upon Congress by the Federal Constitution is the power "to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." In this provision was compromised the contention on the one hand that authors and inventors had a property right in all copies of their works, and the adverse contention that they had no rights whatever entitled to legal protection in such copies. Jefferson thoroughly expounded this subject in his correspondence, showing that authors and inventors have an equity to protection for a reasonable time, but that inventions are not property. "It would be curious," he said, "if an idea—the fugitive fermentation of an individual brain—could of natural right be deemed an exclusive and stable property." "Nature," he said, "made ideas like fire, expansible over all space without lessening their density at any one point; and like the air in which we breathe, move and have our physical being, incapable of confinement or exclusive appropriation." Again, "He who receives an idea from me receives instruction himself without lessening mine; as he who lights his taper at mine receives light without darkening me." On such clear perceptions rests our Constitution and our patent system, and they have universal respect because of the equity and justice that underlies them in granting "exclusive rights for limited times."

In the Federal Convention which framed the Constitution, James Madison of Virginia and Charles Pinckney of South Carolina suggested the provisions as to copyright and patent-right which resulted in the formulation of the constitutional clause which I have quoted. The author of the identical language is not known, but it emanated from the Committee on Style, of which Dr. Johnson was chairman. The first act of Congress on the subject was reported by Mr. Burke of South Carolina on the 10th of April, 1790, from a committee of which he, Mr. Huntingdon of Connecticut, and Mr. Cadwalader of New Jersey were members. The first American patent was issued on July 31, 1790, and bears the signatures of George Washington, the President of the United States; Thomas Jefferson, the Secretary of State, and Edmund Randolph, the Attorney-General. The reorganization of the Patent Office occurred in 1836, under the administration of Andrew Jackson, a Southern President. What mighty strides have been made within the century past is attested by the records. Only three patents were issued in 1790, thirty-three in 1791, and eleven in 1792, that is forty-seven in three years; and only twelve within the first fifty years. Now more than these are issued in one year; and in the year 1890 over 26,000 were issued for every variety of invention and improvement. And within a single century the United States, surpassing all the older nations, has taken the foremost rank and risen to "the highest heaven of invention."

It is from the soil that all men gain their sustenance, and as a people who long made its tillage their chief vocation, the South is first indebted to those who have ameliorated the methods of its cultivation. The ancients plowed with a crooked stick—the crotch of a tree. The plows of the colonists in America were made wholly of wood, and it was only in the last century that they were tipped with iron. Farmers were slow to welcome improvements, and even contended that cast-iron plows poisoned the ground, produced weeds and spoiled the crops. The first cast-iron plow seen in this country was after the War of the Revolution. It was imported from Holland, and was the invention of James Small of Berwickshire. Again Thomas Jefferson comes to the front. He was the first American to study and improve the plow, inventing a new form of mould-board and fixing its curvature to avoid friction. His son-in-law, Colonel Randolph, invented a hill-side plow. Soon the field was entered by many inventors; and in 1816 eleven patents had been issued to citizens of New York, eight to Maryland, three to Connecticut, two to Virginia, one to Kentucky, and one to New Jersey. There are now over 2,000 establishments in the United States for manufacturing agricultural implements. They employ over 40,000 hands, their product is worth over $68,000,000; there are 200,000,000 acres of ground plowed, requiring the service of over 2,000,000 teams for eighty days during the year. Harrows, rakes, cultivators, diggers, reapers and mowers in bewildering array arise before us, and farming has become a fine art, requiring as much brain and method for success as any of the learned professions, and our agricultural machinery is sent all over the world, its superiority being acknowledged.

To all the great inventors the South is as much indebted as is any other portion of the civilized globe for the blessings and comforts which they have conferred on mankind. To Watt and the steam engine, to George Stephenson and his locomotive, to Morse and the electric telegraph, to Edison, the wizard, and all of his electrical and other inventions, to Bell and his telephone, to Howe, to Singer, Willcox and Gibbs, and Weed and their sewing machines, to Hoe and his printing press, to Fulton and Fitch and Rumsey and their steamboat, to Davy and the safety lamp, to Westinghouse and his air-brake, and Pullman and his sleeper—each and all of these should be remembered as benefactors of the world. But if I were asked to designate the two inventors to whom the South is perhaps more peculiarly indebted than to others, I would answer with the names of Eli Whitney, the inventor of the cotton-gin, and Henry Bessemer, the inventor of the modern process for making steel.

The invention of Henry Bessemer consists in the process of eliminating carbon and silicon from iron by passing a stream of oxygen through the melted mass. This converts it into steel. He also constructed the machinery for accomplishing this result of exquisite adaptation to its purposes. A Bessemer converter, weighing with its contents twenty or thirty tons, is moved on its axis by the touch of a hand and receives thereby a blast so powerful that every particle of the metallic mass within is heated to the highest temperature, and by the infusion of oxygen is turned into ingots of steel.

Twenty-two Bessemer works had been established in this country in 1884. Rolling mills at Chicago produced the first steel rails by this process in 1865. Now great steel works are starting up in many directions. Since 1880 Rhode Island and Vermont have abandoned steel-making, and three Southern States have begun it; that is, Alabama, Virginia and West Virginia. The trend is southward. It is this cheap steel that is upsetting the values of the great land-holdings of the British nobility, and is pouring into the lap of commerce the crops of the South and West. The "Age of Steel" dates from the success of Bessemer.

A Southern iron master — William Kelly, of Eddyville, Kentucky—preceded Bessemer in the discovery of the pneumatic principle of the Bessemer process, and successfully antagonized him in claiming priorty of invention in a contest in the Patent Office. But Bessemer, with the aid of Robert Mushet, was more successful in the application of his principle to the production of steel, and the machinery was successful from the first in its operations.

In 1793 Eli Whitney, a young school teacher from Massachusetts, located in Georgia, and was the guest of Mrs. Greene, widow of General Nathaniel Greene, of Revolutionary fame. She got into trouble about her tambour frame. He fixed it. Conversation one day turned on the separation of cotton from the seed. "Send for Mr. Whitney," she said, "he can make anything." Whitney studied the subject, and the cotton-gin was the result. This instrument could be worked by a man or woman, and could clean more cotton in a single day than could be done by a person in several months by hand. It had an enormous effect upon the development of cotton planting in the South and of cotton manufactures in the North. Five English inventors—Kay, who invented the fly shuttle; Hargreaves, who, watching his wife at the spinning-wheel in his cottage, took the hint from her nimble fingers and invented a machine to which he gave her name, the "Spinning Jenny"; Richard Arkwright, the inventor of the water frame; Samuel Crompton, of the spinning mule, and Edmund Cartwright, of the power loom—these five inventors had laid the foundation of cotton manufacture as one of the greatest of the world's industries. "For this industry has," as Towle writes, "in a century created the English Manchester out of a straggling rural hamlet and Liverpool out of an obscure fishing village, and has transformed the English County of Lancaster from a dreary and barren waste into a noisy network of dense busy towns and crowded factories." Now came Eli Whitney, giving to Southern agriculture the one machine needed to give cotton its imperial position amongst the great products of the world, and feeding New England with the staple of manufacture out of which arose splendid prosperity.

In 1787 the first American cotton mills were erected (in Massachusetts), but so slow was progress that in 1807 only fifteen mills (chiefly in Rhode Island) were in operation, with about 8,000 spindles, producing some 300,000 pounds of cotton yarn a year. In 1807 came the embargo and non-importation act, under the second administration of Jefferson. Within less than two years nearly $4,000,000 were invested in cotton mills, 4,000 persons employed, the number of spindles doubled, and arrangements made for increasing them from 8,000 to 80,000. An impetus was given to New England's manufactures which has known "no retiring ebb."

The vast importance of these and kindred inventions to the South cannot be estimated until we remember what a wonderful land it is, and how richly nature has endowed it with the elements of wealth. We call it the South, but its southernmost point is 1,700 miles north of the Equator. It is a part of our northern continent. It lies wholly in the temperate zone, and while its suns are warm enough to stimulate the fruits of nature and the energies of man, they are not so hot as to parch the one or to enervate the other.

It is washed for over 2,000 miles by the Atlantic ocean. It is intersected by the Father of Waters and by many rivers. It produces all the cereals and grasses to perfection, and an infinite variety of fruits, from the apple to the banana, and from the peach and apricot to the orange and lemon. It is a land of corn and oil and wine, and milk and honey; it is a land of rice and sugar and cotton and tobacco; it is a land of coal and iron, and of green pastures and virgin forests.

The value of the raw cotton that we sent abroad in 1890 was $250,000,000; a hundred million more than the value of all the breadstuffs we export; a hundred millions more than all the manufactured products we export; a hundred millions more than all the meat and dairy products we export; eight times more than all the cattle, sheep and hogs we export. It is the chief item of our foreign trade. It secures to us the balance in our favor. It is the under-pinning of our financial system, that keeps our gold with us and sustains the value of our investments. There is not a nation on the earth that does not clothe itself with cotton. There is no nation that can vie with us in its production, and the South is the only part of our country that produces it.

The inventor has given a new value (estimated at $2.50 per acre) to the cotton field. For seventy years the seed were thrown away; now they are turned into oil and oil-cakes, and are the basis of an industry valued at $50,000,000. Cotton seed mills are operating in Alabama, Arkansas, Georgia, Illinois, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee and Texas. Two Virginians, Digges of Albemarle as far back as 1820, and Glowes of Hamilton in 1825, invented oil presses, and seemed to discern the future use of cotton seed. Now there are inventions by the score of presses and processes for their utilization.

Cotton, iron, wool, wood and the various clays are the most important raw materials of manufacture. In all these the South abounds. It is a mass of coal and iron. The great Appalachian range, stretching 700 miles and penetrating the very heart of the South, contains every variety of bituminous, block, splint and cannel coals. Here is forty times as much in sight as is accessible to economic production in Great Britain. The coal field is covered with virgin forests of white, black, Spanish chestnut and best oak, yellow poplar, yellow pine and walnut. It is stored also with iron ore and limestone.

Edward Atkinson has expressed the opinion that you can stand on the summit of the Great Smoky mountain in this range and behold the situs of the future iron-center of the world.

Iron is the king metal as cotton is the king vegetable fiber. Solon was right. When Croesus boasted of his golden treasures, he said: "If another comes that hath better iron than you he will be master of all this gold."

The epochs of the world have been marked by the weapons and utensils of its inhabitants. First, the stone age, when they were of stone and flint or wood or bone. Then the bronze age, when they were of a metal composed of copper and tin. Then came the iron age, and now, since the Bessemer process has been inaugurated, the age of steel. Myriad are its uses: baby toys and ironclad navies, cannon balls and knitting needles, railroad tracks and surgical instruments, bridges and houses and fortifications, locks and keys and buttons, the steam engine and the delicate watch, the nail, the axe, the saw, the plow, the pen, the sword.

The United States is the greatest consumer of iron and steel in the world. We make 35 and use 40 per cent. of the world's product. In eleven years Great Britain's product decreased from 45 to 33 per cent., while ours increased from 16 to over 30 per cent.

There are vast bodies of Bessemer ore at the South out of which Bessemer pig can be made at ten dollars per ton.

Carroll D. Wright, Esq., the Commissioner of Labor, compared the cost of making iron from the ore at twenty-five Northern furnaces and at twenty-five Southern furnaces. The highest cost at the Northern furnaces was $15.78 per ton, the lowest $12.42, the average $13.97 At the South the highest cost was $12.91, the lowest $8.55, the average $10.75, an average difference of $3.22 per ton.

The last decade of Southern progress has indeed been a revelation and a revolution. Northern brains and capital have freely mingled with our own, and every season emphasizes the truth of Judge Kelly's prophecy that the South is the coming El Dorado of American adventure. There are southern cities to-day with ten, twenty or thirty thousand inhabitants, which a few years ago were scarce a local habitation or a name. Witness Anniston, with 1,000 in 1880 and 10,000 in 1890; Birmingham, with 3,000 in 1880 and 26,000 in 1890. Chattanooga sprang from a village to a city of 30,000, and Roanoke from a way station to a city of near 20,000.

It is estimated that within the decade $800,000,000 has been expended on southern railroads. Its railway mileage has increased from 20,000 to 40,000 miles, and it is now constructing more mileage than all the rest of the country.

Its coal output within the same period has increased from 6,000,000 to 20,000,000 tons, and its product of pig iron from 390,000 to nearly 2,000,000 tons. Its cotton mills have increased from 160, with 660,000 spindles, to 355 with over 2,000,000 spindles. Its live stock has increased in value from $390,000,000 to near $600,000,000, and its agricultural products from $600,000,000 to nearly $1,000,000,000.

We are sending coal and pig iron to Pennsylvania, making cars for New England railroads, making woolen goods for Northern markets, shipping cotton goods to New England, and producing a variety of manufactures which it would take a dictionary to catalogue, but they range from egg-crates to iron bridges, from a tooth-pick to a locomotive, from paper bags to the armor of ironclad battle-ships.

The Superintendent of the Census, R. P. Porter, Esq., has kindly furnished me with these advance figures of the coal product:

COMPARATIVE STATEMENT OF PRODUCT OF COAL FOR THE SOUTHERN STATES, TENTH AND ELEVENTH CENSUS.

	Tenth Census. (Short Tons.)	Eleventh Census. (Short Tons.)
Alabama	323,972	3,572,983
Arkansas	14,778	279,584
Georgia	154,644	226,156
Kentucky	946,288	1,933,643
Maryland	2,228,917	2,939,715
Missouri	556,304	2,557,823
North Carolina	350	....
Tennessee	495,131	1,925,689
Virginia	45,896	865,786
West Virginia	1,839,845	6,180,757
Total	6,606,125	20,482,136

Not less eloquent are the figures from the same source that show comparatively the product of the mineral industries of the whole United States in 1870, and those of the Central Southern States in 1890.

MINERAL INDUSTRIES.

	Production of the United States in 1870. Tons.	Production of the Central Southern States in 1890. Tons.
Bituminous coal	15,000,000	17,772,945
Iron ore	3,163,839	2,917,529
Pig iron	2,052,821	1,780,909

Thus we are now nearly up to the mark of the entire production of iron in the United States in 1870; and in coal are now nearly 3,000,000 of tons ahead of its entire product then.

This item of the foreign trade of the United States is scarce less instructive. From July 1, 1890, to January 1, 1891, there was an increase in our foreign exports of $7,000,000, but from the South of $8,000,000—that is, a decrease of $1,000,000 from the whole country but for the Southern increase. The most striking item was the increase at Newport News, Va., of $4,736,000 as compared with $2,387,209 for the corresponding period of the previous year, a gain of nearly 100 per cent.

In such facts as these the stars of empire gleam. In 1893 the navies of the world will assemble in Hampton Roads, off Norfolk, Newport News and Fortress Monroe, preparatory to the grand review at New York inaugurating the Exposition at Chicago. They will there behold the seat of a coming commerce and industrial movement that will tell a tale of progress in the next census as wonderful as any page in the history of the New South.

The commanding position of Great Britain amongst modern nations is vastly due to the fact that it has drawn the raw materials of its factories from all quarters of the globe, giving employment to skilled artisans at home, and at once sustaining its commerce and enriching its merchants and manufacturers.

When it had lost the brightest of its crown jewels by the obstinacy of George III, and Burgoyne and Cornwallis had surrendered America, British inventors and mechanics were developing machines which restored the prestige lost by arms at Saratoga and Yorktown.

The Northern and Eastern States have copied upon the English models, and the raw materials produced by the South have vastly aided them—being first carried North to their factories, and then returned South in manufactured articles.

The secret of the great economic change that has come over the South lies in a nutshell—it possesses the richest and most diversified supply of the staple raw materials—it has begun on a vast scale to manufacture them where they can be manufactured cheapest—that is, at the mine and in the field and forest that produces them. It will henceforth give employment to millions of skilled artisans. It will henceforth employ only the most improved methods of production. Its industries will be more diversified than those of any other people. Under its genial skies, on the banks of its many rivers, beside its wide-stretched cotton and grain fields and orchards and pastures, in its noble forests, and at the mouths of mines that pour forth inexhaustible treasures will rise teeming cities, and in its broad ports the merchantmen of the world will assemble its fleets of commerce.

In the great work of renovation and advancement the inventor will lead. The inventor of an idea is the discoverer of a special providence, and he who knows how to use it "hitches his wagon to a star." The world has grown wise enough to know that with every invention that saves labor luxury is laid at the feet of the toiler, and skillful hands and brains are released from menial tasks for others more exalted. Ignorant mobs will no longer break the shuttles of a Kay, or drive the smelters from the coal pits of a Dudley.

The inventor has redeemed us from the curse of poverty, dissipated the mysteries of humbug, and destroyed the monopoly of knowledge. He has torn down the idol in the temple and driven the false god from the grove and the mountain. He has tamed the spirit of the savage with his power, and inspired the spirit of Christ with his benefactions. He has compelled peace by making war too terrible to tamper with.

He has instituted fraternity by bringing distant ones in converse and in contact. He has established the union of mankind by disclosing the unity of the universe. The oceans which he has mapped, the waves which he has bestridden, the lands which he has woven and banded together with steel, the winds whose coming and going he has foretold, and whose whispers he has interpreted; the very stars whose secrets he has read, and the lightnings which he has made to utter speech, to illumine darkness, and to bear burdens—all these proclaim him as earth's true conqueror and man's best friend.

Ere long I trust a great National Hall of Sciences will rise here at the Capital to display the mechanical achievements of American genius, and I would that Washington might teem with the statues of inventors.

THE COPYRIGHT SYSTEM OF THE UNITED STATES—ITS ORIGIN AND ITS GROWTH.

BY HON. AINSWORTH R. SPOFFORD, LL.D., LIBRARIAN U.S. CONGRESS.

"The chief glory of every people," says Dr. Samuel Johnson, "arises from its authors." The history and present condition of the law of literary property in the United States possesses both for writers and readers a commanding interest. Amid all uncertainties which have beset the proper protection of the rights of authors, and the sometimes conflicting decisions of the courts thereupon, the fact that this protection has always been recognized as due stands prominently out. And its foundation appears to be broader and deeper in this country than in any other, since it is distinctly laid in the Constitution of the government itself. That instrument declares that "the Congress shall have power to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

Upon this broad and salutary provision are founded all the statutes regulating copyright in books, from the earliest act signed by George Washington, in 1790, to the most recent legislation of the last Congress enacting international copyright.

To James Madison belongs the honor of having first offered, on the 18th of August, 1787, in the Federal Convention which framed the Constitution, a provision for this, among other powers, as "proper to be added to those of the general legislature," namely: "to secure to literary authors their copyrights for a limited time." Mr. Pinckney of South Carolina submitted other proposed grants of power to Congress, among which was this: "To secure to authors exclusive rights for a certain time." These were coupled, in each case, with an independent proposition empowering Congress to grant patents for useful inventions. All the propositions were referred to the "committee of detail," who formulated the desired provisions into the clause ultimately adopted in the Constitution, and previously cited. This ultimate provision amalgamated what were two independent propositions, as drawn by their authors, into one, doubtless for the sake of greater economy of words, in an instrument remarkable for its condensed style and plain, perspicuous language.

It is a very notable fact that the United States of America was the first nation that ever embodied the principle of protection to the rights of authors in its fundamental law. Thus anchored in the Constitution itself, this principle has been further recognized by repeated acts of Congress, aimed in all cases at giving it full practical effect. No right is ever complete without a remedy; and our National Legislature has very properly guarded the conceded rights of authors by provisions of law, designed to secure to them an exclusive privilege in the benefits to be derived during the term prescribed, and enforcing these rights by ample penalties.

The first copyright act was passed early in the first Congress, and received the presidential approval of Washington on the 31st of May, 1790. By its provisions the term of duration of each copyright was limited to fourteen years, with a further right of renewal for fourteen years longer, provided the author were living at the expiration of the first term. If it is asked why the authors of the Constitution gave to Congress no plenary power, which might have authorized a grant of copyright in perpetuity, the answer is, that in this, as in many other provisions of the Constitution, British precedent had a great, if not a controlling influence. Copyright in England, by virtue of the statute of Anne, passed in 1710 (the first British copyright act), was limited to fourteen years, with right of renewal, by a living author, of only fourteen years more; and this was in full force in 1787, when our Constitution was framed. Prior to the British statute of 1710, authors had only what is called a common law right to their writings; and however good such a right might be, so long as they held them in manuscript, the protection to printed books was extremely uncertain and precarious.

It has been held, indeed, that all copyright laws, so far from maintaining an exclusive property right to authors, do in effect deny it (at least in the sense of a natural right), by explicitly limiting the term of exclusive ownership, which might otherwise be held (as in other property) to be perpetual, or during the lifetime of the owner. But there is a radical distinction between the products of the brain, when put in the concrete form of books and multiplied by the art of printing, and the land or other property which is held by common law tenure. Society views the absolute or exclusive property in books or inventions as a monopoly. While a monopoly may be justified for a reasonable number of years, on the obvious ground of securing to their originators the pecuniary benefit of their own ideas, a perpetual monopoly is generally regarded as odious and unjust. Hence society says to the author or inventor: "Put your ideas into material form, and we will guarantee you the exclusive right to multiply and sell your books or your machines for a term long enough to secure a fair reward to you and to your children; after that period we want your monopoly, with its individual benefits, to cease in favor of the greatest good of all." If this appears unfair to authors, who contribute so greatly to the instruction and the advancement of mankind, it is to be considered that a perpetual copyright would (1) largely enhance the cost of books, which should be most widely diffused for the public benefit, prolonging the enhanced cost indefinitely beyond the author's lifetime; (2) it would benefit by a special privilege, prolonged without limit, a class of book manufacturers or publishers who act as middle-men between the author and the public, and who own, in most cases, the entire property in the works of authors deceased, and which they did not originate; (3) it would amount in a few centuries to so vast a sum, taxed upon the community who buy books, that the publishers of Shakespeare's works, for example, who under perpetual copyright could alone print the poet's writings, would have reaped colossal fortunes unequaled by any private wealth yet amassed in the world.

If it is said that copyright, thus limited, is a purely arbitrary right, it may be answered that all legal provisions are arbitrary. That which is an absolute or natural right, so long as held in idea or in manuscript, becomes, when given to the world in multiplied copies, the creature of law. The most that authors can fairly claim is a sufficiently prolonged exclusive right to guarantee them for a lifetime the just reward of their labors, with, perhaps, a reversion for their immediate heirs. That such exclusive rights should run to their remotest posterity, or, *a fortiori*, to mere merchants or artificers who had no hand whatever in the creation of the intellectual work thus protected, would be manifestly unjust. The judicial tribunals, both in England and America, have held that copyright laws do not affirm an existing right, but create a right, with special privileges not before existing, and also with special limitations.

To return to the provisions of the earliest copyright enactment of 1790—granting the exclusive privilege of printing his work to the author or his assigns for 14+14, or twenty-eight years in all: it prohibited all others from printing, publishing or selling the same work, under penalty of forfeiture of every copy to the author or proprietor, and the further penalty of fifty cents for every printed sheet found in possession of the offender or exposed to sale. This latter pecuniary penalty was found in practice to entail the payment of damages to such heavy amounts that they could not be enforced in many cases, and the law was changed to provide for the awarding of such damages, for violation of copyright, as may be recovered on trial of the case.

The act further required (1) entry of the title, before publication, in the office of the Clerk of the United States District Court in the State where the author or proprietor resided; (2) an entry fee of sixty cents for recording, and sixty cents for a copy of the record, or $1.20 in all; (3) an advertisement of the copy of record of each title, by author or proprietor, in some newspaper for the space of four weeks; (4) the deposit of a copy of each publication in the office of the Secretary of State at Washington within six months from date of issue.

This remained the law, with slight amendment, until 1831, when a new copyright act extended the duration of copyright from fourteen to twenty-eight years for the original, or first term, with right of renewal to the author (now first extended to his widow or children, in case of his decease) for fourteen additional years, making forty-two years in all.

By the same act the privilege of copyright was extended to cover musical compositions, as it had been earlier extended (in 1802) to include designs, engravings, and etchings. Copyright was further extended in 1856 to dramatic compositions, and in 1865 to photographs and negatives thereof. In 1870 a new copyright code, to take the place of all existing and scattered statutes, was enacted, and there were added to the lawful subjects of copyright, paintings, drawings, chromos, statues, statuary, and models or designs intended to be perfected as works of the fine arts. And finally, by act of March 3, 1891, the benefits of copyright were extended so as to embrace foreign authors, coupled with securing to American authors full copyright in such foreign countries as may extend copyright privileges to Americans.

The law of copyright, as codified by act of July 8, 1870, made an epoch in the copyright system of the United States. It transferred the entire registry of books and other publications, under copyright law, to the city of Washington, and made the Librarian of Congress sole register of copyrights, instead of the clerks of the District Courts of the United States. Manifold reasons existed for this radical change, and those which were most influential with Congress in making it were the following:

1. The transfer of the copyright records to Washington it was foreseen would concentrate and simplify the business, and this was a cardinal point. Prior to 1870 there were between forty and fifty separate and distinct authorities for issuing copyrights. The American people were annually put to much trouble and expense to find out where to apply, in the complicated system of District Courts, several of them frequently in a single State, to enter titles for publication. They were required to make entry in the district where the applicant resided, and this was frequently a matter of doubt, involving special inquiry. Moreover, they were required to go to the expense and trouble of transmitting a copy of the work, after publication, to the District clerk, and another copy to the

Library of Congress. If both copies were mailed to Washington at once, this double duty would be diminished by half. Next, the books would be received at Washington while fresh from the press, instead of, as formerly, several months after issue, or not at all. Then the copyright records would be constantly at hand, where the publications to which they relate were deposited. This would simplify and facilitate reference to the greatest possible degree. In the then existing complicated system, a person seeking to establish the validity of a copyright must sometimes go to two or three widely separated localities to verify the various points of evidence, and would perhaps fail at last from the very imperfect manner in which the law regarding copyright entries and deposits was executed.

How much less is the time and trouble required to transact the business through the mails, instead of dispatching a special messenger with each title for entry and each book for deposit, it needs but a moment's consideration to perceive. Out of the many thousands of authors and proprietors of copyrights in the United States, it is probable that less than two hundred resided in the immediate vicinity of a District clerk's office. The unnecessary delays and expenses, therefore, in the registry and deposit of copyright publications, were clearly much greater under the once existing system than under a uniform system of registry at Washington, as in the parallel case of patents, which have been registered in one central office at the seat of government from the beginning.

2. The advantage of securing to our national library a complete collection of all American copyright publications can scarcely be over-estimated. If such a law as that enacted in 1870 had been enforced since the beginning of the government, we should now have in the Library of Congress a complete representation of the product of the American mind in every department of science and literature. Many publications which are printed in small editions, or which become "out of print" from the many accidents which continually destroy books, would owe to such a library their sole chance of preservation. We ought to have one comprehensive library in the country, and that belonging to the nation, whose aim it should be to preserve the books which other libraries have not the room nor the means to procure.

3. This consideration assumes additional weight when it is remembered that the Library of Congress is freely open to the public throughout the year, and is rapidly becoming the great reference library of the country, resorted to not only by Congress and the residents of Washington, but by students and writers from all parts of the Union, in search of references and authorities not elsewhere to be found. Its complete catalogue system lends an additional value to its stores. The advantage of having all American publications thoroughly catalogued and accessible upon inquiry is one which it may require some reflection fully to appreciate, but which would be an invaluable aid to thousands. Its effect would be to build up at Washington a truly national library, approximately complete and freely open to all the people.

4. It was urged with reason that the proposed reform of the unsatisfactory methods of recording and perfecting copyrights would take away the objections so freely brought against the law. It was complained of by authors and publishers (and upon valid grounds) that they were put to much trouble and some expense to secure a privilege of uncertain value. There were so many points required to be complied with to perfect a copyright title, and these points were so subject to the mistakes and omissions of many officials concerned, as well as to those of the author or proprietor, that it might be said of most copyrights taken out that they rested under a cloud, which an ingenious or unscrupulous person might take advantage of to invalidate them. In the first place, the deposit of a copy of the publication in the office of the clerk of the District Court was frequently neglected, and this omission invalidated the copyright. Secondly, the records of the District clerk's office were often so imperfectly kept as to show no deposit of the publication even when made, and this might invalidate the copyright. Thirdly, the transmission of a second copy to the Library of Congress was very frequently neglected, as is shown in the fact that more than one thousand requisitions for publications, whose proprietors had not complied with the law, had been issued in a single year; and in each of these instances the copyright was void until the law was complied with. And what motive had the publishers to

use more zeal in complying with the law and transmitting copies of their publications through the District clerks to the Patent Office, when they saw that the books were thenceforth lost and buried, so that not even their authors, or the owners of the copyrights could find them again?

5. The proposed change, it was urged, would be a great economy for the government. It saved the Patent Office the trouble, expense and room of providing for a great library of material which it could not use and did not want. It left its officers and its space free to be concentrated upon the great and rapidly-growing inventive art of the country. A copyright is not an invention or a patent; it is a contribution to literature. It is not material, but intellectual, and has no natural relation to a department which is charged with the care of the mechanic arts; and it belongs rather to a national library system than to any other department of the civil service. The responsibility of caring for it would be an incident to the similar labors already devolved upon the Librarian of Congress; and the receipts from copyright certificates would much more than pay its expense, thus leaving the treasury the gainer by the change.

These considerations prevailed with Congress to effect the amendment in copyright registration referred to. The Commissioner of Patents, then Hon. Samuel S. Fisher, gave his hearty coöperation to the measure, and the Hon. Thomas A. Jenckes of Rhode Island, chairman of the Committee on Patents, which had charge of the whole matter, lent the resources of his active and vigilant mind to formulating the law, to answering objections, and to carrying the measure through Congress.

By the enactment of the statute of 1870 all the defects in the methods of registration and deposit of copies were obviated. The original records of copyright in all the States were transferred to Washington, and all records of copyright entry were thenceforward kept in the office of the Librarian of Congress. All questions as to literary property, involving a search of records to determine points of validity, such as priority of entry, names of actual owners, transfers or assignments, timely deposit of the required copies, etc., could be determined upon inquiry at a single office of record. These inquiries are extremely numerous, and obviously very important, involving frequently large interests in valuable publications in which litigation to establish the rights of authors, publishers or infringers has been commenced or threatened. By the full records of copyright entries thus preserved, moreover, the Library of Congress (which is the property of the nation) has been enabled to secure what was before unattainable, namely, an approximately complete collection of all American books, etc., protected by copyright, since the legislation referred to went into effect. The system has been found in practice to give general satisfaction; the manner of securing copyright has been made plain and easy to all, the office of record being now a matter of public notoriety; and the test of experience during twenty years has established the system so thoroughly that none would be found to favor a return to the former methods.

The Act of 1870 provided for the removal of the collection of copyright books and other publications from the overcrowded Patent Office to the Library of Congress. These publications were the accumulations of about eighty years, received from the United States District Clerks' offices by the Department of State and at the Patent Office, under the old law. By request of the Commissioner of Patents all the law books and a large number of technical works were reserved at the Department of the Interior. The residue, when removed to the Capitol, were found to number 23,070 volumes, a much smaller number than had been anticipated, in view of the length of time during which the copy tax had been in operation. But the observance of the acts requiring deposits of copyright publications with the Clerks of the United States District Courts had been very defective (no penalty being provided for non-compliance), and, moreover, the Patent Office had failed to receive from the offices of original deposit large numbers of publications which should have been sent to Washington. From one of the oldest States in the Union not a single book had been sent in evidence of copyright. The books, however, which were added to the Congressional Library, although consisting largely of school books and the minor literature of the last half century, comprised many valuable additions to the collection of American books, which it should be the aim of a National Library to render complete. Among them were the earliest editions of the works of many well-known writers, now out of print and scarce.

The first book ever entered for copyright privileges under the laws of the United States was "The Philadelphia Spelling Book," which was registered in the Clerk's Office of the District of Pennsylvania, June 9, 1790, by John Barry as author. The spelling book was a fit introduction to the long series of books since produced to further the diffusion of knowledge among men. The second book entered was "The American Geography," by Jedediah Morse, entered in the District of Massachusetts on July 10, 1790, a copy of which is preserved in the Library of Congress. The earliest book entered in the State of New York was on the 30th of April, 1791, and it was entitled "The Young Gentleman's and Lady's Assistant, by Donald Fraser, Schoolmaster."

It should not be inferred, from the foregoing recital, that no copyrights were granted in America prior to the act put in operation by the general government in 1790; on the contrary, Massachusetts and Connecticut had both, through their legislatures, granted copyrights to authors for a term running to twenty-one years. This was in 1783; and in the same year Mr. Madison offered a resolution in the Congress of the Confederation (which had no legislative powers) recommending to the several States to pass acts securing copyrights to authors for the term of fourteen years. In 1785 Virginia, acting in accordance with this recommendation, passed a copyright law, and New York and New Jersey, in 1786, followed with statutory provisions securing a fourteen years' copyright to authors.

But none of these various copyright enactments could operate to secure any protection to authors beyond the limits of the State in which they lived. It was necessarily reserved to a government embracing all the States within its paramount constitutional functions to give such protection to authors as should avail them throughout the United States.

Objection has occasionally, though rarely, been made to what is known as the copy-tax, by which two copies of each publication must be deposited in the National Library. This requirement rests upon two valid grounds: (1) The preservation of copies of everything protected by copyright is necessary in the interest of authors and publishers, in evidence of copyright, and in aid of identification in connection with the record of title; (2) the library of the government (which is that of the whole people) should possess and permanently preserve a complete collection of the products of the American press, so far as secured by copyright. The government makes no unreasonable exaction in saying to authors and publishers: "The nation gives you exclusive right to make and sell your publication, without limit of quantity, for forty-two years; give the nation in return two copies, one for the use and reference of Congress and the public in the National Library, the other for preservation in the copyright archives, in perpetual evidence of your right."

In view of the valuable monopoly conceded by the public, does not the government in effect give far more than a *quid pro quo* for the copy-tax? Of course it would not be equitable to exact even one copy of publications not secured by copyright (the daily newspapers, for example), in which case the government gives nothing and gets nothing; but the exaction of actually protected publications, while it is unfelt by publishers, is so clearly in the interest of the public intelligence, as well as of authors and publishers themselves, that no valid objection to it appears to exist. In Great Britain five copies of every book protected by copyright are required for five different libraries, which appears somewhat unreasonable.

Regarding the right of renewal of the term of copyright, it is a significant fact that it is availed of in comparatively few instances, compared with the whole body of publications. Multitudes of books are published which not only never reach a second edition, but the sale of which does not exhaust more than a small part of the copies printed of the first. In these cases the right of renewal is waived and suffered to lapse, from defect of commercial value in the work protected. In many other cases the right of renewal expires before the author or his assigns bethink them of the privilege secured to them under the law. It results that more than nine-tenths, probably, of all books published are free to any one to print, without reward or royalty to their authors, after a very few years have elapsed. On the other hand, the exclusive right in some publications of considerable commercial value is kept alive far beyond the forty-two years included in the original and the renewal term, by entry of new editions of the work, and securing copyright on the same. While this method may not protect any of the original work from republication by others, it enables the publishers of the copyright edition to advertise such unauthorized reprints as imperfect, and without the author's or editor's latest revision or additions.

The whole number of entries of copyright in the United States since we became a nation considerably exceeds three-quarters of a million. This is no place for detailed statistics of the extensive and steadily growing copyright business of the country. It may, however, be of interest to give the aggregate number of titles of publications entered for copyright in each year since the transfer of the entire records to Washington in 1870:

1870	5,600	1877	15,758	1884	26,893
1871	12,688	1878	15,798	1885	28,410
1872	14,164	1879	18,125	1886	31,241
1873	15,352	1880	20,686	1887	35,083
1874	16,283	1881	21,075	1888	38,225
1875	14,364	1882	22,918	1889	40,777
1876	14,882	1883	25,273	1890	42,758
				Total	476,353

The reduced number of copyrights registered in 1875 and years immediately following was due to the transfer to the Patent Office, by Act of June 18, 1874, of the registration of all labels and prints illustrative of articles of manufacture. These had been, from the beginning of the government, entered as copyrights, thus encumbering the records with a great mass of so-called publications which have no relation whatever to literary copyright, but belong to the mechanic arts. The number of these entries was about 5,000 annually, and, notwithstanding their withdrawal, the increase in the aggregate of other publications has been so large as to exhibit the greatly advanced progress in the publishing activities of the country above recorded.

It will readily be seen that this great number of copyrights (now about twice as large as the annual average registry of patents) does not represent books alone. Many thousands of entries are periodicals claiming copyright protection, in which case they are required by law to make entry of every separate issue. These include a multitude of weekly journals, literary, scientific, religious, pictorial, technical, commercial, agricultural, sporting, dramatic, etc., among which are a number in foreign languages. The entries of periodicals also embrace nearly all the leading monthly and quarterly magazines and reviews, with many devoted to specialties—as metaphysics, sociology, law, theology, art, finance, education, and the arts and sciences generally. Another large class of copyright entries (and the largest next to books and periodicals) is musical compositions, numbering recently some 8,000 publications yearly. Much of this property is valuable, and it is nearly all protected by entry of copyright, coming from all parts of the Union. There is also a large and constantly increasing number of works of graphic art, comprising engravings, photographs, photogravures, chromos, lithographs, etchings, prints, and drawings, for which copyright is entered. The steady accumulation of hundreds of thousands of these various pictorial illustrations will enable the government at no distant day, without a dollar of expense, to make an exhibit of the progress of the arts of design in America, which will be interesting and instructive in a high degree. An art gallery of ample dimensions for this purpose is provided for in the new National Library building, now rapidly rising on Capitol Hill.

It remains to consider briefly the principles and practice of what is known as international copyright.

Perhaps there is no argument for copyright at all in the productions of the intellect which is not good for its extension to all countries. The basis of copyright is that all useful labor is worthy of a recompense; but since all human thought when put into material or merchantable form becomes, in a certain sense, public property, the laws of all countries recognize and protect the original owners, or their assigns to whom they may convey the right, in an exclusive privilege for limited terms only. Literary property therefore is not a natural right, but a conventional one. The author's right to his manuscript is, indeed, absolute, and the law will protect him in it as fully as it will guard any other property. But when once put in type and multiplied through the printing-press, his claim to an exclusive right has to be guarded by a special statute, otherwise it is held to be abandoned (like the articles in any newspaper) to the public. This special protection is furnished in all civilized countries by copyright law.

What we call "copyright" is an exclusive right to multiply copies of any publication for sale. Domestic copyright, which is all we have hitherto had in this country, is limited to the United States. International copyright, which has now been enacted, extends the right of American authors to foreign countries, and recognizes a parallel right of foreign authors in our own. There is nothing in the constitutional provision which restrains Congress from granting copyright to other than American citizens. Patent right, coming under the same clause of the Constitution, has been extended to foreigners. Out of about 20,000 patents annually issued, about 1,000 (or 5 per cent.) are issued to foreigners, while American patents are similarly protected abroad. If we have international patent right, why not international copyright? The grant of power is the same; both patent right and copyright are for a limited time; both rights during this time are exclusive; and both rest upon the broad ground of the promotion of science and the useful arts. If copyright is justifiable at all, if authors are to be secured a reward for their labors, they claim that all who use them should contribute equally to this result. The principle of copyright once admitted, it cannot logically be confined to State lines or national boundaries. There appears to be no middle ground between the doctrine of common property in all productions of the intellect—which leads us to communism by the shortest road—and the admission that copyright is due, while its limited term lasts, from all who use the works of an author, wherever found.

Accordingly, international copyright has become the policy of nearly all civilized nations. The term of copyright is longer in most countries than in the United States, ranging from the life of the author and seven years beyond, in England, to a life term and fifty years additional in France and Spain. Copyright is thus made a life tenure and something more in all countries except our own, where its utmost limit is forty-two years. This may perhaps be held to represent a fair average lifetime, reckoned from the age of intellectual maturity. There have not been wanting advocates for a perpetual copyright, to run to the author and his heirs and assigns forever. This was urged before the British Copyright Commission in 1878 by leading British publishers, but the term of copyright is hitherto, in all nations, limited by law.

Only brief allusion can be made to the most recent (and in some respects most important) advance step which has been taken in copyright legislation in the United States. This act of Congress, providing for international copyright on prescribed conditions, was signed by the President on the 3d of March, 1891, and is aimed at securing reciprocal protection to American and foreign authors in the respective countries which may comply with its provisions. There is here no room to sketch the hitherto vain attempts to secure to authors, here and abroad, an international protection to their writings. Suffice it to say that a union of interests was at last effected, whereby authors, publishers and manufacturers are supposed to have secured some measure of protection, not before enjoyed, to their varied interests. The measure is largely experimental, and the satisfaction felt over its passage into law is tempered by doubt in various quarters as to the justice, or liberality, or actual benefit to authors of its provisions. What is to be said of a statute which was denounced by some Senators as a long step backward toward barbarism, and hailed by others as a great landmark in the progress of civilization?

The main features added to the existing law of copyright by this act, taking effect July 1, 1891, are these:

1. All limitation of the privilege of copyright to citizens and residents of the United States is repealed.

2. Foreigners applying for copyright are to pay fees of $1 for record or $1.50 for certificate of copyright, instead of 50 cents for record or $1 for certificate.

3. Importation of books, photographs, chromos or lithographs entered here for copyright is prohibited, except two copies of any book for use and not for sale.

4. The two copies of books, photographs, chromos or lithographs deposited with the Librarian of Congress must be printed

from type set, or plates, etc., made in the United States. It follows that all foreign works protected by American copyright must be wholly manufactured in this country.

5. The copyright privilege is restricted to citizens or subjects of nations permitting the benefit of copyright to Americans on substantially the same terms as their own citizens, or of nations who have international agreements providing for reciprocity in the grant of copyright, to which the United States may at its pleasure become a party.

6. The benefit of copyright in the United States is not to take effect as to any foreigner until the actual existence of either of the conditions just recited, in the case of the nation to which he belongs, shall have been made known by a proclamation of the President of the United States.

There are some doubtful questions involved in the interpretation of the act, which is not free from ambiguity, and which must wait for their solution upon the construction placed upon it by the judicial tribunals. Meanwhile, authors and publishers should await the results of such measure of international copyright as has been achieved, doing what they may to guard their interests, while the experiment is being fairly tried. A measure which was regarded as worth so many years effort to secure should be worth a little patience on the part of those who have secured it.

In conclusion, the writers of America, with the steady and rapid growth of the art of making books, have come more and more to appreciate the value of their preservation, in complete and unbroken series, in the library of the government, the appropriate conservator of the nation's literature. Inclusive and not exclusive, as this library is wisely made by law, so far as copyright works are concerned, it preserves with impartial care the illustrious and the obscure. In its archives all sciences and all schools of opinion meet and mingle. In the beautiful and ample repository, now being erected and dedicated to literature and art through the liberality of Congress, the intellectual wealth of the past and the present age will be handed down to the ages that are to follow.

THE EFFECT OF INVENTION UPON THE RAILROAD AND OTHER MEANS OF INTERCOMMUNICATION.

By Octave Chanute, of Illinois, President of the American Society of Civil Engineers.

A century ago, Washington being then President of the United States, the art of transportation, both by land and by water, was practically still in the same stage of development, as measured by speed of transit as well as by cost, which had prevailed for the preceding eighteen hundred years, or since the establishment of the Roman Empire.

Upon the sea there had been, it is true, considerable increase in the size of vessels, and some changes in the mode of their rigging, especially since the length of the voyages had been increased by the discovery of America; but the sail was still the sole means of propelling ships, and the speeds attained were little, if any, greater than those in antiquity. An average progress of one hundred miles per day, under varying conditions of wind, was considered satisfactory, and the quickest passages between New York and Liverpool were performed in twenty days, or at the rate of 176 miles per day.

Upon the land there had been, since the days of the Roman Empire, many fashions in carriages, but the common road was still the principal way traveled, and the horse was the power chiefly used in transporting passengers and freight. There were canals, it is true, but the average speeds were only two to three miles per hour, and the charges were from six to ten cents per ton per mile. Upon the turnpikes the maximum speed for mail coaches was from eight to ten miles per hour, and a fair day's travel at that period of time may be stated as averaging about 100 miles in twenty-four hours.

Extraordinary performances might attain to twice that speed. Thus, upon his disastrous return from Moscow the first Napoleon, anxious to reach his capital in the shortest possible time, rode in his traveling and sleeping carriage from Smorgoni to Paris, a distance of 1,000 miles, between the 5th and 10th of

December, 1812, and this speed of say 200 miles a day may be considered as the utmost that man, with unlimited resources at his command, could then accomplish on a thousand miles journey.

Freight rates by wagon were twenty-seven cents a ton a mile between London and Leeds, and thirty cents a ton a mile between Liverpool and Manchester.

All this has been changed by one mighty invention, bringing in its train a multitude of other inventions. Steam came into the world to transform into mechanical energy and speed the light and heat of past ages, stored in the coal during the carboniferous period; and applications to various means of transport soon followed, so that to-day a fair day's journey for a steamship may be stated at 400 miles, and runs of 500 miles in twenty-four hours are not uncommon, while the distance of 1,000 miles, traveled by Napoleon in five days, can now be done by rail in twenty-four hours without the necessity of becoming an emperor to accomplish the feat.

Indeed, one of the most remarkable characteristics of the improvements which have occurred in methods of transportation within a century is the fact, that they have chiefly benefited the mass of the people. So that the man in moderate circumstances now travels as rapidly and as cheaply as the wealthy, and that enormous economies have been accomplished in the transportation of freight and in the exchange of commodities.

All this, clearly, has been entirely the effect of invention. Improvement has followed upon improvement, because invention has been more active and successful than at any period in the world's history.

It would take much too long to pass in review, even in the most cursory manner, the various steps through which this era of invention has passed; but now, practically, one hundred years after the commercial acceptance of the steam engine by the industrial world, it seems a good time to inquire, in a general way, what has thus far been accomplished and what the future may have in store for us.

It will be remembered that Fulton built the first commercially successful steamboat in 1807, and that the "Savannah" was the first steamship to cross the ocean in 1819. In those days, and for many years thereafter, the speeds of steam vessels were small, and the consumption of fuel was great, say four to ten pounds per horse-power per hour. Invention has since been busy with the marine engine, and advancing step by step it has now reduced the coal consumption to one and three-quarter pounds per horse-power per hour, while the speed has been increased 50 per cent. As stated by W. C. Church, the biographer of Ericsson, it is now possible to carry across the Atlantic 2,200 tons of freight with 800 tons of coal, where it was in 1870 only possible to carry 800 tons of freight with 2,200 tons of coal.

This is the result, it need scarcely be said, of the substitution of the screw-propeller for the paddle-wheel, of surface condensation, of high steam pressures, and double, triple and now quadruple expansion; each of them a successive step resulting in such growth, that steamers now plow every sea, and their aggregate tonnage is nearly as large as that of the sailing vessels.

The following table, compiled from data published in connection with the large model of the globe at the Paris Exposition of 1889, exhibits the estimated number of sailing vessels and steamships now belonging to the various nations of the world:

MARINE OF PRINCIPAL NATIONS.

COUNTRY.	SAILING VESSELS.		STEAMSHIPS.	
	No.	Tonnage.	No.	Tonnage.
England	14,030	4,510,000	4,870	6,592,000
United States	5,900	1,975,000	400	532,000
France	2,050	363,000	430	722,000
Norway	3,660	1,345,000	270	150,000
Sweden	1,910	390,000	370	149,000
Germany	2,190	796,000	540	628,000
Italy	2,700	782,000	180	243,000
Spain	1,410	262,000	340	388,000
Russia	2,150	464,000	220	159,000
Holland	910	261,000	160	198,000
Greece	1,380	279,000	....	....
Austria	....	....	110	143,000
Denmark	910	261,000	170	125,000
Other countries	3,040	740,000	650	597,000

It is a source of regret that the United States has not maintained upon the sea the rank which it occupied earlier in the century. It is now the second in sailing vessels and the fourth as to steamships among the nations of the earth. Many reasons have been assigned for this state of affairs, chief among which are probably our navigation laws and the higher scale of wages which prevails in this country, while vessels engaged in the ocean trade have to compete with all nations.

It is just possible that some labor-saving inventions, applicable to steamship service, may diminish the relative importance of the wages upon the aggregate cost, and eventually enable us to occupy upon the sea the same position in the world's advance, that the railway has given us upon the land.

The Railway.

In discussing the effect of invention upon the railroad, it may be interesting to allude to its early history, which is now being forgotten.

It seems to be popularly supposed that the railway dates no further back than the Liverpool and Manchester Railway in 1829. This, to be sure, was the first great success and commercial recognition, but railways, like most human inventions, had previously gone through a process of experiment, evolution and improvement, which prepared the way for the final result.

Tramways had been used in operating coal mines in England for many years. They were crude structures, generally laid with cast-iron plates or rails about three feet long, and worked by horse-power.

Trevithic built a fairly good locomotive in 1804, but the road was not strong enough to carry it, and it was speedily abandoned. Stephenson built his first locomotive in 1814, and he gradually improved upon its construction in subsequent locomotives placed upon the coal tramway with which he was connected, until an opportunity was offered of embodying his skill and experience in the three locomotives furnished to the Stockton and Darlington Railway, of which he became the engineer.

This was practically the first line built for public use and intended to convey freight and passengers. It was twelve miles long, and its opening, September 27, 1825, marks the beginning of the present railway era.

Although it was a great advance upon what had been done before, its construction was still crude and left plenty of room for subsequent invention. About half of the track was laid with cast-iron rails, and the remainder with wrought-iron rails, weighing twenty-eight pounds to the yard. These were of the "fish-bellied" pattern, being two inches in depth at the joints, where they rested upon chairs, and three and one-quarter inches deep in the middle or bellied part; the top of the rail being two and one-quarter inches broad, with the flange three-quarters of an inch thick.

I remember seeing rails of this pattern still in use on a side track at East Albany in 1851, it having been the impression at an early day among engineers that the best results were to be obtained with rails, by following the practice which prevailed for cast-iron girders.

For some years the Stockton and Darlington Railroad was worked in a mixed sort of way, by both horses and locomotives. The latter ran at speeds of four to six miles per hour, although occasional performances of twelve to fourteen miles per hour are recorded, and it was not till 1829, when at the public competition of locomotives for the Liverpool and Manchester Railway, the "Rocket," built by Stephenson, attained a speed of twenty-nine miles per hour, and the "Novelty," by Ericsson, ran at twenty-eight miles per hour, that the merits of steam for railway propulsion became fully recognized, and that the active nations of the world began commercially the construction and operation of railways.

This commercial movement at once enormously stimulated invention, and a host of ingenious men took up the various problems connected with the railways. Experiment and improvement rapidly followed each other, and a large number of inventions and devices were introduced in all departments, including the track, the motive power, the rolling stock, and the organization.

Indeed, these devices and inventions were so numerous, that many which were fairly good have since been eliminated.

Thus Messrs. Zerah Colburn and Alexander L. Holley, in their report upon the "Permanent Way of European Railways," in 1858, described and figured no less than sixteen systems of English track as the principal types of what had been tried, and of these but three have survived.

For the sleepers or ties, stone blocks were used and found too rigid; timber was laid, both as longitudinal stringers and as cross-ties, and many forms of cast-iron sleepers had been experimented with before any cross-tie system, whether of wood or of metal, became universally accepted.

For rails, after the "fish-bellied," came the strap rail and its attendant snake heads. Then followed the edge rail, whether double-headed or with a flat foot, the inverted "U" rail, the "saddle-backed" rail bearing directly upon the ballast, and a whole host of compound rails in several pieces, together with an almost endless variety of joints, from the cast-iron chair to the fish-plate, until the present time, when the double-headed rail still obtains favor in Europe, while the foot rail is uniformly used in this country; there being in all countries considerably less diversity of practice than there was in 1858.

In locomotives almost numberless experiments have been tried, and yet the improvement has been rather one of degree than of kind. Stephenson's "Rocket" owed its superiority over all predecessors to the simultaneous introduction in its construction of the multitubular boiler, and of the steam exhaust up the chimney to create draft over the fire; and these are still the distinctive features of modern locomotives.

These engines are, to be sure, much heavier, more simple, and especially much more economical than their original prototype, but the speeds are not considerably greater than were obtained within the first few years of the railway era.

In rolling stock, a long series of successive inventions has largely added to the comfort of passengers, and to the useful freight load in proportion to the weight of the car; while in the organization, improvements in the methods of handling business, among which may be mentioned signals and the application of the telegraph, have very largely increased the efficiency and diminished the cost.

And since the telegraph has been mentioned, further reference may be made to the marvelous development of electrical science and its applications within the railroad era. A century ago Franklin had shown the dependence of certain phenomena upon electricity, but it was still a scientific toy confined to laboratory experiments. As soon, however, as Morse, Henry, Vail and Wheatstone harnessed it to conveying thought, in 1845, it became the adjunct and indispensable companion of the railway, and the telegraph line found its home upon the railroad right of way.

Later on came the telephone and the domestic uses of electrictity about our homes, in which it has proved such a nimble and effective servant, until these latter days when it has been pressed into service to convey power as well as intelligence, and is now applied to the running of motors for hundreds of purposes, and to the supplying of light and heat.

Probably the most remarkable growth among these purposes has been for street railroads, of which nearly 3,000 miles have been opened in the United States during the last five years, which are operated by electric motors. These have been found so much more rapid, economical and capable of overcoming gradients than those operated by animal power, that the day seems not very distant when the horse will be superseded on the street railway line, just as he has been on the general traffic railway.

Allusion may also briefly be made to the effect of the railroad upon the art of bridge building. A century ago such structures were comparatively few in number, and a span of one hundred feet was considered a long one. Masonry was the recognized material with which to build, but the necessities of the railroad brought about an evolution, first with wood and then with iron construction, which resulted last year in the opening of the Forth Bridge, the greatest present achievement in this art, with two channel spans each 1,710 feet in the clear, and a clear headway of 150 feet under the bridge.

Whether these tremendous spans are to remain the limit, or whether man will spin an iron web across still greater distances, will mainly depend upon the railroad necessities of the future, for it is only the concentrated traffic of the railway which will warrant such very expensive structures.

Now, let us inquire as to what extent the various nations of the earth have availed of the railway.

Progress in civilization may fairly be said to be dependent upon the facilities for men to get about, upon their opportunity for intercourse with other men and nations, not only in order to supply their mutual needs cheaply, but to learn from each other their wants, their discoveries and their inventions.

Prior to the invention of the steamer and of the railway such opportunities were but few, so that there have been ages in the world, that of the crusades for instance, where war itself was not a wholly unmixed evil, in consequence of the beneficial new ideas which it introduced among men.

In order to arrive at the railway mileage of the world I have started from a table published in the last issue of "Poor's Railroad Manual," which furnishes the statistics up to the close of the year 1888. These are the latest data available, and they have been compared with a similar statement published in "Archiv fur Eisenbahmweser" covering the same date, which shows 804 miles more than Poor's table.

From these tables, knowing the annual rate of recent increase, which was 63,941 miles for the four years from 1884 to 1888 (say 16,000 miles a year), and allowing for decreasing or increasing activity in the various countries, as chronicled in the daily and the technical press, I think it is possible to make an estimate which shall approximate closely to the actual facts on the 1st of January, 1891. Such a statement, believed to be pretty nearly correct, will be found in the subjoined table.

ESTIMATED RAILROAD MILEAGE, JANUARY, 1891.

Country.	End 1888 Miles.	Increase 2 years.	Estimated 1891 Miles.	Estimated Locomotives.	Population.	Population per mile of railway.
United States	155,801	10,724	166,525	33,200	62,600,000	376
Canada	12,764	1,236	14,000	2,660	5,300,000	378
Mexico	4,168	632	4,800	770	11,000,000	2,292
Central America	1,900	200	2,100	420	8,100,000	3,857
North America	174,633	12,792	187,425	37,050	87,000,000	464
South America	13,850	2,150	16,000	2,880	32,000,000	2,000
Europe	132,836	8,164	141,000	64,860	347,000,000	2,461
Asia	17,618	2,382	20,000	4,200	789,000,000	39,450
Africa	5,152	848	6,000	960	197,000,000	32,833
Australia	10,409	2,591	13,000	2,340	38,000,000	2,933
Totals	354,498	28,927	383,425	112,290	1,490,000,000	3,886

From this it seems to appear that there are at the present time 383,425 miles of railroad in the world, operated by 112,290 locomotives, without including street lines in cities, at mines or in connection with various industrial enterprises. Of these, 187,425 miles, or nearly one-half, are in North America, and the latter, if placed end to end, would reach around the earth seven and one-half times, without counting the double, triple or quadruple tracks, or the sidings. The total mileage of the globe would encompass it fifteen and one-half times, and would reach more than one and a-half times to the moon (237,840 miles), if there were only supporting ground to lay the track upon.

It is estimated that there are 112,290 locomotives, and as a fair average will give them about 500 horse-power each, they are seen to be equivalent to no less than 56,145,000 horses.

It will be noticed how tardy some of the oldest nations have been in availing of this improved means of inter-communication. The 789,000,000 inhabitants of Asia, for instance, have but 20,000 miles of railway, this being chiefly in British India. If the whole world were as well provided for in this respect as North America, where there are 2,154 miles of railroad for each million inhabitants, there would be on this earth more than 3,000,000 miles in the aggregate, or eight times the present mileage.

There is therefore still a good deal for the railway builders and organizers to do, and foreign fields may yet be opened to the energy of Europeans and North Americans, should some of the Asiatic nations, like China, for instance, enter upon an epoch of railroad construction, or have the good fortune, like India, to fall into strong hands.

Perhaps the latter country exhibits more than any other the beneficial effects of railway construction. Before the British conquest it was very poor, torn by internal strifes and subject to periodical famines. Now it is successfully exporting wheat in competition with the United States and Russia, and it is also supplanting China in the production of tea, a fact as yet but little appreciated; while in the meantime, wages, though still low, have more than doubled within the century.

In Africa there are 6,000 miles. We have all been following with deep interest the various journeys of Mr. Stanley across this continent. Each of them occupied nearly three years of tremendous effort, and the thought that the actual distance traversed from coast to coast could have been gone over by railroad in three or four days, may cause us to realize the economy of labor and of time which has been brought into the world by the effects of invention on the railroad.

It is almost impossible to estimate in money, even approximately, what has been the economical effect upon the world. There have been so many concurrent causes in the increase of wealth that it seems impracticable to isolate any one of them. We may, however, gain some idea by estimating what the present volume of traffic would cost at prices prevailing a century or less ago, and for this purpose we may select the United States.

It has been said that the cost of freight hauling was 27 and 30 cents a ton a mile in England. In this country it used to be 20 cents a ton a mile between New York and Buffalo before the opening of the canal, and within thirty-five years it was 29 cents a ton a mile across the plains from the Missouri River to Denver. In order to avoid all possible cavil as to the cost being diminished by increased volume of traffic, we will assume a freight rate of 16 cents a ton a mile, which corresponds to the hauling of a ton of goods on a turnpike twenty-five miles per day at an average cost of $4.00.

For passenger rates we will assume that a century ago they were 10 cents per mile. Now, the freight traffic of the railroads of the United States in 1889 was equal to 68,604,012,396 tons miles, and the passenger business was 11,965,726,015 passengers one mile. If we carry these out at the assumed prices, and deduct from the account (in which the miscellaneous earnings are included at the same figure on both sides to make it complete) the actual amounts collected by the railroads from the people in 1889, we have the following balance sheet :

NATIONAL BALANCE SHEET WITH RAILROADS, 1889.

68,604,012,396 ton miles of freight, @ 16c......		$10,976,641,983
11,965,726,015 passenger miles, @ 10c.........		1,196,572,601
Miscellaneous earnings..............................		66,685,396
Total earnings at prices of 1791.........		$12,239,899,980
Less freight earnings, 1889........	$666,530,653	
Less passenger earnings, 1889...	259,640,807	
Less miscellaneous earn'gs, 1889.	66,685,396	992,856,856
Estimated national saving.................		$11,247,043,124

Which is more for one year than the entire cost of our railroads, as represented by their stock, bonded debts, liabilities and current amounts, which in 1889 aggregated a sum of $9,931,453,146. So that the annual saving to the nation, over the prices prevailing in 1791, seems to be greater than the whole capital invested in railroads, if we assume the possibility of the volume of traffic having been the same.

This assumption is, of course, a fallacy, because the prices prevailing a century ago would have been largely prohibitory, and the volume of traffic would be much smaller, yet this estimated national saving may bring some comfort to the citizens who think that the rapidly-vanishing railroad rates do not go down fast enough, and who say that these corporations are impoverishing the people.

We may also gain some idea as to how greatly the improved means of inter-communication have benefited other countries which have availed of them, by considering the vastly-increased scale of national expenditures which prevail among them, as compared with their national expenses a century ago. Some of them, indeed, are now enabled to keep a considerable portion of their working population in idleness, in their standing armies, and yet the comfort and prosperity of the remainder is far greater than that of their people a hundred years ago, while among those nations in Asia and Africa which have failed to avail of the new methods of transportation, wages are still very low, and occasional famines still prevail.

But man is still unsatisfied with what has been accomplished, and all over the civilized world invention is still trying to improve means of transport. The sea, the land, the air, are being experimented upon to gain higher speeds or more economical modes of transit.

It may be perhaps doubted whether greater cheapness will be attained than with the steamer or the railroad, but it is believed that greater speeds are possible in the near future.

On the sea the great transatlantic steamers have attained within the past two years speeds of twenty and twenty-one knots per hour; while various experimenters hope to get, with novel means of propulsion, the fabulous speed of thirty to forty miles per hour.

Upon the land inventors calmly talk of superseding the present maximum railroad speed of 70 miles an hour with velocities of 120 to 150 miles per hour. Recent developments in electrical science have given good hopes for this, and both European and American inventors are experimenting. Among the latter may be mentioned the "Weems Electric" system, by which speeds of 115 miles per hour have already been attained on a most imperfect track; the "Williams Porte-Electric" system, of attracting forward at high velocities, a railroad car forming a magnetic core, through a series of helices or coils charged with an electric current, and the "Chemin de Fer Glissant" system or water borne railroad cars which was exhibited at the Paris Exposition of 1889.

Allusion may be made to the "bicycle locomotive," with which it is claimed that far greater speed can be obtained than with the engines in general use; the principal object of inventors in every case seeming to be to gain higher velocities than those which have hitherto been found practicable.

In the air, man gazes at the birds and longs to imitate them. I know personally of eight or ten perfectly sane men in the United States, in England, in France, in Australia, and in Egypt, who are experimenting with flying machines—not dirigible balloons, with which a measure of success has already been accomplished, although only low velocities are to be expected from them, but real flying machines, depending like the birds upon the reactions of the air for their support.

Of these experimenters, probably the best equipped is Mr. Maxim, the inventor of an electric light and of the automatic machine gun, who made the remarkable statement last November, in a letter to the New York *Times*, that his experiments show that as much as 133 pounds may be sustained in the air by the expenditure of one horse-power; that he has succeeded in making a motor which will develop one horse-power for every six pounds of weight, and that a speed of 100 miles per hour would seem to be attainable.

If his experiments, which are now being carried on in England on a large and skillful scale, succeed as he hopes, or if some other of the many inventors who are working on the problem hits upon the right combination, there seems to be no reason why man may not emulate eventually the flight of the swallow, whose speed is computed at 150 miles per hour, or that of the swifter martin, which is said to flash through the air at the rate of 200 miles per hour.

THE INVENTORS OF THE TELEGRAPH AND TELEPHONE.

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The word telegraph was introduced about one hundred years ago as a name for a means of conveying intelligence to a distance by means of signs. The signs were produced in a variety of ways, as for example, by the shapes or positions of bodies placed on high poles, or by letters or words of sufficient magnitude similarly exposed. The meaning of the word telegraph, interpreted by its original use, would thus be to write or make signs at one place in such a way that they could be read or interpreted at a distant place. It appears, therefore, that so long as we confine our attention to early methods of telegraphing, the signs or signals were made at the sending station and read from the receiving station. Modern usage gives a slightly different meaning to the word, namely, a means of producing visible, audible or written signs at a distance. That is to say, the signs are to be produced at the receiving station. This was first accomplished on an extensive scale and at great distances by means of electricity. Methods of transmitting sounds, or even speech, to moderate distances by means of tubes and by means of what we now call string or mechanical telephones have, however, been known for several centuries.

Methods of conveying intelligence to a distance have been known and used from very early times. Fires seem to have been the earliest means employed for giving signals, and we find such signs referred to in the writings of the Prophet Jeremiah, of Eschylus, of Polynius and others. Schottus, in his "Technica Curiosa," proposes the application of the telescope to view posts erected on an eminence at a distant station, and on which signs were to be placed. The Marquis of Worcester, in his "Century of Inventions," enumerates a day and a night telegraph; and Kessler, in his "Concealed Arts," proposes to cut out letters in boards and make them visible at a distance by placing them over the end of a cask in which a light is burning, the letters or other characters being exposed in proper succession any message can be transmitted.

One of the earliest telegraphs of which we have now a direct representative was the flag signals introduced about the middle of the seventeenth century by the Duke of York (afterwards James II of England), who was at that time admiral of the English fleet. This was the beginning of the flag telegraph still used for communicating between ships at sea; originally introduced for the purpose of directing the manœuvres of the fleet. In 1684 Dr. Robert Hook communicated to the Royal Society of London a proposal for a telegraph. In this method the signs were to consist of bodies of different shapes placed on high poles in an exposed position. Some years afterwards a similar method was proposed to the Academy of Sciences by M. Amontons, a French natural philosopher. In 1767 Mr. R. L. Edgeworth proposed to telegraph by means of the arms of a windmill, the positions of the arms of the mill to be used to indicate the signals. In 1784 the same author proposes to make the signals indicate numbers, and to interpret by means of vocabularies of numbered words. In 1794 the semaphore telegraph of M. Chappe was adopted by the French government. This telegraph consisted of a high post and two bars of timber, the middle of one pivoted to one end of the other, and the free end of this second bar pivoted to the top of the post, so that the whole of the motions could take place in a vertical plane. The positions, relative to the vertical or horizontal, of the two arms indicated the signal. These and other modifications of the semaphore have been at various times used, and are still used on railways for train signals.

The chief interest of these early telegraphs, a great many forms of which might be enumerated, is in illustrating the fact that some means of conveying intelligence to a distance quickly and without a messenger has, from the earliest times, been recognized as of great importance. It is well also to keep before us the things that have been done in earlier times when we attempt to judge of the advances which have been made by modern invention.

The telegraph of to-day is almost entirely electrical, and in its present form it is of comparatively recent growth. It may be well, however, in this branch also to glance briefly at the early history of the subject. To begin with what we may call the fable period, we find in the year 1617 an allusion in one of Strada's "Prolusiones Academicæ" to the belief that there existed a sympathy between needles which had been touched by a species of loadstone, which caused them always to set parallel to each other if they were free to take up such positions. Two such needles it was said, could be used to convey intelligence to any distance, because if they were pivoted on cards marked with letters or words and the card properly placed, so that corresponding letters occupied similar positions, when one needle was made to point to any letter or mark the other needle would immediately point to the corresponding mark on its card. The same belief is referred to by Galileo in one of his dialogues in 1632, and again by the Abbe Barthelemy in a work entitled "Voyage du Jeune Anacharsis," published in 1788. So far this may be said to be mere fable, but it gives an idea of what were then looked upon as possibilities in magnetism, and we can hardly help comparing with these ideas some almost equally extraordinary ones which are occasionally expressed at the present day with respect to electricity.

The discovery of Stephen Gray, in 1729, that the electrical influence could be conveyed to a distance by means of an insulated wire, is probably the first of direct influence in connection with telegraphy. As a result of this discovery, and the investigations which followed it, we find a considerable number of proposals to use electrical forces for the transmission of intelligence. The first of these of which there is any record was made by Charles Morrison, of Renfrew, Scotland, in a letter to Scot's Magazine, written in 1753, and signed "C. M." As many insulated wires as there were characters to be signaled were to be erected between the two stations. At the receiving station the ends of the different wires were to be connected to a series of balls, underneath which the characters, printed on light pieces of paper, were to be placed. If any one of the wires became electrified by the distant end being put in contact with the source of electricity, the character under the ball on the end of it would be attracted and thus indicate the signal. An interesting modification was suggested in the same letter, namely, to replace the balls by a series of bells of different pitch, arranged in such a way that when the wires became electrified they would discharge into the bells and cause them to sound: . . . . "the electric spark, breaking on bells of different size, will inform his correspondent by the sound what wires have been touched; and thus, by some practice they may come to understand the language of the chimes in whole words without being put to the trouble of noting down every letter." A similar telegraph was invented in 1767 by Joseph Bozolus, a Jesuit and a lecturer on natural philosophy in Rome. (See a Latin poem, entitled "Mariani Parthenii Electrocorum," in VI Libros, Roma, 1767, p. 34). In 1774 a telegraph on the same principle was established by Le Sage. In this system each wire terminated in a pith-ball electroscope, and the signals were read in accordance with the indications of these electroscopes, of which twenty-four were used. This telegraph was improved upon by Lomond in 1787, one wire only being used, and a code of signals forming the means of interpretation. A similar proposal was made by Betancourt in the same year and again by Cavallo in 1795. The latter proposed to use combinations of sparks as a code of signals. In 1794 Reizen proposed to cut letters out of tinfoil, leaving a series of short interruptions of the tinfoil at short distances apart, so that a discharge of electricity around the tinfoil would illuminate the letter by a series of sparks. This method of producing illuminated patterns is still a common class-room experiment in physical lectures. The next to propose the use of static electricity for telegraphic purposes seems to have been Ronalds, of Hammersmith, in 1816. In this telegraph the letters were printed on a disk which was mounted on the seconds arbor of a clock. One of the clocks was placed at the sending and the receiving stations, and arranged to bring corresponding letters simultaneously opposite a small window in the dial of the clock. When the proper letter was exposed a signal was sent by means of a pith-ball telegraph. This telegraph was more complicated than several which have been mentioned above, and required two clocks going synchronously.

In the year 1767 an important observation was made by Sulzer. He found that when two plates of different metals were placed one above and the other below the tongue, a peculiar sensation and taste was felt when the metals touched each other outside the tongue. Sulzer failed to find the explanation of this phenomenon, and no further advance was made until the well-known frog experiments of Galvani gave fresh impetus to the subject. The discoveries of Volta and the invention of the voltaic pile shortly followed. In the same year (1800) an attempt to close the circuit of a voltaic battery by means of a drop of water led Nicholson and Carlisle to the discovery that water is decomposed by the galvanic current.

This gave rise to the galvanic or electrolysis telegraphs of Sömmering, Coxe and Sharpe, and is the basis of all the chemical printing and copying telegraphs which have in more recent times been produced. Sömmering's telegraph was invented in 1809, and was similar in principle to that of Morrison, except that the decomposition of water and consequent accumulation of gas in a series of tubes gave the necessary indications. To call attention, it was proposed in connection with the telegraph to liberate an alarm by means of an accumulation of gas. Professor Coxe, of Pennsylvania, described a similar telegraph in 1810, and proposed to use either the decomposition of water or of metallic salts. Mr. J. R. Sharpe proposed a voltaic telegraph in 1813, and exhibited it before the Lords of the Admiralty, "who spoke approvingly of it, but added, that as war was over and money scarce, they could not carry it into effect." (See Repertory of Arts, Second Series, Vol. XXIX, p. 23).

Perhaps the most important electrical discovery in its influence on telegraphy was made by Romagnési, of Trente, in 1805, but received little attention and no development until it was rediscovered by Oersted in 1819. This was the discovery that a wire conveying an electric current is capable of deflecting a magnetic needle. In the following year Schweigger discovered that the deflecting force was increased when he wound the wire several times round the needle. These two discoveries formed the foundation for the construction of the galvanoscopes and galvanometers since so much used in connection with electrical appliances and measurements. One of the most extensive applications has been to telegraphy.

Galvanoscopic, or, as they have been more commonly called, needle telegraphs resulted very shortly from these discoveries. In this field of invention we find, prominent among the early workers, the distinguished names of Ampere, Gauss and Weber. Ampere proposed a multiple wire telegraph with galvanoscope indicators in 1820. A modification of Ampere's telegraph was carried out by Ritchie, and afterwards exhibited in Edinburgh by Alexander. In this telegraph thirty wires were used, twenty-six for the letters of the alphabet, three for signs of punctuation and one for the end of a word. The galvanoscope needles each carried a small screen which in its normal position covered the letter, but which, on the passage of a current through the wire, was drawn aside exposing the letter to view. The transmitting keys were arranged like the keys of a piano-forte. With the exception of the use of galvanic instead of static electricity this telegraph was not much in advance of the proposal of Morrison. A single circuit telegraph was invented in the year 1828 by Tribaoillet, who also used a galvanoscope as the indicator.

In 1832 a five-needle telegraph was invented by Schilling, who also used a single needle and single circuit telegraph, using reverse currents and combinations of signals for an alphabet. Models of this telegraph were made and exhibited before the Emperor Alexander and others, but Schilling unfortunately died before any practical result was attained. In 1833 Schilling's telegraph was developed to some extent by Gauss and Weber, who used it for experimental purposes. The chief modification introduced by these experimenters was the substitution of induced currents, produced by the motion of a coil of wire surrounding a bar magnet, for the galvanic currents used by Schilling. The following translation of a part of a report of the magnetic observations of these physicists given in Poggandorf's Annalen, 32, p. 568, is quoted from "Sabine's Electric Telegraph," "There is, in connection with these arrangements, a great and until now in its way novel project, for which we are indebted to Professor Weber. This gentleman erected during the past year a double-wire line over the houses of the town (Göttingen) from the Physical Cabinet to the Observatory, and lately a continuation from the latter building to the Magnetic Observatory; thus an immense galvanic chain (line) is formed, in which the galvanic current, the two multipliers at the ends being included, has to travel a distance of nearly 9,000 (Prussian) feet. The line wire is mostly of copper, of that known in commerce as 'No. 3,' of which one metre weighs eight grammes. The wire of the multipliers in the Magnetic Observatory of copper, 'No. 14,' silvered, and of which one gramme measures 2.6 metres. This arrangement promises to offer opportunities for a number of interesting experiments. We regard, not without admiration, how a single pair of plates, brought into contact at the further end, instantaneously communicates a movement to the magnetic bar, which is deflected at once for over a thousand divisions of the scale." And further on in the same report: "The ease and certainty with which the manipulator has the direction of the current, and therefore the movement of the magnetic needle, in his command, by means of the communicator, had a year ago suggested experiments of an application to telegraphic signaling, which, with whole words and even short sentences, completely succeeded. There is no doubt that it would be possible to arrange an uninterrupted telegraph communication in the same way between two places at a considerable number of miles distance from each other."

The method of producing the currents in Gauss and Weber's experiments was an application of the important discoveries of Faraday and Henry in the induction of currents by currents and by magnets, which have since borne so very important fruit in the field of dynamo-electric machinery.

On the recommendation of Gauss this telegraph was taken up by Steinheil, who following their example also used induced currents. The important contributions of Steinheil were the discovery of the earth circuit, made while attempting to use the rails of a railway as telegraphic conductors; the invention of a telegraphic alphabet and a recording telegraph. Of these the discovery of the earth circuit, made in 1837, has proved of great value. An interesting description of Steinheil's telegraph, together with illustrations of the magneto-electric and recording apparatus used on the line erected in 1837, between Munich and Bogenhausen, will be found in Sturgeon's "Annals of Electricity," (Vol. III). This account, written by Steinheil himself, shows that he had at that time an excellent appreciation both of the mechanical and electrical properties which a good practical electric telegraph should have, and also that he was well versed in the knowledge then existing of electrical science. The relative merits of scopic, acoustic and recording telegraphs are discussed, and the advantages, which experience has since brought into prominence, of the acoustic telegraph is pointed out. A very good discussion of the most economical method of arranging signals for a telegraphic alphabet will also be found in this paper.

Schilling's telegraph, which we have just seen, was the model on which Gauss and Weber's and, therefore, also Steinheil's telegraphs were based, was, as we shall see presently, also the basis of Cooke's, and of Cooke and Wheatstone's needle telegraphs.

Previous to the date which we have now reached (1837) another epoch-making discovery had been made, which has had great influence on telegraphy. This was the discovery of the magnetizing influence of the current. The discovery of Oersted was followed up by Ampere in a long series of researches, in which, among other things, he established the mutual attractions and repulsions of wires carrying currents, the fact that the voltaic element itself acts on a magnet like any other part of the circuit, and that a spiral of wire forming part of a circuit would magnetize steel needles. In the same year M. Arago found that a wire conveying an electric current attracted iron filings, and in 1824 the law of the variation of magnetic force with varying distance from the wire was investigated by Barlow. In 1825, Sturgeon found that a bar of soft iron was rendered temporarily magnetic if surrounded by a helix of wire through which an electric current was passing. In the year 1827, Ohm propounded his celebrated law of the conduction of currents. In 1831, Faraday in England, and Henry in America, discovered the induction of currents by currents and by magnets. We see from these leading facts that in the twelve years succeeding Oersted's discovery the knowledge of electricity and of magnetism in the directions important for telegraphic application was very great, and we shall see that it quickly bore fruit.

Schilling's telegraph was exhibited at a meeting of German naturalists held at Bonn in 1835, and was there seen by Prof. Muncke, of Heidelberg, who, after his return to Heidelberg, made models of the telegraph and exhibited them in his classroom. These models were seen by Cooke in the early part of 1836, and gave him the idea of introducing the electric telegraph in England. Cooke immediately set to work to construct a telegraph on a similar plan, and worked out a three-needle system of signals, which has been to some extent confounded with the five-needle telegraph afterwards patented and introduced by him in conjunction with Wheatstone. While arranging for experiments on the London and Manchester Railway, Cooke was introduced to Wheatstone, and afterwards consulted him as to difficulties he had met with in his experiments. A partnership soon followed, which led Wheatstone to devote considerable attention to the subject. The result has been the production of a considerable variety of telegraphic apparatus of great value and ingenuity.

Steinheil was anticipated in the idea of making the electric telegraph self-recording by Morse, of New York, who, according to a considerable amount of evidence brought forward by Morse himself, thought out some arrangement as early as 1832. Exactly what Morse's first ideas were seems somewhat doubtful, and he did nothing till 1835, when he made a rough model of an electro-magnetic recording telegraph. This telegraph consisted essentially of a pendulum, which carried a marking pencil on its lower end, and which could be deflected by an electro-magnet. The deflections of the pendulum were recorded on a band of paper, which was moved forward by clockwork under the pendulum, and simple combinations of deflections were to represent numbers. The interpretation of the message was to be made by means of a telegraphic dictionary, in which the words, phrases or sentences were to be numbered. There was no hint at this time of the alphabet with which we are now so familiar as the "Morse Code" or the "Morse Alphabet." This alphabet now almost universally used and which has probably done more than anything else towards perpetuating the name of Morse, being that which perpetuates the name "Morse System," was not invented by Morse but by Vail, who was associated with him in the development of the telegraph. The dictionary of numbered words proposed by Morse was proposed by Edgeworth in 1794 in connection with his semaphore telegraph. The model made in 1835 shows little mechanical ingenuity. The method of transmitting the signals, which was by means of type moved through a contact-making device, was somewhat crude and much less convenient than the simple make-and-break circuit devices of several previous workers, and the electro-magnet used to deflect the pendulum showed almost complete ignorance of the principles then known of electro-magnetism. The chief points of interest in connection with the early history of the Morse telegraph lie in the proposal to use electro-magnetism as the motive force to move the recording pendulum and the idea of making the telegraph self-recording. Morse made positive claims to have been the first to do both of these, and it seems proper that his claim should be examined.

After the discovery of Sturgeon in electro-magnetism became known among scientific men the subject was taken up by Professor Henry, who was then teaching physics in Albany Academy. An account of part of Henry's experiments was published in "Silliman's American Journal of Science" for January, April and July, 1831.

The following, among other things, were subjects of investigation in these experiments: The laws which govern the magnetizing effect of a helix under varying conditions as to number of turns in the helix, nature or arrangement of the battery, and length of the external circuit. The carrying power of magnets having different kinds of winding and different lengths of wire in the coils. The construction of an electro-magnetic engine. The transmission of power to a distance by means of his electro-magnetic engine. Among the applications were the closing of a distant electric circuit by means of the armature of an electro magnet, the coils of which were included in another circuit passing through an operating or transmitting station, and the transmission of signals to a distance by causing the armature of an electro-magnet to strike a bell each time a current was sent through the coils of the magnet from the transmitting station. The latter of these applications was illustrated by means of a model apparatus included in a long circuit of wire taken several times round one of the rooms in Albany Academy. The following claims made in this connection by Professor Henry are well founded, and deserve quotation:

"1. Previous to my investigations the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to the transmission of power to a distance."

"2. I was the first to prove, by actual experiment, that in order to develop magnetic power at a distance a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current."

"3. I was the first to actually magnetize a piece of soft iron at a distance, and to call attention to the fact of the applicability of my experiments to the telegraph."

"4. I was the first to actually sound a bell at a distance by means of the electro-magnet."

"5. The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance."

It is to Henry, undoubtedly, that is due the credit not only of first pointing out the application of electro-magnetism to telegraphy, but also of supplying the requisite knowledge of how to make magnets suitable for the transmission of signals through long distances, which rendered the practical application possible at that time. Besides this, we see that Henry actually constructed an experimental line and made the first electro-magnetic sounder, which consisted of a receiving magnet with a polarized armature, one end of which was attracted by the magnet and the other end made to sound a bell. Again, in the method of closing one circuit by means of a magnet in another circuit, we have the electro-magnetic relay, afterwards reinvented by Morse and others, and now very widely used on long telegraph circuits both for closing "local circuits" and for "translation."

The credit of inventing the electro-magnetic telegraph was claimed by and has usually been, popularly at least, given to Morse. There has been some dispute as to who first suggested the idea, it having arisen out of a conversation among the passengers on board the ship Sully during a passage from France to New York in 1832. Dr. Jackson, of Boston, claimed to have been the originator of the idea, and it seems not unlikely that information which he is said to have given with reference to the early experimental telegraphs then being worked on and exhibited in various parts of Europe did originate the idea. It is not clear, however, that the use of the electro-magnet was suggested by Jackson, and there is sufficient evidence to show that Morse had had opportunities of seeing a copy of Sturgeon's magnet in Professor Dana's laboratory in New York. The magnet made by Morse was itself almost an exact copy of this, and it was only after failure with it that he appealed to Dr. Gale for assistance. Dr. Gale gave the necessary information and supplied the materials for making the change, afterwards informing Morse that he had learned how to arrange such an apparatus from the writings of Professor Henry. Probably the idea of using an electro-magnet was original with Morse. He didn't know of Henry's work or, indeed, anything about the subject beyond the few experiments in which he had seen Sturgeon's magnet used, and would naturally turn to that means of obtaining motive force. It is not necessary, however, when giving Morse due credit for his originality to ignore the fact that, although unknown to him, the scientific part of the invention had already been worked out by Henry, and besides that, through Dr. Gale, Morse actually made use of Henry's discoveries before he succeeded in making his scheme practicable. Morse afterwards objected to Henry's claims, which were brought before the public by enforced testimony in the law courts, and not by any individual motion on Henry's part. The public have lauded Morse and have paid him liberally for the little he actually did, while it was with great difficulty that Congress could be persuaded to make a petty allowance to Henry's family, although he had been for many years a public servant, and besides had probably added more than any other man to the scientific reputation of the United States. Many people think that scientific men ought not to patent their discoveries. Which is the better known name, Henry or Morse? Would not Henry have gained both in popularity and in scientific reputation if he had patented and made the public pay liberally for his discoveries?

From the brief sketch just given it will be seen that in looking over the history of the early endeavors to produce a telegraph many ideas have been brought forward as to codes of signals, alphabets, telegraphic dictionaries, methods of calling attention by alarm apparatus, methods of arranging and operating the circuits, and so on, that only required an efficient motive force to render them practical and reliable systems. In looking over the subject, therefore, we are forced to the conclusion that the telegraph was not the invention of any man, but the result of a gradual growth towards which many minds, some of them the ablest the scientific world has known, have contributed.

We have now reached a stage in the history of this subject when inventors may be said to have had the fundamental principles of the subject, as it now stands, before them and we have simply to look for developments. These developments have been great and of a very varied character. It is impossible in this address to do more than sketch a few of their leading features.

As already stated the telegraph of Schilling, through a model exhibited by Professor Muncke, of Heidelberg, gave the idea of an electric telegraph to Cooke in the year 1836. It appears, also, that Wheatstone was aware of these early experiments, and had himself paid some attention to the subject. His experiments on the velocity of electricity, made in 1834, are sufficient to show that he was at that time aware that signals could be produced at the end of long circuits of wire by electrical means. The joint work of Cooke and Wheatstone led, within a few years, to considerable improvements in the needle telegraphs. The various forms of needle telegraph used by them, resulting in the final adoption of the single-needle system, for a long time extensively used in England, were passed over in a few years. Various modifications of the needle telegraph were, somewhat later, patented by the brothers H. and E. Highton, including an interesting form in which the current was passed through a strip of gold leaf placed in front of the pole of a magnet. Each time the current passed the gold leaf was deflected, and thus served in place of an index needle.

A patent was granted to Wheatstone and Cooke in 1840 for improvements in giving signals and sounding alarms at distant places by means of electric currents. In this patent the first form of the letter showing, dial or A, B, C telegraph, as it has been variously called, is described. Improvements were subsequently made in this apparatus by Wheatstone, and several modifications have been made by other inventors, of which the best known are Brequet's, Froment's, Siemens' Chester's, Kramer's, Siemens and Halske's, and Hamblet's. The first apparatus devised by Wheatstone was actuated by voltaic electricity, but in the later forms magneto-electricity was applied. One or other of these methods have been used in the other forms of apparatus for the same purpose. Wheatstone also worked on a type-printing telegraph, which was a modification of his A, B, C instrument, but it never came into practical use. Probably the greatest achievement of Wheatstone, judged at least by its practical results, was his automatic recording telegraph, which is so largely used for press and other long despatches in England, and which has attained to marvelous speeds for a mechanical recorder.

Morse's telegraph first came before the Patent Office in the form of a caveat filed by him on the third of October, 1837. The following inventions were specified: First, a *system of signs* by which numbers, and consequently words and sentences, are signified; second, a *set of type*, adapted to regulate and communicate the signs, with rules in which to set up the type; third, an *apparatus called the port rule*, for regulating the movement of the type rules, which rules, by means of the type, regulate the times and the intervals of the passage of electricity; fourth, a *register*, which records the signs permanently; fifth, a *dictionary*, or vocabulary of words, numbered and adapted to this system of telegraph; sixth, *modes of laying conductors* to preserve them from injury.

This caveat gives a good idea of the invention by Morse of the recording telegraph previous to his partnership with Vail. The partnership was agreed upon in September, 1837, and according to it Mr. Vail undertook to construct at his own expense and exhibit before a committee of Congress one of the telegraphs "of the plan and invention of Morse;" that he should give his time and personal services to the work, and assume the expense of exhibiting the apparatus and of procuring patents in the United States. In consideration, Vail was to receive one-fourth of all the rights in the invention in the United States. Provision was also made for securing to Vail an interest in any foreign patents which he might furnish the means to obtain.* A large amount of documentary evidence bearing on the development of the telegraph exists in the possession of Mr. Vail's family, and in the National Museum at Washington. From this evidence there seems no doubt but that Morse assumed and has been accorded very much more than his share of the credit of the invention of the telegraph as it is now known. The patents taken out in Morse's name included many important improvements which were entirely due to Vail, and for which Morse promised to give him credit, a promise which was never publicly redeemed. The alphabet now used was, as I have already said, worked out by Vail, who, it appears, first began its formation by an attempt to classify the letters of the alphabet according to frequency of occurrence, with the view of giving to these letters the simplest signs. After working on this for some time, it occurred to him that valuable information might be obtained in a printing office, and a visit to an adjacent newspaper office showed him the whole problem solved in the printers' type tray. The alphabet which he afterwards formed is still used in this country and also, with some simplifications, as the European and international code. The modification of the recording apparatus from the vertical pendulum and recording pencil to the compact instrument with a horizontal lever and metallic stylus, marking by indentation, used on the first telegraphic line between Washington and Baltimore, was also due to Vail.

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*See F. L. Pope in the *Century Magazine*, Vol. XXXV, p. 924 et seq.

Many other things might be mentioned to show that in the early stages of this invention, which has marked so wide a step in our modern civilization, the name of Vail deserves a prominent place. It is very unfortunate that his own modesty, together with his confidence in Morse's promises to do him justice, prevented the matter from being publicly ventilated during the lifetime of the inventors.

After several unsuccessful attempts to induce Congress to assume the expense of building a line of sufficient length to practically test the proposals of Morse, an appropriation of $30,000 was made in March, 1843, for the purpose of building a line from Washington to Baltimore. This line was completed and successfully opened on the 24th of May, 1844. The system practically introduced with the opening of this line, modified in some of its mechanical details, has continued to be the principal one used, and is the basis of most of the recording telegraphs in all countries. One important modification should, however, be mentioned, that is the wide use of the click of the armature for reading the message in preference to the recorder. This is a return to the electro-magnetic acoustic telegraph of Henry. It gives one of the simplest possible receiving instruments, and, as was long ago pointed out by Steinheil, possesses the great advantage that it leaves the eyes of the operator disengaged.

Of other forms of telegraphic apparatus, the most important are the type-printing telegraph. Among the early inventors of these we find Vail, who invented a type-printing telegraph as early as 1837, and Wheatstone; but the first instrument practically used was invented in 1846 by Royal E. House, of Vermont. This instrument was used for some time in the United States, and was brought to a considerable degree of perfection. It worked on the step-by-step principle and was patented in 1846. Another type-printing telegraph of great ingenuity was invented by D. E. Hughes, of Kentucky. This apparatus embodies many of the features of the apparatus used at present in this country, which is a modification of Hughes's instrument due to Mr. Phelps. The Hughes instrument is still largely used in France and to some extent in other European countries. The Hughes patents in this country were purchased in 1856 by the American Telegraph Company, and the apparatus has undergone successive modification at the hands of Mr. Phelps, tending towards simplification, accuracy of working, and increased speed. One of the latest modifications is known as the Phelps's Electro-Motor Telegraph, in which the mechanism is driven by means of an electro-motor which, running at a high speed, allows the trains of clock-work to be short and light. The principle here used is the synchronous movement of a transmitting shaft on the transmitter and the type-wheel of the receiver. Synchronism is obtained by a governor, and continuous rapid motion is kept up. The letter printed is regulated by the position of the transmitting shaft when the circuit is closed, this position being under the control of the operator. Phelps is also the inventor of stock telegraphs and private line printing telegraphs, and, besides his, similar instruments have been invented by Laws, Calahan, Gray and others. These instruments work on the step-by-step principle and all of them are beautiful specimens of mechanism and scientific ingenuity.

Another system of recording telegraph messages requires notice—that is the chemical method. We have seen that very early in telegraphic history the decomposition of liquids and of solutions of salts were made the basis of telegraphs. It was soon found that a ribbon of paper or cloth saturated with certain chemicals could be very readily marked by the passage through them of the electric current. One of Morse's first plans appears to have been a chemical telegraph, but that, I believe, was never worked out. The first patent for such a telegraph was given in England to Edward Davy in 1838, but the system never came into practical use. It was complicated in construction and required four line wires. One interesting feature was the use of an electro-magnetic escapement for moving the paper, an idea which had occurred to Cooke and to Wheatstone some years earlier. The first successful chemical telegraph was due to Bain of Edinburgh, and was patented in 1846. In this system it was proposed to transmit the message by an automatic transmitter, using a punched slip of paper to regulate the contacts. Some difficulties with the mechanical operation of preparing the necessary stencil slips prevented this being very successfully used, but the chemical record was used for some years both in England and America. With the apparatus now available for transmission, very high speeds can be attained by this method of recording the signals.

The chemical method of recording has been mostly used for copying or autographic telegraphs, and of these a considerable number have been devised. The automatic method of transmission has been brought to a high state of perfection. Among others who have worked at the subject are Wheatstone, Siemens and Halske, Garnier, Humaston, Little, Edison, Park, Thomson.

The next important step in telegraphy was the employment of one line-wire to convey more than one message at the same time. A solution of the problem of sending two messages, one in each direction, was attempted by Gintl of Vienna, in 1853, and in the following year by Frischen and by Siemens and Halske. These methods were not very successful, but they were mechanically sufficient for the purpose. They, however, left an important item out of the account, namely, the electrostatic capacity of the line. The proper solution of the difficulty was given by J. B. Stearns of Boston, in 1871, who solved the problem completely, so far at least as land lines were concerned. The same principle is sufficient for all purposes, but some important modifications in detail are necessary for submarine cables. These modifications were successfully made by Muirhead of London, and at the present time duplex working is an ordinary accomplishment. The chief workers in this field were Frischen, Siemens and Halske, Stark, Edlund, Gintl, Nystroin Preece, Fur Nedden, Farmer, Maron, Winter, Stearns and Muirhead.

Next the problem of sending two messages in each direction was worked out. This involves the additional problem of the simultaneous sending of two messages in the same direction. The solution of this problem was attempted by J. B. Stark, of Vienna, in 1855, and during the following ten years it was worked at by Bosscha, Kramer, Maron, Schaak, Schreder, Wartman, and others. The first to obtain success was Edison, in 1874; and his method, with some modifications, is still used. Systems of quadruplex were also invented by Gerrit Smith of the Western Union Company, in 1875 and 1876, and a modification of Edison's method was made by Prescott and Smith.

Smith's 1876 method is known as the Western Union Company's Standard Quadruplex.

A system of multiple transmission was devised by M. G. Farmer, of Salem, in 1852, in which, by a commutation arrangement, the line-wire was put successively in contact with a number of local circuits. A similar system was exhibited by Meyer at the Vienna Exposition in 1873, and an improved form was introduced a few years ago by Delany, which is in use in several countries. These systems are of use if the line-wire is capable of doing more work than any one of the stations is capable of supplying, and may be likened to one of the main wires from the central to a district telephone exchange, with this exception—that all the correspondence goes on simultaneously, and there need be no difficulty as to precedence. Distinctive from these is the harmonic telegraphs of Elisha Gray, Edison, and Bell. In this system, which has been most completely worked out by Gray, any number of messages may be sent simultaneously, without reference to speed of transmission. In principle, the method consists in causing each of a number of vibrating reeds at one end to produce pulsations of the current flowing through the line, which have the same period as the vibrations of the reed. A corresponding set of reeds at the receiving end of the line are arranged so as to be acted on electro-magnetically by the current. Each of these receiving reeds will, providing the periods of the different reeds forming any one set are incommensurable, respond only to the pulsations of its own natural period, and hence only to the vibrations of the corresponding reed at the sending end. The continuity of these vibrations may be broken up by means of a sending key, and thus a message transmitted in the ordinary "Morse" alphabet.

The autographic or writing telegraphic apparatus, which has been developed of recent years, is of great interest, both from the fact that the handwriting of the sender is reproduced in fac-simile, and from the great ingenuity of the apparatus employed. The writing telegraph of Cowper and the telautograph of Elisha Gray are good examples of this mode of transmitting messages.

In Cowper's system two rectangular components of the motion of the pen are made to vary the resistance, and consequently the current, in two line wires. These currents act on two electro-magnets at the receiving station, and the armatures of the electro-magnets are arranged to produce two rectangular components of the motion of the receiving pen. Bands of paper are kept moving at approximately the same rate under each of these pens, and hence the characters traced by the motions of the transmitting pen are reproduced with considerable accuracy by the receiving pen in consequence of the varying positions of the armatures of the receiving magnets, caused by the variations of the current. In Gray's apparatus two rectangular components of the motion of the transmitting pen send pulsatory currents into the line-wire. These pulsatory currents cause corresponding movements of the armatures of two receiving magnets, which are made to move the receiving pen in the direction, in corresponding directions, and through proportionate distances. Separate electro-magnetic arrangements lift the pen off the paper between the words and at the end of the lines, and allow the receiving pen to be moved backwards or forwards without marking the paper. Still another electro-magnetic arrangement is used to move the paper forward between the lines. Anything that can be made with a pen—such as a sketch or drawing—can be telegraphed in this way. The whole apparatus is exceedingly ingenious, but much too extensive and complicated to admit of clear description here.

Although the mere extension of telegraphs from land to submarine lines can hardly be called an invention, yet very many new problems presented themselves for solution in this extension. Many of these problems were of a more purely scientific character than those presented in the developments which had been in progress, and consequently tested the knowledge then existing of the laws of electricity much more severely. It was very soon discovered, for example, that the rate at which signals could be transmitted, and the battery power or other electromotive force necessary to effect the transmission, did not, as in land lines, depend almost entirely on the size and length of the conductors used. The electrostatic capacity of the line immediately began to play an important part, and signals were found not to be transmitted so instantaneously as they were on existing land lines. Again, there was no opportunity of using relays, so as to effectively shorten the longer lines, and the investigations of Thomson led him to point out that the rate of signaling would be inversely as the square of the length.

Such difficulties as these, combined with the very evident difficulties involved in manufacturing and submerging a cable in deep water, were, to say the least, discouraging. Experiments on short lengths in the English Channel and elsewhere proving successful, faith in the possibility of longer cables grew, and very soon, through the enterprise of a few American and English business and scientific men, an attempt was made to lay a cable across the Atlantic. The history of that undertaking and its various failures are almost common knowledge, but perseverance conquered all the difficulties, and to-day no one thinks of the probability of failure when a long cable is proposed.

The laying of long cables brought out the fact that, as had been anticipated, existing telegraphic apparatus was not of great enough sensibility to render moderately rapid signaling possible. This difficulty was almost immediately met by the mirror galvanoscopic receiver of Thomson, followed some years later by his siphon recorder, which is undoubtedly by far the most sensitive recording telegraph known. Improved methods of working cables soon followed, among which, in the early days, probably the most notable is the introduction of condensers between the ends of the cable and the earth by Varley. The successful duplexing of cables by Muirhead has already been referred to, but it is somewhat curious to note that although the electricians interested in cable working were familiar, as early as 1856 and perhaps earlier, with the difficulty which had prevented success on land lines, no one seems to have thought of applying the remedy. As early as 1858 a patent was taken ont by Thomson, in which he proposed to overcome the difficulty of duplexing a cable by a mechanical arrangement for varying the compensating currents at the same rate that the signaling current varies. He has since said that he did not propose the use of condensers, because a means of producing a sufficiently good model cable was not then known.

Such a model cable was not available for nearly twenty years after the above date, and was finally produced by making practically a copy of the actual cable, using tinfoil strips for the conductor insulated from an earth plate by means of thin paraffined paper, so as to give electrostatic capacity.

The invention of the telephone constitutes one of the greatest advances that have been made in telegraphic communication. This is an acoustic telegraph, which has the very important merit that the audible signals are spoken words, and hence the instruments can be used by any one who can hear and speak and who understands the language in which the message is transmitted.

It is well known that sound is transmitted through the air from the source to the hearer by waves of condensation and rarefaction, which affect the drum of the ear. Wheatstone, as early as 1831, showed that these waves could be transmitted from one place to another, at a moderate distance, through wooden rods and afterward conveyed to the ear by the vibrations given to the air by the end of the rod. Similarly, vibrations given to one diaphragm can be conveyed to another, at a considerable distance, by connecting the two diaphragms together by a stretched cord or wire. This appears to have been known for several centuries in the central districts of India, and a similar apparatus was described by Hook in 1667. A similar apparatus is now used and known as the mechanical telephone.

To cause the vibrations of one diaphragm to produce corresponding vibrations in another diaphragm, at a distance, through the agency of an electric current, was the problem of the electric telephone. The first to propose this seems to have been Charles Bourseul, who, in 1854, suggested the use of two plates—one at the transmitting station, which, by the varying pressure of the air due to the sound waves, would open and close an electric circuit; while the other was to be acted on at the receiving station by an electro-magnet, through which the coils of the electric current passed. The varying strength of the electro-magnet, due to the rapid succession of currents, was thus to be taken advantage of to give the proper succession of impulses to the receiving diaphragm. In 1861 Philip Reis, of Friedrichsdorf, proposed, in a lecture delivered before the Physical Society of Frankfort, to use an instrument, which he called a telephone, for the reproduction at a distance of music and human speech. The apparatus consisted of a stretched membrane forming part of one side of a box, into which, by means of a mouthpiece, the sounds could be directed. This membrane was made to open and close an electric circuit at each vibration. At the receiving end an electro-magnet, consisting of a thin rod of iron surrounded by a coil, was placed. The successive interruptions and closings of this electric current was, in accordance with a discovery made by Dr. Page, of Salem, Mass., in 1837, to produce sounds of the same pitch as those of the sound directed into the box of the transmitter. This method failed for speech, for the simple reason that speech has more characteristics than pitch; and it was only partially successful for musical sounds, from its inability to produce, with any approach to accuracy, the necessary variations of loudness and quality.

To produce not only the frequency of vibration, but also the loudness and quality of the sounds evidently required a transmitter and a receiver which did not depend for its action on simple interruption of the current, but which varied it in an undulating manner, similar to the variations of pressure to which the diaphragm receiving the sound vibrations was subjected due to the sound waves. Such an apparatus of a very perfect type was produced by Graham Bell in 1876, who, in the descriptions of his apparatus given in his patent specifications and elsewhere, shows that he thoroughly understood what had to be done. We all know from actual experience that the instrument which he produced did it. Since the publication of Bell's invention a great many modifications have been produced. Most of them have, however, been held to embody the same essential principle as that of Bell, the variation being simply one of mechanical arrangement. One field of investigation has, however, been fruitful of improvement. In the original patent of Bell, and also in a *caveat* filed almost simultaneously by Elisha Gray, it is pointed out that the variations of the current may be produced by causing the vibrations of the diaphragm to vary the resistance of the circuit. This idea has proved of great value in increasing the loudness of the sounds given out by the Bell telephone when used as a receiver. A great many forms of these "microphone" transmitters have been invented. Among those who have made important contributions we may mention Berliner, Blake, Edison, Gower, Gray, Hughes and Hunnings.

Another form of telephone has been proposed by Professor Dolbear. In this telephone system one diaphragm of the receiver is made to form one plate of an electric condenser, and the varying electric force on this plate, due to the fluctuations of the charge, causes it to vibrate in response to the varying electro-motive force produced by the transmitter. This condenser telephone can evidently be used either as a transmitter or as a receiver, and, as Dolbear has pointed out, may be rendered sensitive by keeping one plate of the condenser at a high potential.

Another interesting discovery in this subject should be mentioned, namely, the transmission of speech from one place to another by means of beams of light or radiant heat. This was based originally on the discovery by May and Smith of the variation of the electric resistance of selenium when exposed to light or radiant heat. Many other substances have since been found to have the same property in a greater or less degree. The experiments of Bell and Sumner Tainter have shown that if a beam of light be reflected from a thin mirror, and, by means of lenses or otherwise, made to pass as a parallel beam from the transmitter to the receiving station, and there received on a bar or series of bars, or a coil of a substance having the properties of selenium, the resistance of this substance will be affected by vibration of the mirror. If, then, the mirror be used as a transmitting diaphragm, like that of a telephone transmitter, words spoken to the mirror will be repeated by a telephone, in the circuit of which the selenium is placed and through which an electric current is kept flowing.

In this address an attempt has been made to sketch very briefly the development of the application of electricity to the transmission of intelligence. Many important applications (as, for example, fire-alarms and railway signal systems, etc.) have not been referred to, and a host of important contributors have, as a matter of necessity, been entirely ignored. To go into detail, and do justice to every one who has contributed to the present state of the electric telegraph was an impossibility and has not been attempted.

INTERNATIONAL PROTECTION OF INDUSTRIAL PROPERTY.

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The convenient phrase Industrial Property, recently naturalized into our language, comes to us from the French, who are more apt than we in finding terms to express generic ideas. It does not include all property employed in industry, but only incorporeal property related to production and trade, and has its analogue in the phrase Literary and Artistic Property. The latter includes the property of the author and artist in the productions of their labor and genius; such, in fact, as we usually define by the term copyright. Industrial property includes a wide field of incorporeal rights, such as are embraced in mechanical and design patents and trade-marks, including many for which the English language scarcely has names. The phrase Good-Will is made with us to cover a number of rights constituting a sort of property, for which the French have specific names and a place in their jurisprudence.

For an occasion like this I shall not attempt to traverse so wide a field as implied by the title assigned to me. The general acquiescence of the commercial world in the sentiment that the name and trade-mark of a manufacturer are his property under the law of nations, long proclaimed in Europe, makes their international protection comparatively easy. It has been accomplished by treaty stipulations in many instances, in others it has been conceded without question as a common law right. In few cases, except where shameless piracy of trade-marks is countenanced by a corrupt trade morality, is there serious difficulty in securing their protection. There are some differences in definition yet to be adjusted, some minor obstacles to be removed, but commerce is wielding its mighty iufluence to bring the nations of the world into constantly closer relationships, and to throw down the barriers that civilization and Christianity have found hitherto insuperable. Everything leads to the belief that before long the international character of this kind of property will be completely recognized and full protection accorded to it in all commercial nations. Dismissing, therefore, this branch of the subject, I shall consider briefly the history of International Protection for Mechanical Inventions and its present aspect from an American standpoint.

The world was very slow in coming to the notion of Industrial Property. No trace of it exists in ancient laws or customs. Athens could reward with a laurel crown the originator of a new idea in art, but could not conceive that he possessed any rights in its exercise. In Sparta industry was scorned as the lot of the slave, whose rights were systematically crushed. In Rome the laborer had neither rights nor property, and in the systems of law derived from Rome there is no recognition of the rights of inventors or artisans. During the dark period of the Middle Ages many industries flourished, but under the restrictions of the feudal system, and the more oppressive tyranny of trade corporations, the personal rights of the artisan were lost sight of. When even the right to work was a privilege, accorded by favor and hampered by arbitrary and cruel regulations, the notion of a property-right in an invention, or an improvement in the arts, or a trade-mark, was inconceivable.

Under the fixed rule of the Guilds the introduction of a new improvement was next to impossible, and the marks affixed to merchandise to indicate its origin were property in about the same sense that the brand and chains of a convict are his. They served to point out the producer of merchandise in order that if it failed to come up to the required standard the harsh and irrational penalties which the times permitted might be visited upon the proper victim.

It is not till the darkness of the Middle Ages has passed, and the more reasonable ideas of modern times are gleaming in the horizon, that the notion is evolved of remuneration to the inventor of a new and useful art. Under the Tudors in England, among other privileges that flowed from royal favor, the exclusive right was sometimes accorded to exercise within the realm the entire industry in which the beneficiary had made a useful improvement. Such privileges, going by grace rather than as of right, were allied to the mass of other privileges and monopolies which were slowly crushing the life from English industry.

Two years after the landing of the Pilgrims on Plymouth Rock the first step in the history of the world was taken towards the recognition of Industrial Property by the enactment of the law of monopolies of James I, which abolished privileges while reserving to the Crown the right to grant patents to the authors of new and useful inventions. It would be a mistake to assume that the sentiment expressed in this law recognized a right of property in an invention. The patents granted under it still flowed from royal favor. They were less arbitrary than the privileges which preceded them, since they were granted for limited times, and the monopolies they created were restricted to the enjoyment of the new invention of which they were the object. For this reason they ceased to be an obstacle to industry, but became the reward of the inventor, and laid the foundation for the vast industrial supremacy Great Britain has so long enjoyed.

A hundred and forty years later, by a decree of Louis XV, December 24, 1762, a similar step was taken in France. The preamble to this decree recites that the privileges conferred for the purpose of compensating inventors had failed of their object, because, being accorded for unlimited time, they had become rather an hereditary patrimony than a personal reward to the inventor. Their term was therefore fixed at fifteen years. This legislation, like all before it, recognized no rights of the inventor, but left the concession to the caprice of power, and its exercise subject to the malicious opposition of the corporations. The first step toward the acknowledgment of the rights of inventors in France was in an edict of the same king, March 12, 1776, of which the philosophic Turgot was the author, and which recognized these rights as natural and common. "God," said this edict, "in giving to man needs, and in making necessary to him the recourse of labor, has made the right to labor the property of every man; and this property is the first, the most sacred, and the most imprescriptible of all rights." This concession of the rights of labor was a wonderful one for the old regime in France; but feudalism still reared its head, and the conditions growing out of its arrogant claims, and the arbitrary power of the trade corporations, were an insuperable obstacle to the complete enfranchisement of industry.

Not many years were to elapse, but a new light was to flash over Europe from a source scarcely conceivable at that time. We may confidently claim that the Constitution of the United States, in giving to Congress the power to secure to authors and inventors for a limited time the exclusive right to their respective writings and discoveries, was the first practical and effective step in the history of the world for the recognition of property in inventions.

The act of April 10, 1790, quickly followed, enforcing the provision of the Constitution and establishing for the United States the rights of the inventor. It is conceivable that this feature of the Constitution may have been suggested in part by the French edict of 1776; but it is certain that France was prompt to welcome back the principle; and in the law of January 7, 1791, the National Assembly provided for the protection of new inventions. The preamble of this law is a noble statement of what is true in principle and wise in policy. It runs thus:

"The National Assembly, considering that every new idea, whose manifestation or development may become useful to society, belongs to him who has conceived it, and that not to regard an industrial invention as the property of its author would be to attack the essential rights of man; considering at the same time how much the lack of a positive and authentic declaration of this truth may have contributed till now to discourage French industry by occasioning the emigration of numerous distinguished artists, and by causing to pass out of the country a great number of new inventions from which this Empire ought to have drawn the first advantages; considering finally that all the principles of justice, of public order, and of national interest, imperatively command that it determine for the future the opinion of French citizens with regard to this class of property by a law which consecrates and protects it, decrees—"

The law which followed, firmly establishing the principle of property in inventions, survived in France through all her political changes for the next half century, being superseded by a new law in 1844. Meanwhile nearly all the countries of Continental Europe had enacted patent laws; and the principle, originating in the mutterings of discontent that led to the Revolution in England, carried to its full extent as the logical sequence of American independence, and finding its foothold in Continental Europe during the feverish intellectual and political conditions of the French Revolution, has become the common heritage of the civilized world.

Those who declaim against patent rights as grinding monopolies for the oppression of the artisan may possibly learn from this history that in the economics of modern life the patent system is the first fruit of the protest of labor against enthroned and ancient privilege. It is the offspring of revolution and the very reverse of monopoly. It was created on the demand of the common people simultaneously with the overthrow of monopolies and with the establishment of civil and religious freedom. It is a perpetual token of the concession made to the rights of labor by power and privilege. In its last analysis the right involved in a patent is the right to work and to the legitimate rewards of intelligent industry; and we wonder why the world so long refused it recognition, or that, as its nature has been better understood, opposition to it should have been maintained. But nothing dies harder than error and prejudice, and industrial freedom was only to be secured at the cost of such revolutions on both continents as have established other human rights by the overthrow of thrones and the dismemberment of empires.

There is always room for dispute about the efficacy of different systems for the protection of the inventor and for the encouragement of industry, but the truth of the declaration solemnly made in France a century ago grows ever clearer, until it is hard to find an intelligent person to dispute it, that "not to regard an industrial invention as the property of its author is to attack the essential rights of man."

The establishment among European nations of the idea of property in inventions, and of its protection by law, was at last achieved. It was a step magnificent in what it embodied, and its results upon industry, commerce and social life have passed all computation. But the new conditions which it created quickly proved that the limited protection accorded by national laws failed to a great degree of its purpose. The swift and constant intercommunication of ideas, to which national frontiers were no barrier, carried the improvements in the arts made in any nation to the confines of the civilized world, and for these improvements, beyond the limits of his own nation, the inventor had no rights that other nations would respect. An invention patented in one country was denied protection in others, and thus, while it contributed to promote the industries of all, protection was accorded to its inventor in only one, and was, therefore, disproportionate to the benefits the world derived from it.

Such a state of things is repugnant to human sense of justice. The same conception of the rights of the inventor that had found expression in the constitutions of the United States and of the French republic forced thinking men to the conclusion that the rights in question could not be bounded by geographic lines, but that the protection of the inventor should be coextensive with the benefits he has conferred upon mankind. Hence the idea of international protection.

How far the earlier patent laws fell short of recognizing the rights of alien inventors may be seen by a brief inspection of the successive statutes of the United States.

The act of 1790 grants patents without restriction to "any person;" but this thoughtless liberality was restricted by the act of 1793, by which patents were granted only to "any person being a citizen of the United States," thus cutting off the alien from the privilege. The pendulum had swung too far, for it could not but be seen that in a new country inviting immigration the prospective citizen ought to enjoy the same rights as the citizen in this respect; and in the first section of the act of 1800 all rights respecting patents were given to aliens who had resided two years in the country, conditioned upon an oath that the invention had not been known or used in this or in any foreign country. In this act the pendulum appears to have swung too far the other way, since under it two years residence in the country, without intention to remain or to become a citizen, gave the alien inventor all the rights of the citizen. But this continued the law until 1832, when it was further amended so as to give the privilege of a patent to the alien who at the time of petitioning was a resident of the United States, and had declared his intention to become a citizen, a condition which practically survives in the existing law for caveats. This act guarded against abuse by providing that the patent should be forfeited if the inventor failed to become a citizen within the earliest period possible for him.

It is noticeable that as yet there is no indication of protecting foreign inventors, only those of citizens of the United States and alien residents, and the inventions of the rest of the world are left free to appropriation by all who chose to employ them, while a prior foreign patent is made a bar to a patent in this country.

In 1836 the barriers to granting patents to aliens were thrown down. Any person might now receive a patent, as under the act of 1790, but with the remarkable provision that, while the fee in an application to be paid by a citizen or resident alien was but thirty dollars, the fee to be paid by foreigners generally was fixed at three hundred dollars, and that to be paid by British subjects was five hundred dollars. This was reciprocity with a vengeance; but these invidious distinctions remained in the law until they were completely wiped out by the act of 1861.

Under the act of 1836 a prior patent or printed publication in a foreign country constituted a bar to the grant of a patent in the United States, but this bar was removed by the sixth section of the act of 1839. Since that act, and since the removal in 1861 of discriminating fees, the benefits of the patent law of the United States have been freely open to all the world. Our law gives to all men of all nations the same privileges, and recognizes to the fullest extent the international character of property in inventions. In this respect, as in the original complete recognition of the rights of the inventor, the United States may claim to have led the world and to be leading it still.

Had the nations of Europe in the development of their patent systems been led to adopt similar wise and liberal principles, the difficulties that now environ international protection could never have been experienced. The features of these systems which stand in the way of complete reciprocity are now to be considered.

The patent systems of European nations have not been framed upon the same model, but their clearly defined purpose is to promote the useful arts by rewarding the inventor of a new improvement, in securing to him the exclusive enjoyment of his invention for a limited term. Agreeing in this general principle, they differ widely in details of procedure and in their exactions of the inventor and patentee. Among the most important differences are those between systems which require and those which dispense with preliminary examinations into novelty, between those which grant the patent to the first applicant on the assumption that he is the inventor, and those which require of the applicant evidence that he in good faith believes himself to be the first inventor, and between those which publish as incidental to the application, and those in which publication is only incidental to the grant. Since in theory the patent under all laws goes to the inventor, little difficulty would arise in affording international protection if the practice were made to conform to the theory of law, and no patent granted except on showing by his own oath, or otherwise, that the person filing the application was the true inventor of that for which he seeks protection. It is out of this defect in practice, and the provision in the laws of many nations that the grant of a patent for an invention already published is void, that the difficulty in securing international protection arises, since it results that an inventor, having first patented his invention at home, is excluded by virtue of official publication in his own country from securing protection abroad, while any other person may anticipate the true inventor by depositing an application in another country, and so secure to himself the protection not justly his. Systems like these fail of their avowed object, and stimulate industry by the encouragement of piracy. They date from a period when no nation cared for the rights of the alien, when the recognized standard of trade morality sanctioned the refusal in one country of protection to the incorporeal rights of the citizens of another, and when the international protection of industrial property was not dreamed of. And now, when broader views prevail of the rights of aliens, the narrow ideas embodied in laws long outgrown form the obstacle to the accomplishment of the object desired. These laws are sustained by the same spirit of conservatism in which, in all ages, every ancient evil has intrenched itself.

The laws of the leading patent-granting nations of Europe—England, France and Germany—may be taken as the type of all. In the two latter the patent is refused or void if a prior publication has been made of the invention anywhere. In England, if prior publication has occurred within the realm. Considered with relation to the United States these conditions are practically identical, and cut off the American inventor from protection after the grant of his patent at home. Neither nation requires an oath of invention, and the American inventor is, therefore, helpless against the unscrupulous person who, having acquired knowledge of his invention, may, during the pendency of his application at home, take steps to secure a patent abroad.

This is the American aspect of the conditions which, in these and other countries, bear so hard upon the alien, and which the ingenuity of inventors and the craft of statesmanship have sought for many years to remove.

The question how to protect the true inventor simultaneously in all countries has baffled those who could not see clearly that the only difficulty arises from narrow and ungenerous laws, the repeal of which by common consent would resolve the whole problem. In this state of things it has been necessary to consider how the result may be accomplished under existing laws. Protection has been secured by the difficult and often hazardous process of depositing applications on the same day in all the States in which protection is desired, whereby the legal bar of antecedent publication is avoided in all. The United States patentee modifies this arrangement by filing his application in the countries of Europe on the same day upon which his patent is granted at home. This serves two purposes, it avoids vitiating his foreign patent by reason of a prior publication here, and it avoids the consequences of an unfortunate feature of our law, which abridges his domestic patent by reason of a prior patent abroad. This system, though ingenious, is costly and liable to failure through a variety of accidents, but it is the best hitherto devised under present conditions.

It seems possible to find some way acceptable to all commercial nations, and harmonious with all patent systems, by which a plain and easy road could be opened to the international protection of the inventor without resort to tricks, and not subject to accident or unreasonable expense. It may be that the statesmanship of the Old World has by some defect of vision failed to see the way out of the difficulty which lies directly under its eyes. It is at least remarkable that with the consensus of Europe that publication of an invention must be a bar to the grant of a subsequent patent in another country, or vitiate one if obtained, it has not occurred to their wisdom that absolute relief would be afforded if (by a slight modification of their laws) they would provide that such publication shall not be a bar to the true inventor if made in pursuance of the laws of his own country, and incidental to protection there. Without entering into details it would seem that, if there is an honest purpose to protect the inventor, so much of a concession should be made to him, with such limitations as to time and otherwise as might seem just, but on the whole relieving him of the hard conditions under which he forfeits his rights abroad by virtue of obedience to the law at home. Such action by the various nations would lay the foundation for true reciprocity. If it would be an assimilation to the law of the United States it is because that law, far in advance of those of Europe, already recognizes the international principle. If to this amendment were added another, to the effect that patents granted in the different countries should be independent of each other in respect to their duration, a point in which our own law is still at fault, international protection would be practically accomplished. The features of some patent laws, involving the payment of dues and the working of the invention to keep the patent in force, may be disregarded so long as they subject the alien to no unequal burden beyond what comes from his remoteness, a difficulty that neither laws nor treaties can remedy.

To the average American intellect such a proposition appears equitable, logical, straightforward, and adapted to its end. But it has not so appeared to those who have heretofore attempted to solve the question by international compacts.

The outcome of efforts hitherto made in this direction in America and Europe is to be found in two notable schemes, recently brought to the attention of the people of the United States. The first of these is the International Convention for the Protection of Industrial Property, framed in Paris in 1880, and signed by plenipotentiaries of many American and European powers in 1883. This Convention forms the basis for the International Union for the Protection of Industrial Property, of which the United States became a member in 1887.

Having been drafted by a committee appointed by the French Government, it necessarily embodies French ideas. It was earnestly discussed by delegates from various powers; but, the United States being represented by one of our Ministers at a foreign court, who had no particular knowledge of the subject, the peculiar features of our law were not brought to the attention of the conference. The treaty was adopted with slight modifications of the original draft. Its vital point is the provision of a limited period (called a period of priority) within which an inventor, having first filed an application for a patent at home, may secure protection in other countries without having his rights vitiated by reason of the publication of the invention in his own country, or even by the grant of a patent for the same invention to a third party during the period. This is a long step toward international protection, but signally defective in principle, and from our aspect of it a practical failure. It is not the deposit of an application in one country that vitiates a subsequent patent in another, but the publication consequent on such deposit. And it would seem to have been the practical course to make the period of priority run from the publication, which follows deposit at a greater or less interval, but is always the act fatal to the subsequent patent abroad, rather than from the deposit, which has no such fatal character.

In respect to countries where the interval is short between deposit and publication the arrangement is effective; but where, as here, the two events are unrelated in time, and months or years may elapse between them, this period of priority, well conceived as it is, is practically without value. It is too late now to determine whether the provisions of the fourth article of the Convention of Paris might not have been modified if the features of American law had been brought to the attention of the conference of 1880. Unfortunately this was not attempted.

The Convention of Paris in providing that a person who has filed an application for patent in one of the contracting States is entitled, by virtue of such deposit, to priority of right in any other State, provided he file his application there within the prescribed interval, assumes that the grant of a patent necessarily follows the deposit of the application. It ignores the examination into novelty required by our law, and for that reason is incompatible with it.

Therefore, without scrutiny of the details of that Convention, many of which are wise and free from objection, and according to it its full meed of praise for the exalted purpose it embodies, it must be said of it that it fails of its purpose through its omission to recognize the wide differences in patent systems.

Further than this, by its establishment of a period of priority dating from deposit rather than from publication, it has created a source of danger to patents for the first six months of their existence. The British patentee cannot know until seven months of the life of his patent have passed, but that some American inventor may file in the British Patent Office an application for the same invention, and, by virtue of an earlier application in the United States, cause the existing British patent to be annulled. This is no imaginary source of danger, as is shown by the history of a case published in the *Illustrated Official Journal* of the British Patent Office, January 22, 1890. It appears that Main, an American, having filed an application in the United States April 18, 1887, made an application in Great Britain, November 18, 1887, the very last day of the period of priority. The grant of a patent to him was opposed on the ground of a prior patent, to wit, No. 8262, of June 8, 1887, already five months in existence. Under the provisions of the Convention of Paris, and of section 103 of the Patent Act made in pursuance thereof, Main demanded to have his application dated back to April 18th, the date of his application in the United States. This was allowed by the Comptroller, who was sustained on appeal by Sir Richard Webster, Attorney

General, the prior British patent being thereby rendered void. An ambuscade of this character would be impossible if the period of priority, whether long or short, were made to run from the official publication.

The proposition of the United States to amend the Convention in this respect was earnestly contended for by our delegates in the Madrid Conference of 1890. Objections to it were not so much to the principle it embodied, as on account of the difficulty of changing existing laws, which in several countries had already been modified to accord with the terms of the Convention. The United States delegates were not prepared with an answer to this objection, and they could only hope by an intelligent presentation of their proposition, and by bringing it to the attention of the governments and peoples of the other States, that through its equity and logical consistency and practical character it might, in course of time, be more favorably entertained.

The second project for the international protection of inventions is contained in the draft of a treaty agreed upon in the International American Conference, held in this city last year. This draft was reported to the Conference on March 3, 1890, and adopted without discussion. It is unfortunate that, in a Congress assembled at this capital to consider a subject like this, pains should not have been taken to become acquainted with the United States patent law before formulating the terms of a treaty. Had this been done, it might have been possible to frame a series of articles consistent with our law, and at the same time acceptable to the other American nations.

The report presented by the Committee on Copyright, Trade-Marks and Patents is full of exalted sentiment respecting the rights represented by these terms, and their just claim to international protection. The treaties recommended for adoption concerning these three subjects were the same that had been agreed upon in an International Congress at Montevideo, in which all the South American States but three took part. They are presumably acceptable to most of the South American nations; but that upon patents, with which alone we are now concerned, is very far from agreement with the laws of this country, and must be wholly unacceptable to our people.

The first article provides that any person having a patent in one of the contracting States shall enjoy in all the others all the rights of inventor, provided he shall, within a year, cause his patent to be registered in such States. When it is considered that, with scarcely an exception, the governments of South America grant patents without inquiry into novelty; and further, that in the United States the registration of a patent granted abroad is an unknown thing, it will be seen how widely at variance this proposition is with our system.

The third article provides that questions regarding priority of invention shall be settled according to the date of application for the respective patents in the countries where they were granted. This ignores the principle at the foundation of the United States patent system, that patents shall be granted to the first inventor, and the elaborate system of interference procedure, by which contests for priority are determined.

The fourth article prohibits the grant of patents for inventions or discoveries already made public, either in any of the contracting States or elsewhere. This is as widely at variance with the United States law as are the first and third articles, since under our law a printed publication at home or abroad is no bar to a patent to the inventor who is able to show that he made the invention before the date of the publication, and has not abandoned it.

Those who look for a complete realization of the idea of international protection for inventions must deeply regret the failure of the American nations to profit by the magnificent opportunity afforded them by the International American Congress at Washington. It can be no exaggeration to say that a week's work of the United States Patent Office is more than a year's work of the patent offices of all the other American republics combined, and that a system, the evolution of a century of experience, and the most potent factor in the unrivaled industrial progress of this country, was entitled at least to be recognized in a congress of that character convened at its capital. But with this regret comes the hope that as the American nations draw closer together in the bonds of commercial intercourse to which sentiment invites, and which wise statesmanship fosters, the opportunities may not be far distant when this subject shall be renewed with clearer light, and with better assurance of results advantageous to all the nations concerned.

What has been practically accomplished aside from these two projects may not be overlooked. Complete international protection exists between us and our nearest neighbor, the Dominion of Canada, by virtue of no treaty or concession, but by the enactment of laws in that country as liberal towards the alien as they need to be, and in some respects more judicious than ours. Any person, citizen or alien, may secure a patent in Canada, provided the invention has not been in public use or on sale in the country, with the consent of its author, for more than one year prior to the application. A prior foreign patent is no bar if the application is filed in the Dominion within one year from its grant, a wise restriction which we might profitably adopt, since our law as it stands creates conditions sometimes prejudicial to vested rights of our own citizens. The Canadian statute differs from ours in many particulars, but the two are so nearly assimilated in respect to the rights of aliens that through them the ideal of international protection has been nearly accomplished. Our liberal and progressive sister republic, Venezuela, permits the true inventor to secure a patent after having first obtained protection in his own country, and permits public use of the invention in the country for two years before application for patent. The little realm of Hawaii has bodily adopted our law; and so we have the nucleus for an International Union of four self-legislating governments, created by no formal convention, but called into existence by the recognition in each of the rights of the inventor, and the refusal to limit those rights on account of acts done in order to secure protection under the laws of another country, provided he avail himself of his privileges within a reasonable time. To this list should be added Sweden, whose law, imitating our own in many respects, gives a foreign inventor a limited time after the grant of his home patent during which he may file his application in the kingdom.

Nor is this all. A year ago, when the Conference at Madrid refused the American proposition, the delegates from this country did not believe that the last word had been said.

Their demand was so fair and logical that it could not fail to impress itself on thoughtful minds. And now comes the news that the most powerful empire of Europe, which up to this time has refused to accede to the International Convention because not in harmony with her laws, is contemplating an amendment to them that will amount on her part to an acceptance of that proposition. A commission of the Reichstag has reported in favor of an amendment, which will give to inventors belonging to nations which give corresponding privileges to German subjects the right to file applications for patent in the empire within three months from the date of the official publication of the description of the invention in the country of origin, without fear of having their German patents invalidated by reason of such publication.* Since we already grant that privilege to German subjects, we are prepared to step in and reap the advantage of the proposed legislation the moment it is in force.

This step on the part of Germany is not dictated by sentiment, but by rigid policy. It carries further the principle embodied years ago in her treaty with Austria-Hungary, which was for the mutual advantage of the people of both empires. It proffers to the other nations of Europe a privilege heretofore denied them, provided they can grant the reciprocal privilege; and will almost compel these nations to concede to Germany what they could so easily refuse to us. It puts Germany in line with the United States in the demand we made upon Europe in the Madrid Conference, but in a better position, since Germany has something to give in return which we had not. The adoption of this amendment to the German law will put a new face on the whole subject of international protection of inventions; and it is not unreasonable to expect that when delegates from the United States shall renew our proposition at Brussels in 1893, it will meet with more favor than at Madrid; and at no distant day the truth may repeat itself, that the stone refused by the builders has become the head of the corner.

In considering the prospects of international protection for patent rights in harmony with American ideas, the thought constantly intrudes whether our liberality to the alien has not

* This law went into effect in Germany, October 1, 1891.

been excessive. Those who have sought in conference with the representatives of other nations to secure some concession advantageous to American inventors have been met by the demand, "What can you give in return?" We have nothing to give, since for many years we have lavished everything on the alien, in placing him on precisely the same footing as the citizen in the Patent Office and in the courts. But diplomatic agreements are seldom anything but bargains. They are affairs of barter, in which each party strives to secure the best for himself. In this market those fare best who are able to give real value in exchange for what they desire. Those who have nothing to give are apt to get nothing in return. Our liberal legislation, in throwing wide open our doors to the inventors of every nation, had its origin in the doctrine embodied in the Constitution that the useful arts are encouraged by the protection of inventors, and in the belief that the just reward of the inventor should not be withheld from him, though he chance to be an alien. This theory of our law is the only sound theory of international protection. But many a noble theory has worked badly in practice; and so, while we have been promoting industrial progress at home by beneficent laws, protecting alike the citizen and the alien, we have been unable to secure for our own citizens in foreign lands the rights we have so freely conceded. The golden rule, admirable and exquisite in its simplicity, fails by its very simplicity of application to the complex affairs of diplomacy. The first duty of a government is to its own citizens, and while we act with all beneficence toward the people of other States, our own people have the right to demand that this beneficence shall not be exercised to their injury.

International protection is not to be attained, it is rather hindered, by unlimited concession on the part of a single government. If ever reached it must be through mutual concessions from all. In the progress of the world toward this result the United States, with our present liberal legislation, can be little else than a spectator. We may proudly point to the results of our system, and invite the world to imitate it, but we cannot purchase concession, because we have no longer any thing to give in return. We can scarcely take steps backward, though it is plain we should stand better if we could recover some of our squandered privileges.

But in our attitude of watchful spectator we can take careful note of the timid steps by which the nations of the world by slow degrees are drawing nearer to our position. Such mutual concessions as other governments may make towards the protection of the true inventor, by amelioration of the hard laws which have robbed him of his rights, are all steps leading them nearer to the principles of the American system. As such steps are taken it must be the part of American diplomacy to secure to American inventors the benefits they may confer.

From our vantage point, far in advance of the other nations of the world, we may watch their rivalries, their contentions, their reciprocal demands and proffers ; may note the mutual concessions, each bringing them nearer to us, by which sooner or later they attain to harmonious and profitable relations, until universal comity shall have been reached ; in which, and in every advantage realized in the course of its achievement, we shall be prepared to share.

INVENTION IN ITS EFFECTS UPON HOUSEHOLD ECONOMY.

BY EDWARD ATKINSON, PH.D., LL.D., OF MASSACHUSETTS.

THE HOUSE ITSELF.

Upon first putting pen to paper in order to describe the effect of invention upon the household I have at once become aware that what can be said within the limit of time permitted, must be a mere brief which might well be extended into a volume.

When that volume had been completed it would be more of a record of what we have *not* accomplished than of what has yet been done to render the art of living simple and sincere, to the end that true life may be developed in the dwelling place and that the bodies of which life makes use for a few years may be fitly housed. There are now, perhaps, proportionately more houses in which people dwell in greater or less *numbers*—tenement houses for instance—than there formerly were. How many *homes* are there, relatively to our numbers, as compared to former days? Let us not boast overmuch.

In dealing with this subject I must perforce be governed by my own environment, therefore my observations must be limited by what I have seen and what I know of New England.

From what better standpoint, one may ask, could observations have been made? Has not the Yankee always been striving to invent an easier, if not a better method of doing everything under the sun?

In what respect has progress been made in establishing homes in the land during the century of patents?

Let us first consider the mere aspect of the house.

Until a very recent period the century has been one of decadence, and we have but just now entered upon a period of true *renaissance*. This decadence may be almost wholly attributed to the progress of invention; yet invention must be justified because it had made it easier to build a house than it was formerly. It has also made it easier for many people to become householders. But has not invention for a long period almost destroyed the beauty of the house itself?

What could have been more simple and sincere, and more consistent with all the surroundings than the old farm house, which took the place of the log cabin and may have been developed from it.

The house was well placed, facing the south, under the shelter of great trees; it was framed in solid oak; low studded; the timbers showing everywhere in their true places; it was ventilated by way of the great chimneys, in which cheerful fires gave warmth and light to the very life itself.

Again, witness the pleasant aspect of the village dwelling, with its gable end upon the street, the doorway opening upon a pleasant yard, the gambrel roof well framed and solid, holding living rooms within, and not mere attics, the whole house of solid frame work, closed walls, well filled.

Each of these dwellings was a true development, in a section where timber was abundant, where solid wooden walls are warmer and dryer than brick or stone; and where true architects would have been born, by whom a school of architecture might have been established which should have been wholly consistent with the climate, the soil and the building material of the country, except for progress in invention.

Again, bring into view the houses, aye, the homes of the gentry of old time. The old Colonial type was an example of true architecture in the highest sense, although hardly any one then claimed the title of architect. There were builders and craftsmen in those days who knew their trade, and although they assumed not to be artists, yet the artists of the present day are copying their designs, and in this period of *renaissance* are giving the eye a restful sense of almost unconscious relief from the crazy roof of mustard and pepper-pot design, set off by jig-saw decorations, with which sham houses have in later days been covered; roofs made of open boarding full of leaky valleys, sheathed with slates which may keep out water, but surely let in all the heat of the summer sun.

To whom can this period of decadence in household art and architecture be attributed, if not to the pestilent inventor of the buzz-saw?

Who made it so easy to destroy good, solid timber and to erect hollow shams of basket-like structure, of bad form, badly roofed, badly worked in what is miscalled decoration, in which fire and vermin may go anywhere at their own free will! Who but the innumerable inventors of wood-working machinery? To whom it is nevertheless due that many of us can get a house to live in of any kind; for they have made shelter less costly and have given a sort of home to multitudes who might have had none except single rooms covered in with mud or logs. Yet for these inventions have we not paid for a century a fearful price?

A word of warning here to the people of the great Southland. You have the world's supply of hard wood timber upon your mountains—the country's supply of hard pine, yellow pine and ash upon your plains. Why copy, as you are doing in many places, all the faults of northern types of house from which we are just emerging by way of what I have called a *renaissance* in domestic architecture.

The climate and conditions of the Northern States require compact houses, chimneys enclosed within, powerful heating furnaces as distinguished from the warming apparatus required in the more moderate winters of the South. Why not develop the Southern type of open construction, the true Southern dwelling with open ways between the living rooms, the sleeping rooms, and the dining room, the kitchen and laundry? Wh not develop the Spanish and Moorish type of quadrangle enclosing the *patio* or courtyard? Why not adopt the thick, solid, flat roof, which is almost universal in the hot countries of Europe? Cover it, if you please, with a pent house or secondary roof of picturesque form, to keep the heat from the true roof, thus making it a pleasant, shady resort in Summer. This secondary roof is not closed in at the ends, and merely attached to the frame of the house proper. This whole roof space on the true flat roof and under the pent house may be clear, for the very reason that the Southern chimney should not be enclosed within the house. What better play space for children in hot or wet weather?

One may well envy the upbuilders of the new town and cities of the great Southland, because they can, if they will, avoid all the blunders which we have made in our hap-hazard growth in the North and our hasty growth in the West; our Southern friends may now find men who will make use of all the varied contour lines of hill and valley in laying out the town. They can now find architects capable of inventing houses which may be built of timber in such a way as to make them seem to have grown where they are.

They can find men who can also combine clay tiles and steel in solid and incombustible structures in the more crowded towns or cities, as the Moors built with cohesive tiles in Spain many centuries ago. In this mode of construction, structural steel may now be combined so as to bind tiles and steel together in simple forms. Far better thus, than to copy the brick, stone and iron shams of our great Northern and Western cities, which serve only as screens for the products of the buzz-saw which are put together within in cellular form, plastered over with lime putty worked up in such a way as to hide but not to conceal the sham. The apparent motive being to secure complete destruction by fire from the smallest cause.

When the next centenary of invention is celebrated, the greater part of the inventions in house building which have been applied in the past hundred years will have ceased to encumber the face of the land. Their places will have been taken by the products of many inventions, which are just beginning to be applied. I may venture to name a few of them:

Cohesive tiles of fire clay.

Terra cotta lumber.

Structural steel in combination with light and porous concretes in the construction of floors.

Plaster board.

Adamant and other kinds of adhesive plastering.

Inside walls finished with lime plastering laid on metallic lathing without concealed spaces behind.

Vulcanized timber.

Incombustible paints and varnishes.

Wood pulp mouldings and covering for roofs.

Vitrified brick—moulded brick and various kinds of marble work for inside walls, stairways and the like.

It may well be remembered that if skill and intelligence be applied to the framing and disposal of heavy timber and plank, a better house can be built from these materials where wood is abundant at less cost than the common basket-work of joists combined with thin boards on walls and roof.

Wood is the best of all non-conductors of heat which can be used for building. A house made of three-inch plank laid on suitable timbers and posts set wide apart, roof as well as wall, will be cooler in summer, warmer in winter, and dryer all the time than any house that can be built of stone, brick, or iron, except at an excessive cost for double or vaulted walls. Such a house is but an evolution of the log cabin of the mountain section of the Land of the Sky ; its further evolution offers a wide field for the inventions of the architect, the builder, and the artist.

This is but a transition period in house building. From the age of mud walls, tents of skin, and cobbled walls of stone, we have passed, or are passing, through the age of light wood and plaster and shams of stone, perhaps through a temporary stage of iron, of which some of the worst and most hazardous forms have been devised, to the age of clay ; for the present the clay may be combined with structural steel ; perhaps this period may end in the use of clay only, either baked into bricks, tiles, or porous blocks, or clay converted into the lightest kind of metal—alluminum. So much for the house itself.

HOUSE FITTINGS.

To the matter of fixtures not much time or space can be given. The application of modern tools and machinery has *not* been inconsistent with the greatest progress in effectiveness and in artistic design. Locks, hinges, door handles, window fastenings, and all other fittings, both low-priced and high-priced as well, are, in their best forms, most conspicuous examples of true improvement, in which the inventors and manufacturers of this country have taken the leading and most conspicuous part.

WATER SUPPLY AND DRAINAGE.

During the century the change from the "Old oaken (bacterial) bucket that hangs by the (contaminated) well has given place to various methods of supplying water by the use of vessels or pipes that will not decay, from sources of supply that may not become contaminated. But the progress in drainage and in the removal of sewage has not keep pace with this more abundant supply of water ; hence there is hardly a more important field for future invention than in these directions. The drainage of the cellar and of the soil about the house may now be readily accomplished through the invention of tile drains and of cheap and durable earthen tiles for their construction.

In the matter of sewage more remains to be accomplished than has yet been done. The two sources of danger are kitchen grease and foecal matter. It is probable that the removal of foecal matter by the application of heat will take the place of wet methods of carrying it off mixed with water in a manner most liable to contaminate the surroundings of the house. Already methods of reducing foecal matter to innocuous ashes have been invented by Fuller, Warren & Co. and others, which are being applied in many factories and school-houses in suitable places outside the main buildings and with complete success. The washing of greasy pots, pans, and dishes may perhaps be made much safer by substituting some of the antiseptic products of petroleum for soap in the process of scouring as well as by doing away with a great part of the waste of grease by a complete revolution in the whole practice of domestic cooking.

LIGHTING.

In nothing has there been greater progress than in the transmission of the light of day from without, or in the production of artificial light within the house.

Limiting the consideration of this subject to the isolated dwellings which are out of reach of illuminating gas or electric lights, in which category will be found by far the greater number of houses.

Therefore, taking no note of the marvels of invention in respect to gas and electricity, a few words may be given to matches, glass and lamps.

Nothing remains to be done in the direction of reducing the cost of "*striking a light*" although there is yet a wide field for making the process safer than it now is.

No branch of industry has been more fully promoted by invention than the making of glass, and there is no occupation which presents a more complete example of the rule, that in all arts to which invention and improved processes are applied *the* *cost of labor is diminished while the rate of wages rises and the price of the product is reduced.*

Thus, although the progress of the glass manufacture has been obstructed by high duties on many of the materials which are used, as well as upon the finished products of like kind imported from foreign countries, yet such are our many advantages in the quality of the sand which is converted into glass, and in the abundance of food from which the large amount of physical force or potential energy that is called for in this pursuit is derived, that we have accomplished much in the improvement in quality as well as in the reduction in cost.

In that monumental volume, No. XX of the census of 1880 upon wages and prices, compiled by Mr. Joseph D. Weeks, it appears that in one of the principal glass works of Pennsylvania the following changes had occurred, the wages of every class of operatives had advanced between 1860 and 1880, yet more as compared with 1851. The average earnings of all classes in 1861 were $1.23 per day, in 1880 they were $1.62. The absolute cost of labor per amount of product had been diminished although the percentum of labor in the product had increased. But, through economy of fuel and other applications of invention, it had become possible to reduce the prices of given sets of glass bowls, goblets, wine glasses and tumblers from $18 in 1860 to $3.50 in 1880. (See pages 87, 88, Vol. XX, Census 1880.)

The changes have not been as great or as conspicuous in the matter of window glass, but since 1866, the year of conspicuous paper money inflation, the cost of labor per box of fifty feet has been diminished from $1.75 in paper to $1.10 in gold, while the price to consumers of the same quantity has been reduced from $5.50 to $2.75.

This extraordinary volume, containing the results of able and scientific research, is full of most instructive examples and proofs of the rule that I have presented, to wit: *In proportion to the application of science and invention to the arts of production the price of labor is augmented, the rates of wages rise, the cost of labor is diminished, and the price of the product is reduced.* This volume also gives the most conclusive proof of the inherent power of an intelligent people to keep on in their material progress, in spite of civil war, of the debasement of the currency, and of the obstruction of bad methods of taxation by which free commerce with the world is restricted, and by which labor is diverted from its most profitable course: the home market for the surplus products of the field, the forest, the factory, and the mine being by the same obstructive policy prevented from expanding.

In the matter of artificial light it may be held that while the introduction of illuminating gas and electric linghting have increased the quantity and greatly facilitated the distribution of light, neither invention has to any extent reduced the cost, but on the contrary, by increasing the demand for light everywhere these inventions have doubtless increased the general expenditure.

On the other hand the discovery of petroleum, the application of invention to its preparation and distribution and the invention of innumerable varieties of lamps, have reduced the cost of household lighting both absolutely and relatively, to the end that there is now nothing so cheap in the household as an abundance of light. Yet there are inventions hardly yet known which remove almost the last vestige of hazard from the kerosene oil lamp burning a reasonably high standard oil, doing away also under ordinary care with smoke and smell, while another invention promises to remove all the odor from kerosene oil and to raise the flashing point to 500 or 600° F.

FURNISHING.

Strong and durable as the furniture of the house was a century ago, not much can be said for its comfort. Time will not suffice to deal with the application of invention to the art of furnishing, in which the artist and the skilled mechanic have done so much. Suffice it that the Centennial Exhibition of 1876 gave a greater impetus in this direction than in almost any other, and it is from that event our greatest progress may be dated.*

* NOTE.—I may venture at this point to render the credit to Professor John D. Runkle, of the Massachusetts Institute of Technology, which is his due. He had the sagacity to discover in the Russian method of manual instruction the germ of the system of manual training which is now becoming an integral part of common school instruction all over our land. He applied and developed it in the manual workshops of the Institute of Technology in Boston, and from that first object lesson the conception has spread everywhere.

HEATING AND COOKING.

We now come to the two most important processes of household economy, in which it may almost be affirmed that the progress of invention has been backward.

In the matter of the combustion of fuel we may measure our ignorance by the height of our chimneys and the strength of our drafts.

It would be out of place to deal with the crude methods of combustion in the conversion of coal into power. The tendency toward gaseous fuel is very marked and may ultimately lead to much greater economy.

In dealing with the household art of applying heat to the conversion of crude food material into nutritious food, the position may now be taken that any method of combustion that requires the draft of a chimney and any stove that requires a chimney flue is almost unfit to be used. In the art of nutrition we have given our attention almost wholly to the nutrition of the soil, the plant, and of the beast; but until within a very few years we have wholly overlooked or neglected the nutrition of man.

Taking advantage of this neglect by the true scientist, the venal masters of scientific perversion have exhausted the art of deception in compounding quack medicines for the cure of ailments which are sometimes imaginary, but which when they exist are mainly due to ignorance and incapacity in the art of cooking.

The brick oven and the open fire of a century ago required time and close attention, but the results of the work under the direction of a good housewife were wholesome, nutritious, and appetizing.

The introduction of iron stoves and ranges and of anthracite coal have taken the life out of the house, out of the air, and out of the food as well.

It is only within a very few years that any attention has been given even to chemical physiology; as yet hardly any progress has been made in bringing the lessons derived from science applied to nutrition into the form of an art which may be easily mastered.

I have been led to the study of this matter through the development of the fact by the compilation of statistics, that even in this land of abundance one-half or more of the income of about 90 per cent. of the population is expended in the mere purchase of food material.

Add to this the time, the attention, the discomfort, and the waste of energy which are spent in the conversion of good material into food of which the average quality is bad and we begin to have some comprehension of a field which is almost unoccupied, and in which science and invention have yet to work most beneficent results.

Had I undertaken to deal with this branch of invention in the household arts for mere purposes of personal profit, it would be unsuitable to treat this matter at this time. But since my purpose and my present practice is to devote the income that I may derive from my own crude inventions to the further development of the science of nutrition, I may devote the remainder of this treatise to this branch of the subject.

Without the aid of Mrs. Ellen H. Richards, of the Massachusetts Institute of Technology, and of Prof. Wm. O. Atwater, of the Department of Agriculture, Washington, D. C., I should have been unable to deal with this branch of the subject in the way in which I shall present it. I may also quote from the standard authorities, Sir Henry Thompson, Sir Lyon Playfair, Prof. Voit, Dr. Pavey, and others, without again referring to them by name.

The sole condition on which the application of heat to the conversion of food material into cooked food without constant watching is that a measured heat shall be under complete control.

The two rules for cooking are as follows:

I. Take some heat of the top of a lamp and put it into a box.

II. Take one part of gumption and one part of food, mix together, put them into the box with the heat; the heat will do the work.

These rules cannot be applied in the use of any iron stove or oven heated by the combustion of coal under a strong draft Cooking on such stoves calls for constant attention, and for the discomfort due to close proximity to the stove.

If meats are subjected to a high heat in the effort to cook them quickly in an oven, or by any process except broiling, which requires great skill, the fats are dissociated or "cracked," as it is termed, the volatile portion is diffused, bearing away the finest flavor, and the remainder of the fat is left in an undigestible condition, in which it fails to be assimilated.

In fact the process of cooking is a fine process of chemical conversion and when we put appliances which are not suitable to the process into the hands of incapable persons who are entirely ignorant of the theory, we have no right to expect to get any better results than those with which we are all too familiar.

It would be unsuitable both to the occasion and for myself to describe the processes which I propose to substitute for those which are commonly practiced. I will only give the objective point of my researches and a statement of what has already been accomplished; much more remains to be done.

The proportions of the nutrients which are necessary to the effectual support of a man at moderate work, according to the American standard, are as follows:

Protein or nitrogenous material	125	grains.
Fats	125	"
Carbo-hydrates or starchy material	450	"
	700	

Disregarding fractions a little over one pound (adv.) of starchy food and a little over a quarter of a pound each of fat and of protein.

Professor Atwater has converted these nutrients into calories or units of heat. These chemical elements of nutrition, with the mineral elements which will be found on almost all varieties of food, must supply the working man who is engaged in moderate work with 3,520 units of heat per day: a less supply suffices for women. The variations which may be made for hard work or for sedentary work, or for sex, are few in number and may be readily defined by percents of variation.

If we add for unavoidable waste about 10 per cent., the unit of nutrition for a man at moderate work is 4,000 calories per day. This potential energy will be yielded from the nutrients which are contained therein by certain measurable quantities of vegetable and animal food consumed in about the usual proportions. The proportions of animal and vegetable food may vary according to the special appetite and digestive powers of each person, but dealing in a broad and general way, such is the standard or unit of daily nutrition.

In the purchase of food material at the retail prices in cities and towns, grain, flour and vegetables may be considered as constants in price each season or year according to the crop, the prices of animal food as variable according to kind and quality.

Lists of prices having been prepared, the following course is now within the power of any intelligent person to adopt.

If a dietary be made up for thirty days, for the consumption of the tougher and cheaper parts of meat and of the cheaper kinds of fish, with the right proportion of bread, grain vegetables and sugar the cost of food per thousand calories in Boston at the present time will not exceed three and a-half cents. A man requiring 4,000 calories may therefore purchase a day's full supply for 14 cents, or at the rate of 98 cents per week. A woman occupied in sewing, teaching, or in attendance in a shop may purchase 3,400 calories, which is in excess of ordinary need, at 12 cents per day or at 84 cents per week.

These tough portions of meat may be made as tender as the choicest cuts by the application of moderate heat for a sufficient length of time, and are in every respect as nutritious.

If the consumer wishes to purchase the medium cuts of meat and to enjoy a greater variety, the expenditure may be increased to 5 cents per thousand calories or 20 cents a day—$1.40 per week for men: 17½ cents a day, $1.23 per week for women, the addition being spent on meat and fish.

If the consumer wishes to purchase the choicer cuts of meat, the best quality of poultry and fish, together with a more ample supply of milk, butter and sugar, the price per thousand calories may be advanced to seven cents.

At this standard the cost per day for men will be 28 cents or $1.96 per week; for women, 24½ cents per day or $1.72 per week. Any expenditure beyond this last standard of seven cents per thousand calories will be either an absolute waste or for absolute luxury.

This daily unit of nutrition for one person can now be cooked in the best manner in the crockery vessels in which it may be served, in a cooking pail of my invention, with the heat derived from any common kerosene hand lamp or from any common gas burner over which the pail may be suspended, and while the housewife sleepeth the lamp will do its work.

Multiples of this ration may be cooked in a portable oven of my invention, either by baking, roasting, simmering, stewing and braising, or in imitation of broiling and frying, at the rate of forty to fifty pounds per day in a series of four charges to the oven, with the heat that may be taken from the top of the chimney of a common kerosene oil lamp with a circular wick of one and a-half inches in diameter, consuming one quart of oil in the eight hours required for work.

The work may be done anywhere. Therefore the kitchen and its chimney, the iron stove or range, and the miscellaneous collection of iron pots and pans may, so far as the process of cooking is concerned, be wholly displaced. The room can then be put to a better use if the heating of the room itself and the water for circulation about the house be relegated to the heating furnace in the cellar in winter and to a small special water heater in summer.

I venture to conclude this treatise with the suggestion that the agricultural experiment stations of the United States which are now being so well developed under the general supervision of the Secretary of Agriculture, and under the special supervision of Prof. W. O. Atwater, should not be limited wholly to the nutrition of the soil, the plant, and of the beast.

They will not be complete until a Cooking Laboratory is attached to each, in which the science of the nutrition of man may be developed, to the end that it may become a part of the common knowledge of the whole people, and that the simple rules, of which I have given some examples, may be incorporated in the arithmetics used in the common schools in place of some of the logical puzzles which perplex our children without educating them.

At present I can claim for these computations only theoretic accuracy. Arrangements have been made by myself for the beginning of laboratory practice from which a more definite direction may be given in this almost unoccupied field of applied science.

A few words more upon the general topic. The progress of society and the progress in household economy, like progress in the mechanism of the factory, appear to follow one and the same rule; each beginning in the arduous simplicity of earlier days, each evolving new ways and means of combination by way of new inventions and discoveries, leading up to the utmost complexity, accompanied, however, by greater abundance. Yet this complexity is but a prophecy of more effective simplicity in the fullness of time. Both in society and in the household we seem now to be in the transition period of extreme complexity.

We are compelled to think more of living and less of life. We possess more comfort, but do not enjoy it, because it involves more care. We have many more servants and much less help. We can spare more time, but we get less leisure. We pay for more amusement and are less amused. We may read more books but we do less thinking. We strive to be independent, while we become more and more dependent. We condemn legislators, yet we constantly appeal for more legislation. We admit that the progress of humanity can only come in the development of the individual character. Then we take up all sorts of fanciful fads, which would sink the individual in the collective mass. We boast of our power to manage our own affairs, yet we appeal to Congress to force us to take up unprofitable occupations at the cost of our neighbors. The laborer is proud of his liberty, yet calls upon the Legislature to restrict the use or his time. We ask not to be led into temptation, then we pass laws which convert that which is not criminal in itself into a legal crime. We try to earn all the money of the best kind that we can get, and we call upon the Government to coin a poor kind, and to pass a law to enable us to force our creditors to take it. On Sundays we praise the Lord who has made of one blood all the nations of the earth, and on the week days we ask Congress to forbid us to exchange services with our brothers in blood of other races. We preach the gospel of peace, good will and plenty among the nations, while each nation builds iron, steel and nickel-clad vessels of war for the next inventor to render useless and innocuous.

To whom do we owe all this complexity? Again to the pestilent inventor. Who but the inventor of the turbine wheel brought masses of people into the narrow valley of the river below the fall? Who but the inventor of the steam engine and of illuminating gas made it so necessary for the workman to live near his work that we have generated the slums out of that crowded condition promoted by these very inventions? Who but the inventor of the vertical railway, which we call an elevator, placed household over household in disregard of the separate home? All this is but transition.

Next appears the inventor who sends speech and light and power over wide areas; the inventor who, like the one who devised the multiplex telegraph, sends the rapid car at higher speed above the slow-moving carriages on the street below. But now comes his peer, who, adopting the Irishman's receipt for making a cannon, takes a round hole and puts an underground tunnel of iron and concrete outside of it, and who, boring through sand and clay and rock, will carry the multitude from the crowded streets of the city to the wide area of the suburbs.

Again comes the inventor who, converting hydrogen, oxygen, and carbon into fuel gas, will presently furnish heat at little cost wherever small pipes can be laid, in which this kind of gas can be forced under high pressure over long distances. In every direction we make progress by invention which destroys great volumes of capital previously accumulated at great cost, thus diminishing the relative share in every service which the capitalist may take over to himself, while increasing both absolutely and relatively that which may rightly fall to the industrious and intelligent workman.

There is nothing constant but change, and throughout all these changes we witness progress toward that objective point when the family will again become the unit of society; when a good subsistence and a suitable shelter will be so readily attained by men of common intelligence, rectitude, and industry that it will no longer pay to become rich, and leisure will be found in the diligent and intelligent use of time.

I venture again to call attention to the sequence of events. The collective or factory system of industry was practically unknown until the development of the modern water-wheel, the application of steam to power and illuminating gas to lightning. These inventions brought about a change from separate household industry to this collective method, accompanied by an extreme subdivision of labor. It was a step in moral as well as in material progress, although in its earlier stages it was subject to many abuses. It may have reached its highest point in its application to the pursuits of this country, yet, if we analyze the occupations of the people as given in the census of 1880, we shall find that if we put into the category of the operatives in our great factories all who are occupied in the textile arts, the iron and steel works and machine shops, the clothing, boot and shoe factories, and all other miscellaneous occupations, which can be conducted in the best way by great subdivision of labor, and by bringing great masses of people into single buildings, we barely reach ten per cent of all who are occupied for gain. There are, of course, great masses occupied under analogous conditions, but in collective pursuits like the railway service, the building trades and others individual aptitude and intelligence count for as much or more as the mere manual or mechanical aptitude which is so necessary in a factory. Great factories are conspicuous by their very mass. They appeal to the imagination and may sometimes mislead.

Again, the construction of the railways into undeveloped territory has scattered the population occupied in agriculture under conditions, which, in some respects, are as adverse to the development of men as the massing of crowds in cities. These are the penalties which we pay for invention, and they have occupied a century in their development. May it not be probable that in the progress of invention other new forces, to which I have referred—power, light, speech and heat, carried over wide areas and placed at the control of the household on the tap of a button, may bring about a return to household industry of the highest type under the least arduous conditions of life perhaps wholly free from the monotony of the great factory ; distributing the urban population and doing away with the causes of the slums, so far as those causes may be found in external influences rather than in the individual character or want of character in those who rest contented in the slums.

Again, the intensive system of farming, the adoption of the silo, the application of improved methods in dealing with all the products of the field, are leading to the treatment of land as a laboratory rather than as a mine; thus bringing together into neighborhoods that part of the population which has been too widely scattered, also closer to the factory population which has been too much concentrated.

If such may be the prophecy to him whose vision leads him to visionary and optimistic views, then we may call upon the inventor of the future and of the present to continue on his way undoing the work of his predecessors by doing it better.

We may bid God-speed especially to the inventors of warlike implements of destruction, perhaps the only method of overcoming the ignorance and stupidity of mankind. That ignorance and stupidity finds its most extreme expression in the construction of great vessels of war, especially by European countries such as Italy and Germany, where the weight of taxation is already depriving great masses of the population even of the measure of food which is absolutely necessary to the maintenance of life. The long list of the iron and steel-clad vessels of war belonging to these nations may be taken as the tokens of the barbarism of that system which forbids mutual service among the States which comprise what are called the civilized sections of the globe.

In that provision of the Constitution of the United States which assures the utmost liberty in mutual service among the States of this Union we have found the closest bond. Since slavery destroyed itself by aggressive warfare we have ceased to require an army except for police services, and when the inventor of the most effective gun shall render approach to any of our harbors by armed vessels as impossible as the fear of such approach would be ridiculous, if also we are then as free to exchange services and products with other nations as we are among our own States, the true century of good will, peace, and plenty will have been fairly entered upon.

ADDRESS OF S. P. LANGLEY, LL.D.,
SECRETARY OF THE SMITHSONIAN INSTITUTION,

VICE-PRESIDENT OF THE CONGRESS, PRESIDING AT THE SESSION ON THE AFTERNOON OF APRIL 9th, 1891.

If this Centennial is a memorable occasion in the history of discovery it is so also in that of science, which time out of mind has been so intimately related to it. It is possibly to this that I owe the honor of being here to assure you of the especial interest which is felt in this gathering by the scientific men of Washington, who form perhaps a greater body of professional discoverers than there is in any other city of the country.

Nearly a half a century ago Congress transferred from the shelves of the Patent Office to the Smithsonian, the very few objects of curiosity the government then possessed, and these have since grown into great groups of illustrations of the history of man's thought, as displayed in discovery and invention—groups which are among the most interesting of the collections of the National Museum.

I hope all here will find opportunity to see them, but I allude to these in connection with this centennial occasion, only to notice a suggestion they give of general application to the history of discovery, for so long as man is a tool-using animal, nearly every inventor is still engaged in making a tool or machine of some sort, and the history of the very first tool that was made, may have a bearing on the present of invention, and even throw some light on its future.

We have all seen an Indian axe-head which has been made of stone, by rubbing one piece on another, and looked on it perhaps as the most primitive of tools. This, however, was not the first tool, but an improvement on something still ruder, for you may see in these Smithsonian collections, roughly-broken stones which were made by primitive man before the art of rubbing one on another was invented, and which antedate this comparatively modern form by perhaps hundreds of thousands of years. The thing to note in this connection is, that it took man probably over a hundred thousand years to make this, his first invention—if we can call it one—and that possibly millions of years, but probably a period longer at any rate than the whole progress of world-wide discovery since, was spent by the inventive minds of all united mankind in evolving the one idea, that by rubbing one stone on another you can get a cutting edge. It seems incredible that invention could ever have worked as slowly as that; yet it did so, and only after myriads of years brought about the polished stone age.

Now, we observe, not so much how inventions grow, as how the rate of discovery grows; when we find that the next great improvement was evolved in a time short, compared with the first; for instead of myriads of years, inventive thought had so gained in quickness that it took "only" a few thousand years to make the next invention, which was that of a tool of bronze.

But the third stage, the development of the tool of iron, shows a yet further quickening of the rate of thought, for this stage began only a few centuries ago, and yet has been thought out, with its immensely greater developments, in a fraction of the former time; in centuries, that is, instead of thousands of years, and not, we must observe, merely because there are more inventors, but because the inventive mind itself is becoming of finer and prompter quality.

If this short history—this philosophy teaching by examples—means anything, we can now, I think, predict that whether the fourth stage on which we are entering, is to be the age of aluminum, or whatever else; that the requisite inventions will be made, the problems worked out, and perhaps the material face of the civilized world altered, largely in our own lifetimes.

It has been said that even less than a hundred years ago, if the most powerful and enlightened potentate on earth wished to travel faster on the land or sea, or to send a message quicker than was done in the days of the patriarchs, he could not do it; for if Abraham had mounted his messenger on his best steed, the united wealth, and power, and knowledge of the world, toward the end of the last century, could have only furnished a possibly swifter horse than his, and could have done no more.

Of the important conquests over time and space, which have been made in the past six thousand years, most have come, then, in the life-time of living men. I have myself long personally known the man who competed with Stevenson for the prize for the first locomotive, and am privileged to count among my friends, in the inventor of the telephone, one still a young man. With this incessant achievement, and this increasing rate of progress on the inventor's part, what can we deny to the possibilities of even the coming decade?

It would be rash to predict what these all may be, but I desire to express my personal conviction that one at least, which has been the mere dream of enthusiasts in the past, is soon to become a reality, and to venture the statement that the air may probably be made to support engine-driven flying machines, heavier than the air itself, before the expiration of the present century.

I will detain you no longer from listening to the distinguished speakers who are to address you, but only say that in view of this fabulously increasing rate and value of reproduction, you, as inventors, are certainly taxable with no overestimate of your true importance, if you believe yourselves becoming each day, more and more the real creators of the changes which make this nation materially great, and entitle you of right to the place of honored guests, and to the welcome all extend to you in its Capital.

THE EFFECT OF TECHNOLOGICAL SCHOOLS UPON THE PROGRESS OF INVENTION.

BY W. P. TROWBRIDGE, PH.D., LL.D., OF NEW YORK, PROFESSOR OF ENGINEERING SCHOOL OF MINES, COLUMBIA COLLEGE.

The place now occupied by technical schools in the general system of higher education may be regarded as a direct result of the advance of knowledge, in the natural sciences, which has so signally marked the successive years of the century which now draws to a close.

Living in the midst of the grand developments in material progress at the present day, we can fully appreciate the extent to which these developments are due to the applications of scientific discoveries only by contrasting the state of knowledge at the beginning of the century with that of our own times: and by tracing the changes which have brought about the rise and growth of the new fields of education represented by technical schools, and the reciprocal effects of these institutions in promoting scientific research and the applications of science to useful purposes.

One hundred years ago natural science was in a condition of the greatest speculative crudity. During the century preceding—Newton, Leibnitz, Bernoulli, DesCartes, d'Alembert and others had formulated most of the fundamental propositions in the mathematical and mechanical sciences, very much as they are understood and accepted at the present time, but the application of dynamical laws and general theorems to practical purposes, in the arts and manufactures, had hardly yet been systematically attempted. Teachers of chemistry in the Universities accepted the old Phlogistic theory as late as 1780 and 1790, when Priestly, Watt, Boulton, Smeaton, and others were accustomed to meet together in Birmingham as members of the "Lunar Society" to discuss matters relating to the progress of the natural sciences and their useful applications.

The Lunar Society may be said to have represented more truly, during its twenty-five years of existence, the state of those natural sciences which have a special bearing on material and useful applications, and the extent to which such applications had been carried, than any association then in existence. Among its members were to be found distinguished inventors, manufacturers, iron-masters, engineers, chemists, physicians, and philosophers, all of whom seemed as much interested in improvements in the arts and industries as in purely scientific discovery.

The Society held monthly meetings in Birmingham at the time of full moon, these times being selected in order that the members might have the benefit of moonlight in returning to their homes. The discussions, which were preceded by a generous dinner, extended informally far into the night, and although no records of the discussions were kept, yet from letters of the members, which have been preserved, this Society seemed to have been a true exponent of the condition of knowledge, at that time, as far as it related to material developments.

Priestly had but recently made his remarkable discoveries of oxygen, hydrogen, carbonic acid and other gases, but explained these discoveries to the members of the Society on the old theory which had been held for one hundred years, and maintained that the gases which he had found were different kinds of air from which an imponderable substance—Phlogiston—had been eliminated or evolved. Neither he nor his greatly-interested associates in the Society had at the time any true conception of the nature of chemical combinations, and although the discoveries of Priestly led to the otherthrow, by Lavoiser and others, of the Phlogistic theory and the establishment of the true nature of chemical action before the end of the century, yet Priestly himself remained until his death, in Pennsylvania in the year 1804, a firm believer in this absurd theory, which had been so long taught and accepted, and which if now maintained would be received, not with incredulity, but derision.

Not less remarkable, as it now appears to us, is the fact that another member of the Lunar Society, the distinguished inventor of the steam engine, then engaged near Birmingham with his partner, Boulton, in the construction of engines, could be furnished by men of science with no other theoretical basis for the explanation of the action of steam than that heat, the source of the power which his engines were transforming into useful work, was a material substance; a belief maintained by the great mathematician of that age, La Place, up to the time of his death, in the year 1827.

The true theory of this important branch of physics was not finally established and universally accepted until about the year 1845, after Joule had definitely demonstrated that heat is a form of kinetic energy, by determining the exact and invariable dynamical relations which govern the reciprocal transmutations between this physical agent and ordinary forms of work or energy.

The new science of Thermodynamics, based upon these discoveries, soon became reduced to mathematical analysis, revolutionizing all the physical sciences and leading directly to the establishment of the important principles of the correlation of forces, or the conservation of energy, and finally in more recent times to the recognition of the fact that electricity is also a form of energy subject to exact dynamical laws which, like those of heat, have become developed into a mathematical science.

The otherthrow of the Phlogistic theory about the beginning of the century, attended by the introduction of the true science of chemistry, and the definite foundation of the new science of heat, with its far-reaching consequences, are the two great events which mark the last one hundred years of scientific progress.

Previous to the introduction of the steam engine by Watt mills were dependent upon water or wind power, and were necessarily few in number. Hand labor in the fabrication of implements and the preparation of useful material was the main resource. Ocean and river commerce were dependent upon the winds, and a knowledge of masonry, carpentry and hydraulics were the chief acquirements of the engineer.

In the Universities, although science was taught, yet its domain was limited, and the instruction given was merely an incident in the education leading to degrees in the professions of law, medicine and theology.

A spirit of experimental inquiry had, however, been awakened, which was destined to spread and continue with increasing activity, and which under the later impetus given to scientific thought by the discoveries of the laws of heat and the science of energy, led to the establishment of new sciences, new professions and new fields of labor and invention.

Scientific discoveries were quickly taken up and brought to useful purposes, and in colleges and universities it became recognized, though reluctantly, and not without much controversy that the broad domain of scientific progress was not only giving rise to new learned professions, but that special bodies of teachers, special departments, and even special institutions of learning, with independent faculties, were required to meet the demands of a new education.

Thus originated, in this country at least, the technical schools, which in one form or another are now found connected with most of our great educational institutions, and often exist as true and independent seats of learning, having the full power of conferring technical degrees.

A new principle or motive has thus been introduced in higher education, which recognizes professions that demand not only profound learning in the mathematical and natural sciences, but knowledge and skill in their useful applications.

Academic, as well as popular honors, are now considered to be due to him who makes a scientific discovery *useful* as well as to him who makes a useful *scientific discovery*.

The technical schools are thus not only departments of research in science, but, in their teachings, the exponents of material progress.

They are sought by a large number of young men who finally enter upon vocations intimately connected with engineering and industrial enterprises, and who contribute directly, in many ways, to the diffusion of scientific knowledge among the people.

These are the conditions now existing, under which we have to consider more particularly the effect which technical schools have upon material progress or the progress of invention.

One important feature of these institutions is, that the instruction given aims not only to acquaint the student with the fundamental laws of science by systematic demonstrations and explanations, but also with the methods and the limits of the applications of those laws to useful purposes.

Teaching is illustrated by examples drawn from practice, or by the examination and discussion of hypothetical problems, chosen with special reference to practical applications.

The student is constantly reminded of the fact, that while no successful device or combination, of whatever character, can violate the fundamental laws of science and of nature, yet there is a vast difference between a theoretical conception and its practical and useful realization ; that the circumstances and conditions of use are of no less importance than fundamental principles.

The training of the drawing-room and the exercises in the mechanical, chemical, physical and electric laboratories are designed to give not only a mastery of the principles of drawing, of mechanism, and of chemistry and physics, and thus furnish a broad foundation in scientific learning, but also to cultivate discrimination and judgment, by which errors in practice are to be avoided and time and money saved, which might otherwise be expended in costly or fruitless experiments or constructions.

Technical schools exert a primary and important influence also in *developing and enlarging* the fields of applied science, not only by investigation and research, but by stimulating and encouraging the applications of new discoveries to the arts and manufactures ; by reducing such applications to laws and general principles, and by contributing to the maintenance of scientific scocieties and scientific publications devoted to the diffusion of the knowledge gained by practice and experience.

One hundred years ago important inventions like those of Watt were submitted to a few learned men only, who alone could understand or appreciate their significance. To-day the scientific press scatters far and near, in language easily comprehended, a knowledge of all new discoveries and new devices ; and critics are found in the work-shop, on the farm, and in the household, who are able intelligently to discuss the subjects thus brought before them ; and if an invention successfully passes the ordeal of such discussions, it may be said to be fairly entitled to favorable attention.

The age in which we live is thus intensely practical and excites the inventive spirit; and they who are deceived by what is false in pretended applications of science, are generally misled on account of inexcusable ignorance and a failure to inform themselves through ordinary and accessible channels of knowledge. To technical schools is to be credited in no small degree this diffusion of exact scientific knowledge in its applications to the arts and industries, and in promoting and quickening popular comprehension of the principles which form the basis of all progress.

The cultivation of certain arts of manipulation and of experimental research, which is carried to the highest degree in technical schools, deserves mention, inasmuch as these arts are often not only essential requisites to successful inventions, but furnish the only means for their perfect illustration and explanation. Among these arts are instrumental drawing, methods of chemical analysis, and the use of testing instruments and apparatus in engineering physical and electrical investigations; all of which not only contribute to the formation of habits of exactness in professional work, but suggest ideas which might not otherwise have presented themselves.

Few persons understand, for example, the value of the art of instrumental drawing. A correct drawing is generally regarded as a kind of language which conveys definite ideas from one person to another; but it is not so universally understood that the drawing-board, to the designer or inventor, is more than a tablet for the presentation or record of his ideas by a peculiar sign language; that it is a most efficient instructor, assisting the imagination and furnishing new ideas, or new proportions, as the work of designing progresses. As a ready and complete vocabulary in written or spoken language not only furnishes a great variety of shades of expression, but suggests appropriate illustrations and even new thoughts, so does the drawing-board in the hands of a skillful designer prompt new combinations, new proportions, and often different modes of treatment of a practical problem.

A complete knowledge of the methods of making proper measurements and tests, by which is to be investigated the practicability or usefulness of a supposed discovery, or process, in any of the branches of applied Physics, Mechanics or Chemistry, is best obtained by practice and experience in the laboratories of the technical schools. These laboratories are in fact the only resource of the inventor in cases where private laboratories are not available, or where tests and experiments require apparatus and appliances which are found only in the equipments devoted to research and investigation furnished by educational institutions.

Graduates of technical schools in this country in large and increasing numbers go out to the various communities, carrying with them the broad and thorough acquirements in theoretical and practical knowledge which they have gained, and the facilities in drawing, analysis, testing and measurement attained in their laboratory practice, and become teachers in their professions, diffusing sound principles of science in its applications to every art, manufacture and industry.

While it is impossible, except in a very general way, to estimate the important influences of technical schools in all these respects, yet these influences are universally recognized as familiarizing the public mind with the true agencies of material progress, and as furnishing to inventors, continually, new points of departure for future improvements.

The knowledge thus acquired and diffused tends also to cultivate definite and true distinctions between what is old, or unpatentable, and what is new; and also a discriminating judgment in regard to what is practicable and useful.

That the Patent Office of the government recognizes the value of this new education is evident from the fact, that of the one hundred and fifty-seven assistant examiners one-third are graduates of technical schools. These are employed to a great extent in the divisions which cover the largest industries, such as steam engineering, chemical applications and manufactures, metallurgy, and the manufacture of textile fabrics; where in each a wide range of knowledge in the applied sciences is required.

Another important field of usefulness for technical training, in connection with inventions, is in the drawing up of specifications and claims to accompany applications for patents, and also in legal practice connected with patent cases. The inventor needs both legal and technical advice in preparing his claims and specifications, and his rights are apt to be endangered or sacrificed if such advice is not well founded. It is here that questions of "equivalent devices," of "novelty," and of "usefulness" should be profoundly considered. Although such questions, in case of litigation, must be finally decided by the Courts, yet vast expenditures in the aggregate, both of time and money, depend on a correct analysis of an invention and a proper statement of the specifications and claims of the inventor. This involves the competence and technical acquirements of the solicitor or agent; and there is no doubt that this branch of professional practice has been placed upon a more certain and secure basis of late years through the influence and teachings of our technical schools.

In cases of patent litigation, expert testimony has become a necessity. Questions of fact involved are not, as in other cases which come before the courts and juries, matters of observation merely, but depend often upon a proper interpretation of observed phenomena in a realm of knowledge which often lies beyond the comprehension of unskilled or ordinary witnesses. On account of the great extent of the various fields of art and industry which offer opportunities for new and useful discoveries or inventions, the Courts are obliged to avail themselves of the knowledge of special witnesses, who from their education and training are presumed to be competent to make explanations, to give sound advice, or to express opinions based upon the infallible laws of science and nature. Expert witnesses often take a partisan view of their positions it is true, and consider themselves in duty bound to try to win the cases on which they are engaged. While this is an evil, the tendency of which is to bring all such expert testimony into contempt, yet the discrimination of the Courts is a corrective influence through which the truth is finally established.

Among the important influences arising from the more general dissemination of exact knowledge in the applied sciences through technical schools, is to be considered also the ability of the public to detect and reject what, for an invention, is falsely claimed or pretended. The utility of an invention is a question of practical demonstration; and while many valuable discoveries or devices undoubtedly fail to be brought into use for want of means to procure thorough and exhaustive tests, yet many on the other hand absorb large sums of money in fruitless trials, when a simple scientific investigation would at a comparatively small cost have demonstrated their commercial or industrial inutility.

If the history of the scrap-heaps of our machine shops could be written there would be a startling exhibit of money wasted in such unnecessary experiments. It is true that without trials of some sort there could be no progress, but there is a vast difference between experiments based upon sound principles and reasonable probabilities of success, and those undertaken upon scientific fallacies. It is precisely here in the distinction of what is possible and probable in the use of an invention, and what is impossible or extremely improbable, that exact technical knowledge lends its powerful aid, saving money on the one hand or promoting what is useful on the other.

When those who have superabundant means are induced to aid in costly experimental trials of an invention, success or failure is to them a matter of small moment, but to those who are persuaded to risk their small savings in the success of a patent the matter is more serious, and their greatest safety lies in the increase and diffuson of popular scientific knowledge.

Perhaps at no time during the progress of invention has the necessity of safe-guards against unsound projects been greater than at present. The marvelous successes, financially, of a few patents during late years, while stimulating the inventive spirit, have also tended to create widespread desire among certain classes in all communities to invest, in what, in a certain sense, may be called the "patent lottery." An announcement of a discovery of a new source of power, or of methods by which known sources of power may be economized to a degree beyond all present belief or expectation, and the arts of progress thus practically revolutionized, is one which is sure to command the attention and to enlist the aid of persons, here and there, who know just enough of the laws of energy to make them easy victims, but who with a little better knowledge might have saved themselves and others from serious pecuniary loss. At one time it is the bi-sulphide of carbon engine, which is to save two-thirds of the coal now used by the steam engine. An inventor imagines that the vapor of sulphide of carbon if interposed as a working fluid between the steam boiler and the condenser will in some undefined way increase enormously the power derived from the combustion of a given amount of coal in the boiler. He induces a few friends to aid him in an experimental trial, which is apparently highly satisfactory; a company is formed with an immense capital, the stock, under an inflated scheme, sells at high prices; a few make money by the sale of the stock, but the many stockholders suffer the loss of their investments.

At another time it is discovered by some genius that naptha mixed with steam at the nozzle of a steam pipe and directed upon incandescent fuel furnishes a brilliant combustion and a high temperature, and the discoverer becomes possessed with the idea that the steam is burned—that he has found a process for burning water. A cheap apparatus for showing the phenomena is exhibited; extravagant possibilities are claimed for the invention and the inventor proceeds to sell "territories," realizing a handsome fortune. And although he may possibly honestly believe in his invention, through ignorance, yet, like the other, it fails to produce the enormous results claimed for it.

A complete revolution in the propulsion of vessels in navigation is another prolific theme. An inventor imagines that the great secret of economy and speed lies in jet propulsion. A new idea is propounded, that a very small jet of water driven by pressure at a high velocity from the stern of a vessel is the long looked-for, but hitherto unrecognized, secret of obtaining at the same time great velocity and economy. The "ocean greyhounds" are to be sent across the Atlantic in thirty hours, being propelled by a jet of water a few inches in diameter, forced at a high velocity from the sterns of the ships.

These are not ideal cases, but are unfortunately taken from real life—from actual occurrences during the last decade. The money lost and the time lost in costly attempts to demonstrate what could have been proved to have been fallacious might have been saved to those who were misled, if they had been willing to listen to a few plain, simple explanations of the laws of applied science in the first instance.

The new science of energy, to which reference has been made, has not only furnished clear and definite ideas of the relations to each other of the various sources of power in nature, but has defined the limits, respectively, of their useful and economical applications, and the most elementary scientific discussion of such cases as are above given, illustrative of efforts to find new and extraordinary sources of power or methods hitherto unknown of applying to useful work those sources of power which are known, would have been sufficient to have shown the fallacies under which the attempts were conceived and executed.

Important inventions leading to widespread improvements in the arts or to new industries do not come by chance, or as sudden inspirations, but are in almost every instance the result of long and exhaustive researches by men whose thorough familiarity with their subjects enables them to see clearly the way to improvements. Almost all important and successful inventions which have found their way into general use and acceptance have been the products of well-balanced and thoughtful minds, capable of patient, laborious investigation, and have been prompted mainly by the hope or sentiment of giving something useful to mankind.

This sentiment has characterized the labors of the men in this country whose names make up a long roll of illustrious inventors, and whose works have not only contributed largely to the national prosperity, but have exalted the national reputation.

These are not the men who proclaim in advance the great value of their devices, and endeavor to reap rich profits before the utility of their discoveries has been demonstrated; but on the contrary, among the names composing the long list of public benefactors, whose inventions have given substantial benefits to millions, are found those of men who have received little reward for their personal sacrifices, when a grateful people would have been glad to have showered upon them both pecuniary benefits and public honors.

So rapid is the progress at the present day of both practical and scientific discovery that there is a universal consciousness of the existence of a sort of intellectual *vis viva* in practical and theoretical science, which, reversing the law of material or kinetic energy, seems to increase in proportion to the resistances which have been overcome. Theory and practice have become thoroughly united, the deductions of the former being instantly brought into use by the latter, while both contemplate for the future greater achievements based upon the strong foundations of the past and present.

Electrical, Physical, and Chemical Laboratories were never more active in leading the way for the Engineer, the Metallurgist, and the Manufacturer to follow in the tide of industrial and manufacturing progress; and never before has there been a time when so many young men, splendidly equipped for the work before them, have been added yearly to the ranks of scientific workers.

The field of invention thus grows larger and its aims higher. As one branch of practical knowledge becomes in a degree exhausted to the inventor another springs up to take its place.

In this great and continued movement every man is a benefactor who contributes to that kind of useful knowledge, whether it be theoretical or practical, which increases the conveniences and comforts of living for the great masses of the human race, and through the influences which he thus helps to create, lifts them up to higher planes of intellectual and social life.

With all such workers Technical Schools are in full sympathy and active alliance.

THE INVENTION OF THE STEAM ENGINE.

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There can be, as it seems to me, no more fruitful and interesting subject of investigation and study, in the history of the race, than that which notes the influence of the earlier and the later methods in philosophy upon the material progress of the world, and which observes the result of the introduction of great inventions into the midst of a society, on the one hand, absolutely without sympathy for that inclination which stimulates the contriver, and without ambition to avail itself of the advantages offered by his inventions, or, on the other hand, among people hungry for them, and for the advantages which they promise.

Of this difference between the older and younger civilizations, between Greek and Roman and modern Anglo-Saxon, no better illustration can be found than in the History of the Growth of the Steam Engine. Known two thousand years or more ago, it was made a toy by the speculative and unutilitarian Greek; tendered by Watt to a modern world, it is made the foundation of all material and even intellectual progress. Greece and Rome, like their predecessors Babylon, Nineveh, Thebes, and Karnak, reaching a certain point in their civilization, stood comparatively at rest, and presently only changed to retrograde, while handing on their civilization to later representatives of human advancement.

The world of the nineteenth century moves on with a mighty and accelerated velocity; gaining more in a century than all mankind had advanced in its whole previous history.

It is to Science, pure and applied, that the world owes all these wonderful advances that we are witnessing now, even more than in the immediate past. It is to the *truth-loving* quality of Science that we owe the recent rapid growth of the arts. Only the exact truth is sought, and everything yields to fact. "For her the volume of inspiration is the book of Nature, of which the scroll is ever spread before the eyes of every man. Confronting all, it needs no societies for its dissemination. Infinite in extent, eternal in duration, human ambition and human fanaticism have never been able to tamper with it. On the earth it is illustrated by all that is magnificent and beautiful; on the heavens its letters are suns and worlds." The study of science, directed, as it usually seems to be, to the improvements of the physical condition and the surroundings of Man, actually leads, very directly and promptly, to the improvement of his moral and intellectual character. It gives him the means of performing all necessary work in a shorter time than formerly, and thus sets free the intellect and the soul to carry on their highest work. The applications of science to the useful arts not only give us better and cheaper clothing, a greater variety of wholesome food, and means of rapid and easy transportation, but permit man to think out, in more and more frequent leisure moments, occasional leisure hours, the problems of life, to adjust himself better to his environment, to consider the needs of his fellows, to find opportunity for exercise of his sympathies, to improve his intellectual powers, to acquire knowledge on which to exercise them, to think out the great moral problems of life and of death, and to thus ascend into a higher and better atmosphere, a nobler sphere in a boundless universe of mind.

No one has summarized the work of science in this century better than Macaulay: "It has lengthened life; it has mitigated pain; has extinguished diseases; has increased the fertility of the soil; given new security to the mariner; furnished new arms to the warrior; spanned great rivers and estuaries with bridges of form unknown to our fathers; it has guided the thunderbolt innocuously from heaven to earth; it has lighted up the night with splendor of the day; it has extended the range of human vision; it has multiplied the power of the human muscles; it has accelerated motion; it has annihilated distance; it has facilitated intercourse, correspondence, all friendly offices, all dispatch of business; it has enabled man to descend to the depths of the sea, to soar into the air, to penetrate securely into the noxious recesses of the earth; to traverse the land in cars which whirl along without horses; to cross the ocean in ships which run many knots an hour against the wind. These are but a part of its fruits, and of its first fruits, for it is a philosophy which never rests, which is never perfect. Its law is progress. A point which yesterday was invisible is its goal to-day, and will be its starting point to-morrow."

The intellectual, and largely the moral, progress of mankind depends, in a very great degree, upon the material progress of the race; but this in turn is the product of the labors of the inventor and the laboring classes. The gain of wealth, on which we must inevitably and always depend for any real and permanent advance in whatever field, must inevitably and always in turn depend upon two principal results of the work of the engineer's, the inventor's, the mechanic's brain: (1) the reduction of the cost, in money or in labor as the best gauge, of those necessaries of life and of progress which are in their use subject to destruction, such as food, clothing, protection from the weather; (2) the rapid and permanent accumulation of the permanent forms of wealth, such as constitute the real measure of prosperity and give to a nation the comforts and luxuries which are either essential or conducive to leisure and thought, to intellectual development and moral growth. Poverty and enforced asceticism give unquestionably large opportunity for the development of certain phases of the strongest characters, but only leisure and voluntary asceticism can produce the highest development of character and mental growth combined.

It is to the producer of every facility for the cheap supply of perishable and destructible necessaries that we must mainly look for aid in the laying of a foundation for continual progress in higher fields. It is to the inventor and mechanic that we must appeal mainly for the means of easily sustaining life while seeking time and opportunity to give to the race the means and the opportunity to advance to a higher plane in civilization and mental existence. It is the wonderful result of the work of the inventor in the past century, largely stimulated by modern scientific knowledge, and perhaps even more by modern methods of legal encouragement of the inventor, and of assuring to him the full possession of the fruits of his brain, that we owe the marvelous gain of a century. Watt would have accomplished little had he not at the very start hit upon the scientific principles of the steam engine. He would probably have accomplished little except for the patent system. He would hardly have had the heart to attempt much, even then, nor probably would his financial partner and backer, Matthew Boulton, have felt it safe to invest his capital, no less essential than the invention itself, in such an enterprise had not the new patent system furnished him security for the investment required—in shops, tools and financial operations attendant upon the introduction of the new machine. Machinery and the patent system are the basis of the world's prosperity to-day. Watt made inventions and the capitalist furnished the means of their construction and use, while the patent system gave security to both inventor and capitalist, and assured them of fair return of their investments of time, thought and money.

As has been often suggested, a new invention is simply the materialization of a new idea of scientific character and useful purpose; an idea capable of supplying to mankind new comforts, new conveniences, new safeguards against want, pain, disease and death. Every new advance, even in pure science, is sure of ultimately finding use in the advancement of the race materially and, indirectly, intellectually and morally. The perfection of a science is the means of perfection of an art, and the improvement of the arts is the direct means of promoting the highest as well as the lower interests of mankind. It is thus that it has come to pass that "Machinery, actuated by the forces of nature, now performs with ease and certainty work that was formerly the drudgery of thousands. Every natural agent has been pressed into man's service—the winds, the waters, fire, gravity, electricity, light itself!" On the shelves of my library stand, side by side, as I observed a few days ago—so placed by some curious accident—a copy of the tales of the "One Thousand and One Nights" and two or three little volumes of stories of inventors and their inventions, and of modern discoveries. Comparing these two sets of fruits of the human intellect, I find the results of the "scientific use of the imagination" on the whole far more impressive and, in many respects, far more marvelous—not to say, to the unfamiliar mind, more incredible—than those of the romancist.

The military art has always been the sustainer, as it was originally the parent, of the mathematical and physical sciences. The Greek camp and Alexander's army were the progenitors of the great school of Alexandria. Alexander the Great was the progenitor of the intellectual offspring of Archimedes and of Euclid, as of the the theories of Newton, and ancient Greece has been the source of inspiration of all modern life. The polytechnic schools of Alexandria substituted for the speculative methods of Plato the logical philosophy of Aristotle ; they employed the reason in place of the imagination in all physical and scientific departments of knowledge. The home of Eratosthenes and of Hipparchus and of Ctesibus, the instructor of Hero, was the successor of the camp of the Grecian conqueror, and, conquests being ended, real knowledge became the object of ambition. Speculation gave way to investigation, and the triflings and aimless disputations of the older schools were succeeded by the serious labor of research and of the accumulation of real knowledge. This serious and fruitful labor gave an impulse that was never wholly lost, though often seemingly almost extinguished by the combined forces of the political and the military spirit of later times. A thousand years of trifling, the whole period of the dark ages, could not wholly destroy it.

In the history of the world there have been two distinct periods of marked advance; the one mainly philosophical, the other mainly material. These are the times of the Greek philosophers, and notably of the growth and prosperity of the Alexandrian school, and the times which have brought us a modern civilization—the three centuries just closing. The earlier period "died with Hypatia" of Alexandria, and the later began with Newton, and is still in full career. Both these periods have been distinguished by a singular freedom of intellectual opinion and growth. In the days of Aristotle, of Sophocles, of Plato, as of Archimedes, of Hero, of the Ptolomies, whatever may be said of the political status of the citizen, his opinions were his own, and his intellectual freedom was absolute ; the conflicting sects and philosophies of that time were simply the free growth of mind unrestrained by social or ecclesiastical bonds. In these later days we are just regaining a somewhat similar freedom of intellect, through the all-pervading influence of modern scientific methods and principles. That political freedom which has just begun to come to the citizen of even the monarchies of Europe ; that social freedom which has its best illustrations, as well as its most grotesque monstrosities, in the United States ; that intellectual freedom which stimulates, as well as permits, advance in every department of modern life, in science, religion, invention, in all the arts : all these forms of freedom are but phases of one mighty development of human progress distinguishing our own time. It is all precisely the same universal unrestraint, coming of a common cause, taking its effect primarily in political changes, so far as visible, and marking simply that impulse which is exhibited in any direction in which great forces have been long resisted and restrained, finally to be given vent, and thus allowed to expend the long-stored energy in a mighty, and often unanticipated, outburst. The improvement of the steam engine has been one of the consequences of the same train of events which gave England her Magna Charta, and the United States a republican form of government ; which produced a science of chemistry, and established modern views in astronomy and geology.

The middle ages were periods of repression ; the later days have seen the resultant expansion. During their whole extent the transfer of learning from Alexandria to Bagdad, to Granada ; the distribution of Saracen colleges throughout Western Europe ; the slumbering of intellect in the countries dominated by the church during those centuries ; all were simply the transfer and the storage of energies, the aggregation of the forces of progress, preparatory to their grander action in the days following the martyrdom of Bruno and of Galileo, the events marking the dawning of a new era.

In those older days, when Greek and Roman founded a literature and a philosophy that has been a guide and an inspiration throughout all subsequent times, the inventor and the builder was at a disadvantage ; his brain was trammelled by the difficulty of getting his ideas crystalized in metal and in wood. To-day he can make whatever he can devise ; then he could devise a thousand new instruments, processes or machines, and not one of the thousand might be practically possible. To-day, our progress is only limited by the rate of accomplishment of the brain and its production of representative ideas.

When a stone falls to the ground, from a lofty height, it starts from rest with an imperceptible motion, gradually increases its speed by a regular acceleration, and, falling faster and faster, finally reaches the ground with an acquired velocity that can only be compared to that of a cannon-shot. The alpine avalanche, slowly sliding along the smooth surfaces of rocks and soil at the mountain top, exerting a power that a child might successfully oppose, gathers energy as it moves, increasing its speed, storing more and more power as it slides over the declivity, affects larger and larger masses, and, at last, descends into the valley below with the roar of a tempest and the destructive effect of a thousand torrents, moving downward with the velocity of a lightning-flash. To one who reads the history of the development of civilization among mankind, from the earliest days of the oriental empires to the present, this same universal law of accelerated progress seems to come in play in the origination and perfection of the sciences, the literatures, and the arts. The dawning of civilization among the ancients was but recording in a scanty literature the wanderings, the speculations, the imaginations of adult children, interspersed with the gossip and tradition of verbal history. Science had no place in their pantology; the arts had only made the most simple beginnings in the provision of the merest necessaries of a most simple life. Progress was hardly perceptible, century by century; the people of one age lived much the same as did those of the preceding; "what was good enough for grandparents was considered good enough for grandchildren," and invention and discovery were words of little import. Homer probably knew no other literature than the epic; the builders of the pyramids were unacquainted with any other mechanism than the simplest devices called by us, today, the mechanical powers. Hero and the Greeks were familiar with the expansive force of steam, but they had no way of using it in the arts, and their only steam engine was the aeolipile, a whirling globe, impelled by the reaction of steam jets. The first principles of scientific method and the simplest facts of science were unrecognized by the people of the time of Christ and the Romans. Menelaus and Achilles took their armies to the coast of Troy in boats impelled by sails and oars; and their troops fought with arrows and spears; Alexander conquered the world of his time ignorant of gunpowder; Cæsar conquered Gaul and wrote his commentaries unaware of the potentialities of artillery and of the printing press; and the dark ages that intervened, to the times of Galileo and Newton, were unenlightened by even the intelligent anticipation of gas or the electric light.

Our own ancestors of a century or two ago knew absolutely nothing of any one of the most useful inventions or discoveries that seem to us to-day to be so essential to our comfort, except the one art of printing. The perfection of the steam engine has been the work of this century; the introduction of the telegraph, the railroad, the steamboat, of the telephone and of the power press, are all the work of mechanics and men of science with whom our own parents and grandparents were acquainted, or who are our own contemporaries. The lever, the wedge, and the screw were the great inventions of the ancients. The mariner's compass, and the art of printing, the the introduction of firearms and artillery were the gauges of the progress of the world in the middle ages, while our own times have seen an innumerable list of inventions contributing to the comfort of humanity and its better life.

To one who has read of the rude beginnings of science, and of the arts in the times of the Greeks and Romans, of the Oriental civilizations, of the Egyptians and of the Saracens, and who has noted the slow progress of the world through the middle ages and who has observed the culmination, possibly, of this acceleration in the productive century in which we live; to one who has studied the growth of the steam engine from the toy of Hero of Alexandria, two thousand years ago, through the various rude and ineffective devices of the intermediate centuries, to the time of Worcester, of Savery, and of Newcomen and the wonderful outcome of the work of James Watt; who has seen the steamboat grow from the little craft of the time of Fulton and Stevens to the shape of the floating palaces on Long Island Sound and the great steamer of 10,000 tons burden, carrying a thousand passengers across the Atlantic at the speed of a railway train, and the mighty iron-clad, almost impenetrable by the heaviest ordnance, and itself throwing tons of steel shot at a broadside miles through the air, starting with a velocity double that of sound itself; to one who has witnessed the development of the railroad from an insignificant beginning only a little more than a half century ago, two generations at most, to its present state, with its forty, fifty, and one hundred-ton locomotives, its thousand tons of train, conveying food and comforts across a continent at a cost of less than a cent per ton per mile, bringing to the laboring man on the Atlantic coast a barrel of flour a year for each member of his family, from Minnesota, nearly fifteen hundred miles away, for less than a dollar; with its magnificent train of palace and sleeping cars rushing from New York to Chicago, a thousand miles in twenty-four hours, or swinging in tremendous power across the continent to San Francisco in four days; to one who has wondered at the beautiful applications of electric science to the purposes of life and business, as illustrated in the the telegraph, transmitting its message in the lightning-flash from continent to continent and around the world, or in the telephone, bringing friends, miles apart, *tête a tête*, or in the electric light, turning night into day and driving crime into its remotest dens, while giving all the industries the power of doubling their productiveness; and to one who has seen the modern power-press printing newspapers by the mile, cutting and trimming them to size, folding and wrapping them for transmission to distant readers by a system of mail distribution which equally well illustrates the progress of the age in methods and organization and industries: to one who has perceived all this, the thought must inevitably come that there must be a limit to such speed of advance as we are now witnessing, and the law of acceleration must sometime cease to operate; and the question must suggest itself—Where is the limit? What is coming in the future of the race? What are the possibilities? What wonders may we expect that Science may still discover? What may probably be their effect on the life of the world? What are likely to be the characteristics of the "Coming Race," of its social life and of its moral, its intellectual, its physical conditions?

Bulwer drew upon the imagination of a romancer for his ideal of the future. What may the imagination of a man of science perceive, guided by his more rational view of the past, of the present, and of the general course of progress in invention and discovery?

In all of the great operations of Nature the course and the rate of movement are determined by the well-known principle of the "persistence of energy" and by that of the Law of Newton, asserting that she invariably endeavors to preserve the existing condition of motion, and that all motions tend to continue uniformly to follow a right line, resisting invariably every tendency to effect a deviation from the existing course, with a power which is proportional to the rate at which such deviation from the motion of the moment is forced. Nature never turns a sharp corner, and we may probably as well judge the future of the great intellectual and social movements by the laws of energy as anticipate physical motions.

In writing the history of the "Growth of the Steam Engine" years ago, I divided it into three periods, that of speculation, that of development and application; that of refinement or improvement in detail. The first period is that of Hero and the Greek speculative philosophy, the second that of Watt and his predecessors in the invention of the machine, that of the opening of the modern epoch; and the third is that comprising the whole of the present century, with all its wonders; it is the outcome of the last, the fruit of a minute seed planted in the first of these eras. The men to whom the world is to-day indebted mainly for all that it enjoys of material advantage, and for the opportunity to improve it by the intellectual advances which have accompanied the production of modern comforts and luxuries, are, more than any other, Hero of Alexandria, and his contemporary, possibly, Archimedes; Papin, the Marquis of Worcester, Captain Savery and Newcomen, and most of all, James Watt. Let us inquire who were these men and what their surroundings, and how they brought about the marvelous changes that the octogenarian of to-day has become familiar with as the outcome of their combined efforts.

Hero was born amid the Greeks at perhaps the most interesting period of their history, philosophically considered. The biography of Alexander, the history of the wars of the Greeks, have little importance or interest in comparison with the life of the earliest engineer, permanently recording the invention of the steam engine, and the history of the intellectual awakening that marked his time. Hero's "Pneumatica" is the first record of invention. It only gives us a definite idea of the extent to which the people of that day were familiar with the possible application of the forces of nature to the uses and purposes of mankind. The account is as simple and ingenuous as the devices themselves are simple and undeveloped. It is the description of toys to which interest attaches only because of their revelation of the condition of ancient useful arts and of the fact that they constitute the germ of mighty inventions of of later date. But Hero lived at a time when great inventions were not appreciated, were not even thought of as having possible value in application to the amelioration of the condition of humanity, and were quite impossible of construction, if ever so much desired, because of the fact that no machinery for their construction could then be had. So it happened that the toy steam engine, curiously enough a very perfect type of steam engine scientifically considered, lay unused, a germ only, like the grain of wheat in the hand of the mummy, for two thousand years, finally to take a new life of wonderful works.

Now and then one of the old philosophers hit, by some happy accident in the course of his speculations, upon some notion of the nature of heat and energy which was not far from what we now know to be true. But we also have seen that then it was the fact, as Democritus remarked to the old philosopher: "Nothing is true; or, if so, is certain." Knowledge had in ancient times no stability; and science, in the modern sense of the term, had no existence. But it was otherwise in the domain of application, and the work of the ancient artisan and the development of the mechanic arts among the old Greeks and Romans and their predecessors of India, Persia and Egypt command our respect and admiration. When the lack of facilities possessed by the older nations is considered, their success in the construction of their temples, in the erection of the pyramids, in their naval architecture, is to the modern engineer almost as impressive as would many of our grandest achievements be to them could they return to earth and study the progress made since their own times. No more beautiful edifices are built to-day than existed in the times of ancient civilizations; no modern workman can excel in the perfection of his joints and surfaces those observed, still hardly defaced by the centuries, in the great pyramid and its neighbors; the lines of the ancient war galleys, and of the Scandinavian craft, even of the earlier periods, were as fine as those of the finest yachts of our own day. The ancestors of the ancient philosophers honored the artisan, and their gods were the idolized hero-mechanics of earlier times. Labor was rewarded by the greatest honors that the nation could confer. It was not surprising, therefore, that some advances were made, in even those ruder times, in the mechanic arts.

The reasoning of the old philosopher, Hero, in regard to the physical phenomena involved in the operation of his machines is interesting, as illustrating the state of the science in his time. He introduces the description of the apparatus which has been described by a treatise on the nature of air and the character of the vacuum. He shows that vessels which seem empty are in reality full of air, and proves his assertion by the following considerations and crucial test: "Let the vessel which seems to be empty be inverted into the water. It will be seen that it will not admit the water, although it may appear perfectly vacuous. If a hole be bored in the reversed bottom of the vessel air will issue, and the water will then enter." "Hence it must be assumed that the air is matter." Further: "If a light vessel with a narrow mouth be applied to the lips, and the air be sucked out and discharged, the vessel will be suspended from the lips, the vacuum drawing the flesh toward it that the exhausted space may be filled. It is manifest from this that there was a continuous vacuum in the vessel." Cupping glasses, which were then already known and in common use, were cited as illustrations of a similar operation, the fire placed in them rarifying the air, and the vacuum being thus produced. "Winds are produced by excessive exhalation, whereby the air is disturbed and rarified, and sets in motion the air in immediate contact with it." "It may therefore be affirmed that every body is composed of minute particles, between which are empty spaces less than the particles of the body (so that we erroneously say that there is no vacuum except by the application of force, and that every place is full of ether, air, or water, or some other substance), and in proportion as any one of these particles recedes, some other follows it and fill the vacant space; so that there is no continuous vacuum except on the application of some force; and again the absolute vacuum is never found, but is produced artificially." "These things being clearly explained," the author goes on to consider the methods devised for the application of these principles to his purposes.

The fact that none of these contrivances were, so far as the records show, applied to the promotion of the useful arts in the sense in which that application has taken place in modern times and has thus so wonderfully accelerated the advance of civilization, is probably an indication that the non-utilitarian spirit of the Platonic philosophy, and of the whole learned Greek world, indeed, pervaded the ranks of the people too thoroughly to permit them to profit to any great extent by the inventions of their great mechanicians; who, indeed, seem to have been inclined much more to the gymnastic than to the useful employment of their talents.

This inclination to the display of ingenuity rather than promotion of useful arts was transmitted to the Romans also, and the only account extant of such illustrations of the inventive power of that nation are those relating to contrivances of machinery of war and such curious applications of the genius of the inventor as may have attracted the attention of the classes of leisure and those engaged in scholarly pursuits. Perhaps the only well-known example of such ingenious perversion of what might have been useful powers is the following, given us by Gibbon in his "Decline and Fall of the Roman Empire"—

"In a trifling dispute between Anthemius, the architect of Justinian, and Zeno, the orator, relative to the wells or windows of their contiguous houses, Anthemius had been vanquished by the eloquence of his neighbor Zeno; but the orator was defeated in his turn by the master of mechanics. In a lower room, Anthemius ranged several vessels or caldrons of water, each of them covered by the wide bottom of a flexible tube, which rose to a narrow top, and was artificiallly conveyed among the joists and rafters of the adjacent building. A fire was kindled beneath the caldrons; the steam of the boiling water ascended through the tubes; the house was shaken by the effect of the imprisoned air, and its trembling inhabitants might well wonder that the city was unconscious of an earthquake that they had felt; and the orator declared, in tragic style, to the Senate, that a mere mortal must yield to the power of an antagonist who shook the earth with the trident of Neptune."

What has been referred to comprises nearly all that is known, and probably about all that the ancients themselves knew, of the work of their greatest engineers and philosophers in the field here explored. Centuries of strife and hardly-ever ceasing wars followed the fall of the Roman empire, and the arts of peace suffered retardation, rather than advanced. There was, however, an undertow of movement among the more scholarly and the more industrious peoples; and the transfer of the learning of the ancients to the modern times through the Saracen dominion and the progress made by the pagans of the middle ages, were the means of preserving the seed of that later and wonderfully grand outgrowth which has distinguished the three centuries now coming to a close. During this period, also, the Church which was always the anchor of scholarship, though often the direst foe to science, of real knowledge of the Creator through his works, not only organized its own materiel and personnel into a most effective working apparatus for the promulgation of its tenets, but also provided a system of education, and a working educational organization, that, once it was permitted, by that freedom of personal thought which came of the Reformation, to seek knowledge in every field and to accept the logical results of every investigation in science and in morals, became the most effective possible means of promoting true learning. While therefore, the middle ages seemed to be a period of intermitted growth in all but the sience and art of war, it was realy a time of readjustment, of rearrangement, of the various classes of Europe, and was preparatory to such a movement of the great underlying forces as should finally give opportunity for the most rapid progress, once that progress should begin on the new lines and in the new ways that distinguished the later period of onward motion of the great current.

A more complete idea of the extent to which the inventive talent of the ancients was fruitful of result in practically useful directions may be gained by studying, in addition to the accounts of Hero and others of such curious devices as have just been described, those of other authors telling of the various apparatus of war, and for naval purposes, which were invented by the engineers of the Greek and Roman armies and navies. Works on Greek and Roman antiquities describe the rams used for battering down the gates and walls of beleaguered cities, some of them a hundred and twenty feet long, and weighing thousands of pounds, many tons; in fact, so large that it required three hundred pairs of horses or mules to draw them, and fifteen hundred men to operate them when mounted ready for the attack. They were great beams of wood, sheathed with iron, and, often, covered by an arrow, and perhaps bomb-proof house which protected the soldiers while working the ram. Their engineers constructed towers, called sometimes, *helepoleis*, or city-takers, which, according to Vitruvius, were ninety feet high, in ten stories, and twenty-five feet square at the base, as a minimum; while the largest were a hundred and eighty feet high, in twenty stories, and thirty-four feet square at the bottom. They were mounted on wheels, and from them, when advanced to the spot from which the enemy was to be attacked, engines contrived for the purpose threw stones and other missiles into the city and upon its walls. Machines for throwing arrows and stones were frequently employed, and were often of enormous size and power. Similar engines were built to mount upon their ships; while the vessel itself was converted into an engine of tremendous power by arming its bow with a beak, or "ram," and using the craft precisely as the iron-clad "ram" is employed in modern naval combats. Indeed, the submerged ram now universally adopted for such vessels was the invention of Aristo, the Corinthian, and was itself an improvement upon other forms of ram-bow, long before in use.

The ancients were evidently not deficient in ingenuity, in a talent which is the distinguishing characteristic of our time and people; but in mechanics, as in philosophy, their tendency was always toward the consideration of the ideal and the imaginative, rather than toward the useful and directly helpful in practical directions. Philosophers and mechanicians, scholars and artisans, alike, admired the ingenious and speculative, rather than the productive and the practical. They had departed from the primitive ideas of their progenitors to whom they owed their theology and who had named their gods. They had come to a period in the development of their society which must necessarily result in a cessation of advancement, and a stationary era in their civilization.

The age of the dreamer is the period of rest preliminary to stagnation or even retrogression. The ancient civilization, so called, was the culmination of an earlier movement of which history only exhibits to us the later stages, and which was the prelude to a relaxation, in turn the preliminary to another advance. So it happens that the mechanic arts and their grandest achievments, as illustrated by the engineer of to-day, of the man who, combining intelligence with learning, scientific attainments with the power of practical accomplishment, meets every demand of the age, whether for a railroad or a steamship, a telegraph line or an electric-lighting establishment, could no more have been the outcome of ancient ideas and of ancient methods than could the old philosophers have given rise to modern science. The profession of engineering, like that of the physicist or of the chemist, is thus essentially a product of recent phases of civilization. They are all as much the product of the inductive methods as are the sciences themselves. The systematic collection of knowledge, the systematic arrangement of the phenomena and facts of nature into sciences, the systematic promotion and dissemination of learning, modern systematic education, have set the world in motion and with an accelerating velocity, and the modern methods of thought, in all departments of knowledge, of research in all branches of learning, of education, general and liberal, technical and professional, have produced a new heaven and a new earth for mankind.

Thus as remarked by Prof. Youmans*: "In the history of human affairs there is a growing conception of the action of general causes in the production of events, and a corresponding conviction that the part played by individuals has been much exaggerated, and is far less controlling and permanent than has been hitherto supposed. So, also, in the history of science it is now acknowledged that the progress of discovery is much more independent of the labors of particular persons than has been formerly admitted. Great discoveries belong not so much to individuals as to humanity; they are less inspirations of genius than births of eras. As there has been a definite intellectual progress, thought has necessarily been limited to the subjects successively reached. Many minds have been thus occupied at the same time with similar ideas, and hence the simultaneous discoveries of independent inquirers, of which the history of science is so full."

Writing of the extraordinary importance of the discoveries and researches which, in the nineteenth century, closed this wonderful progress, Dr. Youmans says:

"An eminent authority has remarked that 'these discoveries open a region which promises possessions richer than any hitherto granted to the intellect of man.' Involving, as they do, a revolution of fundamental ideas, their consequences must be as comprehensive as the range of human thought. A principle has been developed of all-pervading application, which brings the diverse and distant branches of knowledge into more intimate and harmonious alliance, and affords a profounder insight into the universal order."

But the consequences of the establishment of the identity of heat and motion, and of the fact that the various forms of energy produced by the various methods of motion of matter, were, if possible, even more important than were the facts just outlined. Once it was perceived that heat and light were forms of motion and energy, it became promptly seen that electricity was also a similar phenomenon, and the question arose whether the vital forces, and all other observed phenomena distinctive of the production of movement and the performance of work, in whatever department of nature, might

* Correlation of Forces; N. Y.: D. Appleton & Co.

not be also similarly related, each to all the others. The doctrines of the Correlation and of the Conservation or Persistence of Forces and of Energies, as these principles have come to be called, were soon seen to be the foundation of all natural science, and to bind all the sciences into one common and closely related system of laws, into a science called by Rankine, "Energetics."

Papin, Worcester, Savery were the authors of the period of application of the power of steam to useful work in our later days. The world was, in their time, just waking into a new life under the stimulus of a new freedom that, from the time of Shakespeare, of Newton, and of Gilbert, the physicist, has steadily become wider, higher, and more fruitful year by year. All the modern sciences and all the modern arts had their reawakening with the seventeenth century. Every aspect of freedom for humanity came into view in those days of a new birth. Both the possibility of the introduction of new sciences and of new arts and the power of utilizing all new intellectual and physical forces came together. The steam engine could not earlier have taken form; and, taking form, it could not have promoted the advance of civilization in the earlier centuries. The invention becoming possible of development and application, the promotion of the arts and of all forms of human activity became a possible consequence of its finally successful introduction into the rude arts that it was to so effectively promote and improve.

But the work of these inventors was in itself but little more important than that of the Greek inventor of the steam aeolipile, for each brought forward a machine which was, from a business point of view, utterly impractable, and which, in each case, only served to show that a better device might prove useful and to lead the way to its introduction. The merit of the inventors of the eighteenth century was that they were able to lead the way, to point out the path to success, to furnish evidence of the value of the coming, crowning invention. The "fire engines," as they were then called, of these now famous men, were merely contrivances by the use of which the pressure of confined steam of high tension could be brought to act on the surface of a mass of confined water, forcing it downward into pipes through which it was led off and upward to a higher level; and thus a mine could be drained, ineffectively and expensively, to be sure, but vastly more satisfactorily than by the animal power of the time. The machine of Savery was the best of all; but that was only a somewhat improved and manageable rearrangement of the engines of Papin and Worcester. And, after all, Papin, the greatest man of science, perhaps, of his time, died in poverty; Worcester languished in prison, and his whole life and the later efforts of his widow brought nothing by way of a return for his invention; nor did either they or their successor, Morland, make the introduction of the engine either general or remunerative. Savery, coming on the stage at more nearly the right time to seize upon the opportunity, gained more than either of his predecessors; but we have no evidence that he ever acquired any large compensation or met with any remarkable business success in the introduction of the rude engine which bore his name, nor did Desaguliers, the great philosopher, or even Smeaton, the great engineer of the later years of that century, make any great success of it. It was reserved for Watt to reap the harvest. But, though he so effectively reaped where his predecessors had sown, Watt is not the greatest of the inventors of the steam engine, if we rate his standing by the magnitude of the improvement which marked his reconstruction of the engine. It was Newcomen who made the modern steam engine.

When Newcomen came forward the labors of Worcester, in Great Britain, had sufficed to attract the attention of all intelligent men to the character of the problem to be solved and to convince them of its importance and promise. The work of Savery had shown the practicability of the solution of the problem, both in mechanics and finance. He succeeded, though under great disadvantages and comparatively inefficiently. Once the task had been performed, though ever so rudely, the rest came easily and promptly. The defects of the Savery system were at once recognized; its great wastes of heat and of steam were noted, and the fact that they were inherent in the system itself was perceived. A complete change of type of machine was obviously requisite. It was *this* which constituted the greatest invention in the whole history of the steam engine, from Hero's time to our own ; and to Newcomen we owe more than to any other man who ever lived, the value of the invention itself being considered and the importance of the services of its introducer being left out of consideration. No such complete and vital improvement and modification of the machine has ever been effected by any other man, Watt and Corliss not excepted. Newcomen and his comrade, Calley—we do not know how the honors should be divided—producod the modern steam engine. Its predecessor, the Savery engine, had been a mere steam "squirt;" Newcomen constructed an engine. Savery built a simple combination of cylindrical or ellipsoidal vessels which wastefully and at once performed all the several offices of engine, pump, condenser and boiler. Newcomen divided these several elements among as many parts, each especially adapted to the performance of its task in the most effective manner, the condenser excepted, for that was Watt's principal invention, and thus produced the first steam engine in the modern sense of that term. It was Newcomen, not Watt, who gave us the train of mechanism that we now call the steam engine. It is to Newcomen, rather than Watt, that we owe the highest honors as an inventor in this series of the most important of all the products of the inventive genius of mankind. Newcomen brought into existence a new, the modern, type of engine, and effected the greatest revolution that has been recorded in the history of the arts. Without Newcomen there might have been no Watt ; without Watt there very possibly may not even yet have been brought into existence that giant of our time, whose mighty powers are employed more effectively than ever those of Alladin's genii in building palaces, in transporting men and material, in doing the work of the whole world ; promoting the welfare of the race in a single century more than had all the forces of matter and mind together in the whole previous history of the world. Newcomen laid down a foundation beneath our whole economic system, out of sight almost, but the essential base nevertheless on which Watt and his successors have carried up the great superstructure which seems to us to-day so imposing, which is so tremendous in magnitude, importance and result. If to any one man could be assigned the credit, it is Newcomen who is to be considered the inventor of the steam engine.

James Watt, indisputably the great inventor that he was, found the steam engine ready to his hand; applied himself to its improvement, and made it substantially what it is to-day. His most important work, the most unique service performed by him was, however, that of its adaptation and introduction to do the work of the world. James Watt was the inaugurator of the era of refinement of the machine, already invented, and the greatest of its builders and distributors. His inventions were all directed to the improvement of its details, and his labors to its introduction and its application to the myriad tasks awaiting it. By the hands of Watt it was made to pump water, to spin, to weave, to drive every mill; and he it was who gave it the form demanded by Stephenson, by Fulton, by the whole industrial world, for use on railway and steamboat, and in mill and factory throughout the civilized countries of the globe. It was this great mechanic who showed how it might be made to do its work with least expense, with highest efficiency, with greatest regularity, with utmost concentration of power.

The grand secret of his success was historical and economic as much as scientific and mechanical. He brought out his inventions just when the world was economically and historically ready for them. The age of authority was past; that of freedom was come; the period of political and ecclesiastical tyranny was gone by, and that of the spontaneous development of man was arrived. The great invention was offered to a world ready and needing it, and, more than all, competent, for the first time in history, to make and use it.

James Watt was himself a product of the modern scientific spirit. He was a man so constituted, mentally, that he could apply scientific methods to problems which his logical and clairvoyant mind could readily and exactly formulate the instant he was led to their consideration in the natural course of his progress. He was the ideal great inventor and mechanic. With inventive genius he combined strong common sense—not always a quality distinguishing the inventor—clear perception, breadth of view, and scientific method and spirit in the treatment of every question. His natural talent was reinforced by an experience and an environment which led him to develop these ways and this mental habit. His trade was that of an instrument-maker; his position was that of custodian and repairer of the apparatus of Glasgow University. He had for his daily companions and stimulus the great men and ozonized atmosphere of that famous institution. He kept pace with advancing science, and was imbued, both naturally and through contact with its promoters, with that ambition and those aspirations which are the life-element of all progress, whether scientific or other. He was aware of the nature of the problems seeking solution at the time, and familiar with the state of his own art and that of the great mechanicians about him. Everything was favorable to his progress, so soon as he should be given an opportunity to take a step in advance and to come into sight at the front. The man and the time were both ready, and all conditions, internal and external, social and personal, were favorable to his development.

The invention upon which Watt was to improve was at his hand. A word in regard to its status at the moment will throw some light upon that of Watt and his creation. Newcomen had, as we have seen, produced the modern type of steam engine as an original and wholly novel invention. But this machine, marvelous as an advance upon pre-existing forms of the steam engine, was still, as seen in the light of recent knowledge and experience, exceedingly defective. The purpose of a steam engine is to convert into usefully applicable power the hidden energy of fuel, stored ages ago in the earth by transformation through the action of vegetation from the original form, the heat of the sun, into an available form for reconversion through thermodynamic operations. In this process of reconversion, whatever the nature of the machine used in the operation, there are invariably wastes, both of heat required for conversion into power and of the power thus produced. That machine which effects the most complete transformation of the heat supplied it into mechanical power, which wastes the least amount of heat supplied and of power produced, is the best engine, and constitutes an advance over every other.

It was this reduction of wastes that made the Newcomen engine so much superior to that of Savery. The latter was by far the simpler and less costly construction; but its enormous losses, both of heat and power, mainly the former, however, made it an extravagant expenditure of money to buy and use it. The Newcomen engine, costly and cumbrous, comparatively, nevertheless wasted so much less heat and steam and fuel that no one could afford to buy the cheaper machine. Before considering what Watt accomplished we may find it profitable to examine into the nature of the wastes which characterized this later and better machine on which he effected his improvements.

The Newcomen engine consisted of a steam boiler, a steam cylinder, a beam, and a set of pumps. By making the boiler do its work separately, the engine acting independently, and the pumps as a detached portion of the mechanism, this inventor had reduced to an enormous extent those wastes of heat and of steam and of fuel, which were unavoidable in the older machines in which all these parts were represented by a single vessel, or by two at most, in each element. In the Savery engine, the steam entering first heated up the interior of the working vessel to its own temperature, and held it at that temperature in spite of the cooling influence of the water present. This consumed large quantities of heat. It then was compelled to surrender probably much greater quantities still to the water itself, coming into direct contact, as it did, with its surface. If the water was agitated, either by the currents produced during its ingress or by the impact of the steam entering the vessel, this heating action penetrated to considerable depths, and perhaps even warmed the whole mass very far above its initial temperature. This constituted another and a very serious loss. Then, again, as the water was gradually driven out of the containing vessel by the steam pressing on its surface, new portions of the vessel and new masses of water were continually brought in contact with the hot steam, taking its full temperature, and thus often probably finally heating the whole mass of the forcing vessel, and a large proportion of the water as well, up to the temperature, approximately, at least, of the steam itself. Thus in many instances, if not always, vastly more heat and steam were wasted in this undesirable heating of water and forcing vessel than were usefully employed in the legitimate work of raising the water to a higher level. In fact, in some cases in which these quantities were measured, the wastes were one hundred times as much as the work done. One per cent. of the heat supplied did the work, while ninety-nine per cent. was thrown away. One dollar or one shilling expended for fuel to do the work was accompanied by an expenditure of ninety-nine dollars or shillings thrown away, because of the imperfections of the system and machine. The whole history of the development of the steam engine has been one of gradual reduction of these wastes, until to-day our best engines only compel us to spend five dollars for wastes to each dollar paid out for useful work. A business man would think that amply extravagant, however, and the man of science is continually seeking methods of evading these losses, a large proportion of which are now apparently unavoidable in heat engines, by finding some new system of heat and energy transformation.

Watt was the instrument maker and repairer at Glasgow University in the year 1763. His companions were, among others, the professors of natural philosophy and of mathematics in the University. Their conversation and their frequent presentation of practical and scientific questions and problems stimulated his naturally inquiring and inventive mind to the pursuit of a thousand interesting and promising schemes for the improvement of existing methods and machinery. Dr. Robinson, then a student, suggested the invention of a steam-carriage for use on common roads, and the young mechanician at once began experiments that, resulting in nothing at the time, were nevertheless continued in one or another form until all modern applications of steam came into view. Dr. Black taught Watt chemistry, then a newly-constructed science, and led him on to the discovery finally made by them independently of the fact and the magnitude of the latent heat of steam, the discovery coming of a series of scientifically planned and accurately conducted investigations, such as the man of science of to-day would deem creditable. The treatises of Deaguliers and others on physics gave Watt a knowledge of that domain of natural phenomena which stood him in good stead later, when he attempted to apply its principles to the reduction of the wastes of the steam engine.

It was while at Glasgow University, working under such influences and in such an atmosphere of intellectual activity, that the accident of the Newcomen model engine needing repair brought to the mind of Watt the opportunity which, availed of at once, made him famous and gave the world its greatest aid, its most powerful servant. The observing mind of the great mechanic immediately noted its defects, sought their causes, found their remedy. He discovered at once that the quantity of steam entering the cylinder of the little engine was four times the volume of the cylinder receiving it; in other words, three-fourths of that steam must be condensed immediately on entrance. This meant, evidently, that only one-fourth of the steam supplied was utilized, and even then inefficiently, in doing its work. The reason of this was as easily seen, immediately the fact was revealed. As Watt himself expressed it, the causes of this loss, causes which would obviously be exaggerated in a small engine, were: "First, the dissipation of heat by the cylinder itself, which was of brass, and both a good conductor and a good radiator. Secondly, the loss of heat consequent upon the necessity of cooling down the cylinder at every stroke in producing the vacuum. Thirdly, the loss of power due to the pressure of vapor beneath the piston, which was a consequence of the imperfect method of condensation." This much determined, the next step looked toward the confirmation of his conclusions and the remedy of the defects.

To meet the first difficulty he made a cylinder of wood, soaked in oil and baked, a non-conducting and non-radiating material. Then he was able to determine with some accuracy the quantities of steam and injection water used in the engine, and a comparison with the original cylinder, and its operation showed that not only four times the quantity of steam, but also four times the amount of injection water was used as was necessary, assuming wastes checked. Further scientific research on the part of Watt gave him measures of specific heats of the metals and of wood, the specific volumes of steam at various working pressures, the evaporative efficiency of boilers, the pressures and temperatures of steam in the boiler under specified conditions, the quantities of steam and of water required for the operation of his little condensing engine.

Then came his enunciation of the grand principle of economy in the construction and operation of the steam engine: "Keep the cylinder as hot as the steam which enters it," as he expressed it. This was Watt's guiding principle, as it has been that of all his successors in the improvement of economic performance of the steam-engine and of all other heat-engines. The great source of waste is the dispersion of heat, uselessly, which should be applied to the production of work by its transformation, thermodynamically, into the latter form of energy. The second form of waste is that of power thus produced in the unprofitable work of moving the parts of the engine itself, and the third is that of heat by transfer, without transformation, by conduction and radiation to surrounding bodies. In modern engines, the latter is but three or five per cent., in the best cases; the second waste constitutes perhaps ten per cent.; while the first of these losses amounts very usually to seventy per cent.; of which last one-third or one-fourth is of the kind discovered by Watt, the rest being the thermodynamic waste incident to all known methods of operation of heat-engines, and apparently unavoidable. In our very best and largest engines, the waste found by Watt to constitute three-fourths of all heat supplied has been brought down to ten per cent., a fact which well exemplifies the advances made since his time of apprenticeship by himself and his successors of this nineteenth century. The steam engine of to-day, in its most successful operation, gives us twenty-five times as much power from a pound of coal as did the engine that the great inventor sought to improve. This is the magnificent fruit of that one discovery of James Watt, and of application of the simple principle which he so concisely and clearly stated.

The method adopted by Watt to secure a remedy, so far as practicable, of this defect of the older machine was as simple and as perfect as the principle which it embodied. He first removed from the cylinder the prime source of its wastes; providing a separate condenser, and thus avoiding the repeated chilling of its surfaces by the cold water used in condensing the steam at exhaust, and also permitting its strokes to be made with far greater frequency, thus giving less time for cooling by the influence of the remaining vapors after condensation. He next went still further and provided the cylinder with a closed top, keeping out the air, and a "jacket" of hot boiler-steam to *keep* it as hot as the steam which entered it. These were the two great improvements which converted the first real steam-engine into an economical form of heat-engine and essentially finished the work so grandly begun by Newcomen and Calley. These changes gave us the modern steam-engine; and these are Watt's first and greatest, but by no means only, contributions to the production of the modern world with all its comforts, it luxuries, and its opportunities for material, intellectual, and moral advancement of individual and of race. His work was to this extent complete in 1765.

But Watt did not stop here. There still remained for him the no less important, and the in some sense still more imposing, work of finding employment for the new servant of mankind and of setting it at its work of giving the human arm a thousand times greater strength, to the mind of man uncounted opportunities to promote the advancement of knowledge, of civilization, of every good of the race. His was still the task of adapting the new machine to all the purposes of modern industry. It had been hitherto confined to the task of raising water from the depths of the mine; it was now to be harnessed to the railway train; to be made to drive the machinery of the mill, to apply its marvelous power to the impulsion of the river boat and ocean steamer; to furnish energy, through endless systems of transfer and use, to every kind of work that man could devise and should invent. All this meant the giving of the machine forms as various as the purposes to which it was to be devoted. It had previously only raised and depressed a rod; it must now turn a shaft. It had then only operated a pump; it must now turn a mill, grind out grain, spin our threads, weave our cloths, drive our shops and factories, supply the powerful blast of the iron-furnace. It must be made to move with the utmost conceivable regularity, and must, with all this, do its work in the development of the hidden energy of the fuel, with the greatest possible economy, through the expansion of its steam. All this was achieved by James Watt.

The invention of the double-acting engine, in which the impulsion of the steam is felt both in driving the piston forward and in forcing it backward, both upward and downward, the application of its force through crank and fly-wheel, the creation of an automatic system of governing its speed, and the discovery of the economy due to its complete expansion, were all improvements of the first magnitude and of the greatest practical importance; and all these were in rapid succession brought into existence by the creative mind that had apparently been brought into the world for the express purpose of giving to the hand of man this mighty agent, to perfect the mightiest power that mind of man has yet conceived.

But to do the rest required more than inventive genius and mechanical skill. It demanded capital and the stored energy of labor and genius in other fields, directed by the mind of a great "captain of industry." This came to Watt through Matthew Boulton, a manufacturer of Birmingham, whose father and ancestors had gradually and toilsomely, as always, accumulated the property needed for the prosecution of a great business. The combination of genius and capital is always an essential to success in such cases, and the good fortune—a providence, we may well say—brought together the genius and the capitalist to do their work, hand-in-hand, of providing the world with the steam-engine. Hand-in-hand they worked, and all the world to-day, and the race throughout its future life, must testify gratitude for the inexpressible obligations under which these two men have placed them, doing the work of the world.

Boulton & Watt, the capitalist with the inventor, gave the world the steam-engine, finally, in such form and in such numbers that its permanent establishment as the servant of man was insured. The capitalist was as essential an element of success as was the inventor, and in this instance, as in a thousand others, the race is indebted to that much-abused friend of the race, the capitalist, for much that it enjoys of all that it desires. The industry and patience, the skill and the wisdom required for the accumulation of this energy stored for future use in great enterprises is as important, as essential, as inventive power or any other form of genius. Talent and genius must always aid each other. This firm was established in 1764, and its main resources, aside from the bank account, were Watt's patent, about expiring, and Watt's genius, and Boulton's talent as a man of business. The patent was extended for twenty-four years, the new inventions of Watt, now beginning to pour from his prolific brain in a wonderful stream, were also patented, and the whole works were soon employed upon the construction of engines for which numerous orders had begun to pour in upon the now prosperous builders. The patent law established Boulton & Watt, and the firm paid paid back the nation with handsome usury, giving it unimaginable profits indirectly through its control of the work of the world, and large profits, indirectly, through the business brought them from all parts of the then civilized globe. There has never, in the history of the world, been a more impressive illustration of the value to a nation of that generous public policy, that simply just legislation, which gives to the man of brain control of the products of his mind. For a hundred years Great Britain has, largely through her encouragement of the inventor and her protection of his mental property, by securing the fruits of his labors, in fair portion, to him, gained the power of dictating to the world, and has gained an advance that cannot be measured. Watt and Arkwright and Stephenson and Crompton and their ilk, protected by their government and its patent laws, made their country the peaceful conquerors of the world. The story of the work of the inventor is a poem of mighty meaning and of wonderful deeds. The inventor proved himself a mightier magician than ever the world had seen.

> "A creature he called to wait on his will,
> Half iron, half vapor—a dread to behold;
> Which evermore panted, and evermore rolled,
> And uttered his words a millionfold."

Such was the outcome of this grand modern "trust," a combination of the wisest legislation, the most brilliant invention, and the most wisely applied capital. There are "trusts" of which the outcome is most beneficent.

Since the days of Watt, the improvement of the steam engine and the work of inventors has been confined to matters of detail. All the fundamental principles were developed by Watt and his predecessors and contemporaries and it was only left to his successors to find the best ways of carrying them into effect. But these matters of detail have been found to involve opportunities to make enormous strides in the direction of securing improved efficiency of the machine. The further application of the principle which led Watt to his greatest inventions, of the principle: keep the cylinder as hot as the steam which enters it, of that which he enunciated relative to the advantage of expanding steam, and of that affecting the regulation of the machine, have reduced the costs of steam and of fuel to a small fraction of their earlier magnitude. One ton of engine to-day does the work of eight or ten in the time of Watt; one pound of fuel or of steam gives to-day ten times the power then obtained from it. A steamship now crosses the Atlantic in one-eighth the time required by the famous "liner" of the "Black Ball Line." The wastes of the engine have been brought down from above eighty per cent. to eight; and a half ounce of fuel on board ship will now transport a ton of cargo over a mile of ocean.

Frederick E. Sickels gave us the first practicable form of expansion-gear is 1841; George H. Corliss gave a new type of engine of marvelous perfection and economy in 1849; Noble T. Green, Wm. Wright and many less well-known but no less meritorious inventors have since done their part in the transformation of the old engine of Watt into the modern wonder of concentrated and economical power, and marvel of accurate and beautiful design and workmanship. The "trip cut-off," with reduced clearness, increased boiler-pressures, higher rates of expansion, accelerated speeds of engine, better construction in all respects, as well as improved design, have enabled us to avail ourselves to the utmost of the principles of Watt, and our mills, our railways, our steamers and our fields, even, have gained almost as extraordinarily by these advances, since the days of the great inventor, as through his immediate labors.

With the introduction of the new form of older energy, electricity, with the reduction of the lightning into thraldom, has now come a new impulse affecting all the industries. Through its mysterious, its still mysterious action, steam now reaches out far from its own place, driving the electric car along miles of rail; giving light throughout all the country about it, turning night into day, and repressing crime while encouraging legitimate labor; reaching into distant chambers and every little workshop, to offer its powerful aid in all the distributed work of cities. Without the steam-engine there would be little work available for electricity, but the appearance of this, the latest and most useful handmaid of steam, has given the engine work to do in an uncounted number of new fields, has called in the inventor once more to adapt steam to its new work. The "high-speed engine" is the latest form of the universal helper. And such has been the readiness and the intelligence of the contempoary inventor that we now have engines capable of turning their shafts three hundred rotations a minute and without a perceptible variation of velocity, whatever the change of load or the suddenness with which it is varied. In the days of Watt a fluctuation of five per cent. in speed was thought wonderfully small; in those of Corliss, the variation was restricted to two per cent., and we wondered at this unanticipated success. To-day, thanks to Porter and Allen, to Hartnell, to Hoadly, to Sims, to Thomson, to Sweet, and to Ide and to Ball, we have seen the speed fluctuation restricted to even less than one per cent. of its normal average.

The inventors of the steam engine are, through their representatives of to-day, according to the statisticians, doing the equivalent of twelve times the work of a horse for every man, woman and child on the globe. We have not less, probably, than a half million of miles of railway, transporting something over 150,000,000,000 of tons a mile a year. A horse is reckoned to haul a ton weight about six and a-half miles, day by day, by the year together. In the United States it is reckoned that the steam engine on the railways alone hauls a thousand tons one mile for every inhabitant of the country every year; or, if it is preferred to so state it, a ton a thousand miles. This is the way in which the East and the West are, by the inventors of the steam engine, enabled to help each other. This costs about $10 each individual; it would require some twenty-five millions of horses to do this work, and would cost about $1,000 a family, which is more than twice the average family earnings.

Dr. Strong, in that remarkable book, "Our Country," says: "One man, by the aid of steam, is able to do the work which required 250 men at the beginning of the century. The machinery of Massachusetts alone represents the labor of more than 100,000,000 men, as if one-half of all the workmen of the globe had engaged in her service." And again: "Some thirty years ago the power of machinery in the mills of Great Britain was estimated to be equal to 600,000,000 men, or more than all the adults, male and female, of all mankind." Mr. Gladstone estimated that the aggregation of wealth on the globe during the whole period from the birth of Christ to that of Watt was equalled by the production in twenty years at the middle of this century, with the aid of machinery driven by the fruit of the brain of the inventors of the steam engine. We may probably now safely estimate the former quantity as rivalled in less than five years, while since the birth of Watt and his engine and the production of the spinning-mule, the power-loom, the cotton-gin and our own patent system and its marvelous mechanism, all events of a century ago, we may estimate that they have together accomplished more in this period which we now celebrate than could have been done in a millenium of milleniums without these now subjected genii. But the power behind all these curious inventions and their work is that of steam. The steam engine even supplies power to the telegraph, and transports words and thought as well as cotton-bales and coal.

And now what has this combination of legislation for private protection and public good, of a genius producing great inventions and of the accumulated capital of earlier years, brought about?

It has given us the best fruits of science in permanent possession. The study of science invariably aids in a thousand ways the progress of mankind. It gives us new conceptions of nature and of the possibilities of art; it promotes right ways of work and of study; it teaches the inventor and the discoverer how most surely and promptly to gain their several ends; it gives the world the results of all acquired knowledge in concrete form. This one instance which we are now especially interested in contemplating has performed more wonderful miracles than ever Aladdin's genii attempted. One man, with a steam engine at his hand, turns the wheels of a great mill, drives forty thousand spindles, applies a thousand horse-power to daily work in the spinning of threads, the weaving of cloth, the impulsion of a steamboat, or the drawing of great masses of hot iron into finest wire. This puny creature, his mind in his finger-tips, exerts the power of ten thousand men working with muscle alone, and aided by a handful of women, boys and girls, clothes a city. A half-dozen men in the engine room of an ocean steamer, with a hundred strong laborers in the boiler room and on deck, transports colonies and makes new nations, brings separated peoples together, unites countries on opposite sides of the globe, brings about easy exchanges between pole and equator. One man on the footboard of the locomotive, one man shoveling into the furnaces the black powder that encloses the energy stored in early geological ages, a half-dozen men mounted on the long train of following vehicles, combine to bring to the mill girl in Massachusetts, the miner in Pennsylvania, the sewing woman and the wealthy merchant, her neighbor, in New York, the flour made in Minnesota from the grain harvested a few weeks earlier in Dakota. All the world is served faithfully and efficiently by this unimaginable power, this product of the brain of the inventor, protected by the law, stimulated and aided by the capital that it has itself almost alone produced.

And thus have the inventors of the steam engine set in motion and placed at the disposal of mankind for every form of useful work, all the great forces of nature. Thus, Hero of Alexandria touched the then concealed spring which called all the genii of earth, fire, water and air to do the bidding of the race. Thus Papin, Worcester, Newcomen, Watt and Corliss and others of our own contemporaries, have applied the genii to their task of leveling mountains, traversing seas, continents, and the depths of the earth, building ships, locomotives, hamlets and cities, cottages and palaces, turning the spindle, operating the loom, and setting in motion and giving energy to every machine; doing the work of thousands of millions of men, converting barbarism into civilization, giving necessaries of life in profusion, comforts in plenty, and luxuries in superabundance.

Aiding and working hand-in-hand with those other genii of progress, the inventors of the printing-press and of the telegraph, the telephone, and the electric railway, of the modern system of textile manufactures, of iron and steel-making, of the mowing-machine and the harvester, they have compressed into two centuries the progress of a millenium, destitute of their aid. Every step taken under their stimulus and with their help is a step toward a higher life for all, intellectually and morally as well as physically; every advance in the improvement of their work is a gain to every man, woman and child; every improvement of the steam engine is a help to the whole world. This progress makes the day of the extinction of the system now grinding the populations of the earth into the ground, the day of the abolition of armies and the restoration to the people of that freedom which characterized the times of the patriarchs, and of the restoration of the rights of the citizen to his own time and strength and producing power perceptibly nearer.

When this final revolution shall have been accomplished, and when all the world has settled down to the steady and undisturbed work of production by daily and regular labor, aided by the genii of steam, of electricity, of all nature combined for good, the results of the intellectual activity of the inventors of the steam engine will be fully seen. Then no monument will be required to keep green the memory of Watt, Corliss, or any other of these great men; but it will be said of them as of Sir Christopher Wren in the epitaph in St. Paul's: "Seek you a monument? Look about you." Every wreath of steam rising to the heavens from factory, mill, or workshop will be a reminder of Hero of Alexandria; every mine will possess a memorial to Papin, Worcester, and Savery; every steamship will bring into grateful memory Fitch, and Stevens, and Bell, and Fulton; thousands of locomotives crossing the continents will perpetuate the thought of the Stephensons and their colleagues in the introduction of the railway; the hum of millions of spindles and the music of the electric wire will tell of the work of Corliss and his contemporaries and successors who made these things possible; and all kingdoms and races, all nations will revere the name of James Watt, the genius to whom the world is most indebted for the beginnings of all this later and grander civilization which has converted the slow progress of earlier centuries into the meteor-like advance of to-day toward a future as grand, and as mighty, and as noble as humanity shall choose to make it.

THE EFFECT OF INVENTION UPON THE PROGRESS OF ELECTRICAL SCIENCE.

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Electrical science really begins with the labors of Dr. Gilbert. These he published in 1600. For almost exactly two hundred years from this date investigation was confined to that domain which is still sometimes called *static* electricity. A new era, however, dawned in 1800, when Volta gave to the world an invention whose importance can scarcely be exaggerated—the voltaic battery.

The simplicity of the device and the wonderful effects which it could produce at once excited the most lively interest, and men of science made haste to investigate it. By means of it Carlisle and Nicholson soon succeeded in decomposing water, and Ritter had a similar success with copper sulphate. Thus commenced a long line of research in *electrolysis* which was pursued with great success by Davy and others, and which finally led Faraday to the grand generalization known as Faraday's *laws* of *electrolysis.*

Meantime, Ritter had noticed that the two plates of the same metal which have just served to convey the current to and from a liquid while undergoing electrolytic decomposition can, themselves, furnish a current, and he was thus led to the invention of the "storage battery." It was Volta, however, who gave the correct explanation of its action.

Ritter, Pfaff and others observed that the conducting wires of the battery are warmed by the passage of the current, and Curtet, on closing the circuit with a piece of charcoal, produced a brilliant light. Davy systematically investigated these heating effects of the current, employing various metals as conductors, thus incidentally testing their resistances, and finally in 1812, on making the current pass between two pieces of charcoal, he produced the well-known *electric arc.*

Thus in little more than a decade from the date of Volta's invention, more real progress was made than in any century previous. But the true progress of electrical science is not to be measured solely, or even mainly, by the number nor by the splendor of the physical results which attend it, but rather by the insight into the operations of nature which we gain. Viewed in this light Volta's invention was itself the embodiment of a great advance which he had made into an entirely new region. It was not the mere outcome of happy accident, but the result of severely logical reasoning upon facts which he had observed while he was investigating the so-called "animal electricity" of Galvani.

Volta's fundamental research respecting the electrical disturbances produced by contact of dissimilar substances afforded him a basis for a rational theory of the action of the battery, and this theory has had a far-reaching influence not only upon the progress of electrical science, but on physical science in general.

The voltaic battery rendered possible an observation out of which grew the next great invention, which we will consider. In 1820 Oersted noticed that a magnetic needle was deflected from its normal position by voltaic current which was flowing in a conductor near it. He determined the relation of the current to the deflection as respects direction, and sent a brief memoir concerning the matter to well known scientists.

Arago immediately found that iron filings were attracted by a wire conveying a voltaic current. In order to strengthen the magnetic action of the current Schweigger invented the magnetizing helix or spiral. By means of this Arago was able to magnetize steel permanently and iron temporarily. The conception of this helix was the first act of invention which was to produce the electro-magnet. Yet it was not until 1825 that Sturgeon wound a conducting wire about a core of iron to produce the electro-magnet proper. The magnet as it left the hand of Sturgeon was a crude device, which the genius of Henry finally perfected between the years 1828 and 1831. Henry constructed several magnets some of which were wound with long, thin insulated wires, while others were wound with shorter and thicker wires in parallel. These could be joined either in series or in parallel. He thus had the means of studying the effects which a given battery can produce when made to actuate magnets having different windings. He also investigated the effects which are produced by the use of batteries having different electro-motive forces. He thus discovered the principles which must be observed in order to secure the best results from the electro-magnet under any given conditions. Indeed, a careful examination of Henry's work will convince one that he disclosed the same result by the light of skillful experiment, as is set forth in Ohm's now well-known formula. Moreover, he clearly perceived that the magnet as he had perfected it offered the solution of the problem of the telegraph, and he made proof of his prevision by actually installing one.

In the hands of Ampere the conducting helix was made, under one form or another, a means of investigation which he pushed with wonderful energy and skill until he unfolded the laws of interaction between magnets and electrical currents as well as those which govern the mutual actions of the currents themselves. In short, it may be said that as the result of his inquiries Ampere was brought to a comprehensive theory of magnetic action which was startling alike for its simplicity and its boldness. It deserves to rank with Newton's theory of universal attraction.

The skillful labors of Faraday and Henry brought to light by the same means the laws of induced currents, and so supplied the elements which practical inventors have since combined so as to do our bidding, whether it be to illumine our streets and dwellings, push our cars or delve in the mountain for hidden treasure.

The electromagnetic phenomena educed by the voltaic current as it flows through a helix constitutes the basis of a most admirable system of measurement for electrical quantities, while the helix itself contains in germ the whole family of measuring instruments by means of which such measurements are made. Moreover, these phenomena led the sagacious mind of Faraday to a wholly new way of regarding electrical action in general. He clearly perceived that the old doctrine of the "imponderables" was untenable, and he looked for some common nexus between all physical actions. He was disposed to refer the interactions which bodies exhibit in consequence of their electrical states to the medium intervening between them. As light is believed to be transmitted by a universal medium, he sought to find, by experiment, some connection between light and electromagnetic action. On passing a beam of plane polarized light through a block of glass within a magnetizing helix he found that the beam was twisted when the current was made to flow through the helix.

Maxwell undertook the very important work of subjecting the results reached by previous workers, and generally set forth in Faraday's "Experimental Researches," to mathematical discussion, which must be considered the final test of truth. Not to mention others, one very important result was his "electromagnetic theory of light." But experiments were wanting, save the single one of Faraday just mentioned, to confirm his deduction. It was reserved for Hertz to supply the necessary evidence in support of Maxwell's theory, which he had lately done by making skilful use of the oscillating discharge of charged conductors, earlier demonstrated by Henry.

Thus it appears that the two great germinal inventions which have most influenced the progress of electrical science during our century are the voltaic battery and the magnetizing helix. The one gave us first the means of evoking electrical energy continuously, while the other gave us the means of applying it as we may have occasion. Both contributed powerfully in a direct way to the progress of electrical science by reason of the various and startling phenomena which they revealed.

But it seldom happens that progress continues long in any department of physical science unaffected by the practical application of its results in the arts, and, conversely, such applications almost invariably react to stimulate scientific inquiry. Two principal reasons for this effect may be noticed. When the apparatus and the operations of the laboratory give place to those which are suited to commercial uses, new conditions arise which frequently bring into prominence phenomena before unobserved or inconspicuous. These then become subjects for new investigations, and in due time scientific progress is the result. Thus, telegraphy brought its knotty problems as well as its successes, especially when its lines were stretched under the sea, and when one wire was required to do the duty of several, and nothing less than the highest skill and the most severe analysis has sufficed to effect their solution. So, too, telephony was early beset with peculiar difficulties, notwithstanding the simplicity of the means which it employs—thanks to the genius of Professor Bell—but they were such as electrical science has profited from. Speaking generally, it may be said that almost every one of the devices which are in daily use for the transformation of mechanical work into electrical energy, and the converse, has compelled its inventors, in the course of its evolution, to contribute something to the common stock of scientific truth.

It was regretted by Franklin that the results of electrical research had not been turned more to the use of man in practical affairs. Faraday did not doubt that the time would come when that reproach would be removed, but he felt it a duty on his own part to push on the work of discovery, and to leave industrial inventions to others. Such applications are now everywhere about us and are rapidly extending. Of course they involve the investment of millions of capital, and this renders it impossible that the great public shall be indifferent to the science upon which they depend. Hence it is that all our schools of technology and most of our colleges have already made provision for training in it.

Every consideration leads us to expect that future progress in electrical science will be more rapid than it has ever been in the past; the present offers to the student the accumulated treasures of knowledge and the hope of scientific distinction as well as that of pecuniary reward. It can hardly be that among the scores of young men to whom these advantages come as inspirations there will not be found some who shall prove to be worthy successors of the great men into whose labors they so easily enter.

THE INFLUENCE OF INVENTION UPON THE IMPLEMENTS AND MUNITIONS OF MODERN WARFARE.

BY MAJOR CLARENCE E. DUTTON, ORDNANCE DEPARTMENT, U. S. A.

That remarkable progress which has characterized the various arts during the present century, and especially during its second half, is well exemplified in the great increase of efficiency in war material and weapons of war. From the time of the invention of gun powder to the close of the last century there was progress in the improvement of arms, but it now seems to us very slow. In no other department of invention were the kings and nobility so much interested. No inventor was so much valued or so richly rewarded as the one who had devised a more deadly weapon or an implement which would increase the efficiency of a soldier. It is a significant commentary on the early part of the 17th century that the discovery of the telescope was at first regarded as having little or no other utility than as an aid to the eye of the commander of troops in the fleld, and an effort was made by the Prince in whose dominon it was invented to keep it secret, and to monopolize its military advantages. But with all the patronage of Kings and Princes, progress in the mechanics of warfare was not materially greater than in other mechanic arts. And yet there was progress. But it was at such a rate that it required half a century at least and sometimes a whole century of improvement to clearly establish by comparison the fact that the methods and materials of warfare had notably changed. Indeed if we compare the cannon used at the beginning of the 15th century with those used by the first Napoleon in his first Italian campaign at the close of the 18th we shall find only a very moderate difference, and such as may be recognized will be chiefly in the method of mounting and transporting the piece, while the structure and effectiveness of the cannon itself apart from its mounting will appear to have undergone no radical change. In small arms the progress was somewhat greater. Yet it may sound like satire to say that from the time of the first arquebuss to the beginning of the present century the most important improvement of the foot soldiers fire-arm was the addition of the flint-lock for discharging it.

In the first half of the present century progress was somewhat more rapid. This progress, however, was not so much in the line of increased power and efficiency of weapons nor in respect to important changes in their functions or structure as in the machinery and methods of fabricating them and improving the workmanship and materials. Prior to 1800 all parts of a musket were made wholly by handicraft, and the founding of cannon was a primitive and laborous operation. But soon after the opening of the present century the introduction of machinery in the armories became a pronounced feature. And in this respect the United States took the lead of all nations. It is more characteristic of our people than of any other to seek to replace the labor of men with the labor of machines. The rolling of gun-barrels upon a mandrel, the extensive use of milling machines for shaping the irregular parts, the systematic use of the drop and die, and above all the practice of finishing the parts of a gun with such precision that a thousand guns could be assembled by taking the distributed parts at random and putting them together without any additional fitting were first adopted and carried into successful practice in our own factories. There were improvements also in artillery, but chiefly in the direction of better workmanship, more effective projectiles, increased mobility of field artillery, better mountings and more powerful guns for fixed armaments. Yet none of these changes were of revolutionary importance.

Between 1850 and 1860 began that wonderfully rapid development which has led to the modern high power artillery, the magazine rifle for infantry, and the rapid-fire machine guns which have developed a radically new function in modern armaments. I propose to allude briefly to the fundamental improvements which distinguish modern arms from those which preceded them, and which exhibit the principles rather than the details. One of the most surprising things about these improvements is the fact that they consist very largely in modifications, which seem to the inexpert comparatively trifling. On comparing a modern gun with such as were in favor fifty or a hundred years ago, the popular mind would doubtless be impressed with the idea that the essential difference lies in the fact that the new gun is a breech-loading rifle, while the old gun was a muzzle-loading smooth-bore. But breech-loading is one of the oldest inventions in gunnery, was revived from time to time, experimented with and rejected as inferior to muzzle-loading, and if the artillerists of a century or more ago could have been furnished with the best breech-closing devices of the present day, they would very properly and logically have been rejected just the same. Breech-loading is not a novel and fundamental improvement in itself; it is, rather, a logical consequence and secondary result made necessary by other improvements which are more fundamental, and which were unknown to our ancestors.

The use of rifling and of the elongated projectile offers similar considerations. Rifling has been known for more than four centuries, and the effect of the resistance of air upon elongated projectiles of various forms was learnedly discussed by Sir Isaac Newton, and a few years later by Benjamin Robbins, one of Newton's disciples. The relations of length and calibre were well understood, and with this knowledge in their possession it might seem at first inexplicable that breech-loading rifles were never used in military service until the last three or four decades. A brief examination, however, will show, I think, that the knowledge and resources of our predecessors prior to 1800, and possibly prior to 1850, were insufficient to construct a rifled-cannon which would be notably superior to a smooth-bore of equal weight. They did not know how to increase the energy of the projectile without imposing stresses upon the gun beyond the limit of safety. Neither did they know how to make stronger guns than those which they used. The knowledge which they lacked, and which was essential to a great increase of ballistic power, has been gained within the last forty years.

The fundamental improvements which characterizes modern ordnance may be classified in three groups:

1. The regulation and control of the action of gunpowder in such manner as to exert less strain upon the gun, and to impart more energy to the projectile.

2. To so construct the gun as to transfer a portion of the strain from the interior parts of the walls, which had borne too much of it, to the exterior parts which had borne too little, thus more nearly equalizing the strain throughout the entire thickness of the walls.

3. To provide a metal which should be at once stronger and safer than any which had been used before.

The regulation and control of the action of gunpowder was attempted more than a century and a half ago and something was accomplished. We owe to the French artillerists some important discoveries in this direction and in 1850 it was well established that strong and mild powders could be produced at will by the manufacturer. But the investigations and experiments of Rodman carried the power of control over the action of powder to an extent so far exceeding anything of the kind which had been attained before that his results were of revolutionary importance. It can hardly be claimed that the principles involved in Rodman's gunpowder experiments were novel. But the extent to which he carried them into practice was such as to make it equivalent to a new discovery. The improvement was one of degree rather than of kind, but such as it was its consequences were great. It rendered possible an increase in the weight of both powder and projectile without increasing the strain upon the gun. A second step leading in the same direction and also of revolutionary importance was an increase in the size of the powder chamber, so as to allow vacant space in it unfilled by the powder. Strange as it may seem to the uninitiated, this, too, was an invention of revolutionary importance. It was first adopted in the Krupp guns. It permits a still further increase in the amount of powder without adding to the strain upon the gun. How a device so simple, so obvious and so necessary could have been overlooked so long is one of those mysteries of invention which it seems now impossible to explain, except upon the assumption that those who had thought of it (and many had done so) dismissed it as worse than useless. The discussion of the form and proportions of the powder chamber had been worn threadbare a hundred years ago, and the effect of a chamber of larger diameter than the bore had not been overlooked. But the idea of partially filling such a chamber with powder and leaving a considerable amount of vacant space seems to have attracted no attention. Yet this device so simple that an old-time artillerist of the greatest learning and widest experience in his art would have sneered at it contained the precious secret that he would have been almost willing to lay down his life to discover. May we not say that the reason why it was not sooner discovered was its too transparent simplicity?

The second group of discoveries consists of devices for constructing guns with initial strains, the metal near the bore being compressed, while the exterior metal is stretched. In a gun without initial strains the restraining effect of the metal decreases rapidly from the surface of the bore outwards, so that the external portions add very little to its strength. With the firing of heavy charges the inner portions are strained to the limit of safety or beyond, while the outer portions are taxed but little. But if the inner parts before firing are highly compressed while the outer parts are stretched, the full stress of firing brings all parts into action with a restraining effect much more nearly equal or much less unequal. This greatly increases the strength of the gun. The first one to put this conception into practice and prove its reality by experiment was Rodman. He applied it to cast-iron guns by the method of cooling them from the interior. This result did not, indeed, fully realize the principle involved, but it did so partially, and to an important extent, and was a long stride in the right direction. His results fully established the value of it and made it a fundamental principle in modern constructions.

The possibility of using steel for guns has from the beginning been merely a metallurgical question. Gun steel, however, constitutes a special department of steel manufacture and its development has proceeded to a considerable extent upon lines of its own. The machinery required for it is the most gigantic and powerful of any, and the furnace practice is the most exacting. The treatment of the steel by oil tempering has until recently been peculiar to gun metal and is needful in order to secure the desired physical qualities. In this field the Krupps have been the pioneers and have kept abreast of all improvements. The magnificent process of Whitworth for making ingots by liquid compression is no doubt the most impressive achievement of the art of steel-making, yielding a piece of metal of such supreme excellence that we are almost tempted to believe that in this respect the ultimate goal of progress has been reached and that nothing is left for future inventors to attain.

The fundamental improvements, then, which constitute the modern as distinguished from the older ordnance are: (1) the control of the combustion of gunpowder; (2) the enlarged powder chamber; (3) the initial tensions, and (4) the employment of steel. All other characteristics are merely logical sequences of these four primary conditions or antecedents. The adoption of breech-loading in place of muzzle-loading, the great increase in the length of the gun, the building up of the gun by shrinking successive cylinders one over the other are all consequences of the four principal improvements. The results of these improvements are that (weight for weight of metal in the gun) the energy of projectiles has been increased four to five-fold, the effective range has been more than doubled, the accuracy of fire has been immensely improved, and the penetrating and destructive power correspondingly increased.

The discovery of gun-cotton by Lenk, and later of nitro-glycerin by Nobel, followed by the discovery of many other nitro compounds, placed before the world a series of agents far more forcible than gunpowder. Their treacherous and detonating characters for a long time rendered them objects of dread and real danger, and gave little promise of utility for ballistic purposes, though for mines and torpedoes they seemed to offer great advantages if they could be deprived of their treacherous nature. In due time methods were discovered of producing high explosives, which were reasonably safe if great precautions were exercised, thus placing them among the most important and useful agents for industrial purposes. The use of them in torpedoes also became practicable, thus placing in the hands of military men a powerful agent of destruction. If it were practicable to direct this terrible destroyer (the torpedo) to its mark with as much accuracy as a projectile from a gun it would be incomparably the most efficient for destruction of any engine of war. But the uncertainty of all existing methods of bringing them in contact with the ships they are designed to destroy deprives them at present of a great portion of their terrors. But the chances of a deadly stroke are still sufficient to render them very formidable weapons. Torpedoes, however, are so new as regularly adopted agents of warfare that they may be regarded as the possible forerunners of a far more terrible class of destroyers. In this connection the pneumatic dynamite gun of Captain Zalinski presents itself as offering great possibilities. It is now in the experimental stage, and on its first trial has shown itself capable of very destructive work. It is an entire novelty and a very bold conception, wrought up with a profound knowledge of mechanical and ballastic principles. Its ultimate development cannot now be foreseen, but it holds out the hope of such great possibilities that every effort to realize them should be made.

The use of high explosives not only as the bursting charges of projectiles but as the impelling force of the projectile itself in the gun is receiving attention. Not only is this problem a rational one but it is a very hopeful one. If we can succeed in controlling its terrible powers and taming its ferocious nature and can provide a variety of it which will keep without deteriorating the problem will be solved; for we are already in possession of the means and science which will enable us to utilize its superior energy. Verily, it begins to look as if the age of gunpowder were passing away and were soon to be followed by the age of high explosives.

In the department of small arms the great improvements belong to the last forty or fifty years. The improvements sought, while partly the same as in the field of heavy guns, were much more in the line of increased rapidity of fire. At the outbreak of the war of the Rebellion all the armies of the world were using the muzzle-loading rifled musket. Many breech-loading rifles had been invented, however, and were competing for favor as military weapons and were slow to find it. Much surprise has been expressed at the tardiness and reluctance of military men to adopt breech-loaders and they were often reproached and derided as too conservative, prejudiced and behind the age in the development of their material, when they ought to be progressive and in the lead. The answer to these criticisms is that while there were numerous good breech-loading small arms offered during the war there were no good breech-loading cartridges, and no machinery for making them. Among the inexpert the musket and its mechanism is all in all, while the cartridge is looked upon as a minor incident. In the eye of the ordnance officer the gun is only the casket and setting while the cartridge is the jewel. During the war the attention of officers was concentrated in the creation of a good cartridge, while the problem of a gun presented no real difficulty; none, in fact, except that of choosing from among a considerable number any one of which would have sufficed. The cartridge problem was one of serious difficulty, for there were few designs to choose from and all of them more or less bad. It was recognized at the outset that a serviceable and satisfactory cartridge must fulfill the following conditions: 1st. It must comprise bullet, powder and priming united in a metallic case or shell; 2d. It must be center-primed; 3d. It must not be liable to deterioration; 4th. It must not be liable to split in firing nor to stick fast after discharge nor to have its head torn off during extraction; 5th. Its case must be easily made, primed and loaded by machinery. While the inventors at large throughout the country were chiefly occupied in improving the breech mechanism of the gun the government work shops were most deeply concerned about the cartridge. It was not until 1865 at the close of the war that a cartridge fulfilling all of the required conditions was attained; and no sooner was it attained than the machinery for making it became the standing problem. It was necessary to invent this machinery almost *de novo*. It was successfully accomplished in about a year and a half, and it seems necessary here to pay tribute to the eminent skill and inventive talent of Mr. J. G. Gill, the master mechanic at Frankford Arsenal, Philadelphia. He devised a series of machines, some of which must rank among the highest triumphs of American invention. In a few years all the great powers of the world had adopted them.

The achievement of a good cartridge was quickly followed by the choice of a gun. The choice fell upon the Springfield breech-loader. It has had many competitors of admirable design, some of which certainly excel it in specific points. But in the full and general test of serviceableness it has kept the field against all rivals. Competing arms have been repeatedly placed in the hands of troops on the frontier for trial, but the preference of line officers for the Springfield pattern officially expressed has been so overwhelming that their verdict could not be set aside without undue presumption. Its excellence consists in its reliability: nothing except extraordinary violence ever deranges its ready action.

The day of the single breech-loader is about over, and it must very shortly give place to the magazine gun. Arms of this class have long been before the world, but have not until very recently been adopted in any military service. The reason has been that the earlier types of this class of arms sacrificed the size and therefore the power of the cartridge in order to get the largest possible number of them into the magazine, and to enable the infantry soldier to carry a larger supply of them without increase of bulk or weight. The logical solution of the magazine problem, however, should be a diminished weight and size of cartridge without decrease of power. The gun itself is no longer a problem. It has been solved for several years. There are many excellent magazine guns, though some may be better than others. The cartridge problem is also narrowed down to a single issue. If we are to diminish the weight without loss of power we must have a more energetic and compact explosive in place of common gunpowder. The projectile has already been reduced in calibre and increased in length; but we are not sure yet of the high explosive. We want one which is safe against accidental explosion andw hich will not deteriorate with keeping. When we have obtained it, as we doubtless shall, the solution will be complete.

Machine guns constitute an innovation among the weapons of war, and are characteristically American in their mechanism and nature. They made their first appearance during the war of the rebellion and were unknown and unthought of by preceding generations. The first successful weapon of this class was the Gatling gun. It was rapidly developed, but did not reach a practical stage of construction and operation until after the close of the war. It has since received many improvements, and as a *mitrailleur* still holds its supremacy, though it has had some ingenious and formidable rivals. Equally important has been the development of a rapid-firing system of artillery. The weapons of this class have a very limited field of utility, but within that field their potency is formidable. They exhibit well the tendency towards special tools for special purposes, which is characteristic of all modern mechanical or industrial progress.

As the Nineteenth Century nears its end we find the armaments of the world as much more formidable than those of the first Napoleon, as his were then those of the Greeks and Romans. Nearly all of this great advance is the result of the last forty years of invention. The part which has been borne in this development by American investigators and inventors will not only compare favorably with the achievements of other nations, but will, I believe, be accorded a preëminent position. No discovery or improvement can be the secret or peculiar property of any nation in these days, and every department of mechanical or industrial art contributes to the world's store of knowledge all that it discovers and draws from the common stock whatsoever it finds in it suited to its uses. Upon a fair review of this branch of development as a whole it may be said that the United States have contributed as much to that stock as any other country in the world, and the only question is whether it has not contributed more of real importance than any other.

During the period from 1872 to 1885 there was a relaxation of interest on the part of Congress in military matters and the War and Navy Departmtnt were without the means of prosecuting the costly experiments, without which the progress of invention in this field must be retarded. But the revival of the Navy, and afterwards of projects for sea-coast defense, quickly disclosed the fact that the inventive genius and progressive spirit of the country had been merely resting a little and gathering strength for the opportunity which at last came. With a continuance of support it is believed that in a very few years our military armaments, both afloat and ashore, will surpass those of any country in the world.

THE RELATIONS OF ABSTRACT SCIENTIFIC RESEARCH TO PRACTICAL INVENTION, WITH SPECIAL REFERENCE TO CHEMISTRY AND PHYSICS.

BY PROFESSOR F. W. CLARKE, S. B., OF OHIO, CHIEF CHEMIST, U. S. GEOLOGICAL SURVEY.

A hundred years ago, just after the first American patent was issued, two other events, fitly to be mentioned here, became a part of history. In 1791 Galvani published his famous book on animal electricity, and at about the same time the Royal Society gave its highest honor, the award of the Copley Medal, to Volta. Between these events and the passage of our first Patent law, no connection was then apparent, nor for many years afterward did any relation become obvious. The patent system dealt with affairs of practical utility, while Galvani and Volta were mere visionaries, prying into matters of only speculative interest, and of no real value or importance to anybody. Indeed, Galvani was ridiculed throughout Europe as the "Frog's dancing master," so remote from all material considerations, so useless to all outward seeming, were his investigations.

In spite of ridicule and indifference, however, the unpractical researches went on, from step to step, from discovery to discovery, until at last they ripened into invention. Galvani and Volta had worthy successors—Oersted, Ampere, Ohm, Faraday, Henry and others, all devoted to knowledge for its own sake, and caring little for any reward other than the consciousness of achievement. The voltaic pile, the galvanic battery, and the electro-magnet were added to the resources of science; facts, principles, and laws came into recognition, and suddenly a relation of the work done to the work the great world was doing became manifest. Nearly half of a century was passed in these preliminaries, and then came the inventions of electro-metallurgy, of the telegraph, and of all the hurrying swarm of wonders that mark this "age of electricity." Suddenly the Patent Office became a centre of interest in what at the date of its foundation, had been apparently remote from its purposes, and to-day, grown from the germs of a century ago, we see one of the chief objects of its activity. All now know the merit of Galvani's work, and yet its lesson of history is far too seldom realized. Every true investigator in the domain of pure science is met with monotonously recurrent questions as to the practical purport of his studies, and rarely can he find an answer expressible in terms of commerce. If utility is not immediately in sight he is pitied as a dreamer or blamed for a spendthrift of time; for the questioning man of affairs can recognize only affairs, and to him speculations not convertible into coin of the realm must naturally seem profitless. High aims count for little or nothing; results, and tangible results at that, are wanted.

It would be easy to multiply instances in illustration of my meaning. For example, iodine, discovered in 1812 by Courtois, was for many years a chemical curiosity. Why should any one waste his time in the study of so useless a body? To-day industries unknown to Courtois, born since his day, find in iodine one of their most necessary appliances. Photography, one of the arts in which iodine is useful, itself grew out of researches which were seemingly useless when made; and the camera, its most essential implement, was once only a philosopher's plaything. Investigations which had only the pursuit of truth for its own sake as a justification, brought rainbows of color out of coal; and coal-tar, not thirty years ago a nuisance to be thrown away, is now a source of profit and prodigal of beauty. From the same hopeless material, through researches still unaimed at profit, have come the latest and best additions to our materia medica; and so again the methods of science, as applied by her highest votaries, are vindicated by the fruits they bear. In short, every department of invention, every advance in civilization, owes much to the student; no industry is independent of the results won by purely abstract research. Even the most trivial details of modern life are affected by the work of the scientific investigator; luxuries and necessities are alike influenced, and so obtrusively evident is this truth to most of us, that, taking it for granted, we daily ask—"what next?" Indeed, our gratitude to science is often manifested in that cynical form which has been wittingly defined as "a lively sense of favors yet to be received." We expect more in the future than we have realized in the past, and as the marvels of the last century become commonplace, we look for new wonders which shall be even greater. The magic of the Ancients is already outdone, and still the tide of discovery has not reached its flood. To preserve what we have gained and to ensure the promise of the years to come, is the problem before us. Speaking in the interest of future invention we may fairly ask, how best shall the work of investigation be furthered?

It is an old saying, and one partly true, that what has been, shall be. We may therefore consider through what agencies science has heretofore grown, and so recognize the foundations upon which building is possible. These agencies, briefly summarized, are as follows: First, individual enterprise; second, schools and universities; third, learned societies and endowments; fourth, government aid. Like nearly all classifiications this list is imperfect; for it represents only one phase of the truth, and the several items, far from being distinct, shade into one another through many gradations of circumstance. Among them all, individual enterprise comes properly first, for without that, without the influence of guiding spirits, the other agencies must fail. No great work was ever accomplished without the personal initiative force of a leader, no "mute inglorious Milton," but an active, earnest, striving man. In a restricted sense, however, except perhaps as regards the beginnings of science, individual enterprise is the weakest force of all. To the modern investigator leisure and opportunities are necessary; in chemistry and physics, at least, apparatus and laboratories are indispensable; and few men working alone can command either the needful time or the bare material resources. During this century nine-tenths of the great discoveries have been made by men with institutions back of them; through the aid of which the work was rendered possible. Wealth, scholarship, ability and the spirit of research too seldom go together; and happy is the man in whom all these conditions are fortunately united. Under our second heading, in the shelter of schools and universities, the science of to-day has chiefly been developed.

The truth of my last statement may be verified by a reference to the files of standard scientific journals in which original researches are recorded, or by scrutinizing in detail the history of any great discovery. In either case, whether we consider this country or Europe, the university work will be found to predominate overwhelmingly, and for obvious reasons. Every true university is something more than a distributor of knowledge, it is a producer of knowledge also; and in Germany, where the university system is most fully developed, the two functions are equally recognized. A German student aspiring to academic honors must do original work, and the professors' chairs are always filled from among the men who have most distinguished themselves as investigators. A chemist who had done nothing for pure science could hardly be recognized in Germany; not one of the higher professional positions would be within his reach; erudition alone, unsustained by evidence of creative ability, would do little for his advancement. In consequence of this policy, Germany now leads the scientific world; and in consequence of that leadership, a certain industrial supremacy is fast becoming hers. One example will serve to illustrate the tendency to which I refer. The aniline dyes were discovered by Perkin, in England, almost thirty-five years ago, and in that country the manufacture began. To-day, through the researches of the German universities, Germany is the centre of the coal-tar industry, and England has only a subordinate rank. Until recently the English universities have slighted experimental science, and English manufacturers are paying for the neglect. One German firm alone, producers of coal-tar colors, employs over fourteen hundred workmen; but with them there are about fifty scientific chemists, every one a man trained in pure research, the product of the university system. These men are employed to make investigations; to improve processes, to discover new compounds of value; and in short, to use the most vigorous methods of science for the upbuilding of industry. The German manufacturer does not employ a chemist who has only learned by rote the wisdom gained by others; he does not ask to be told that which he already knows; he seeks rather to push forward into new fields; to excel his competitors more by intelligence than by brute force; and to gain a growing supremacy in preference to a mere victory for the moment. This practical policy, the outgrowth of intellectual culture, has made Germany a dangerous rival to all other countries in those departments of industry which rest upon scientific foundations. Applied science can not exist until there is the science to apply; and where the latter is most favored, the industrial development is sure to be most perfect. This lesson is one which the United States must learn more thoroughly than heretofore, if it hopes to hold its own in the front rank of manufacturing nations. In a few of our universities the truth is already realized; but in too many American schools the so-called "practical" view prevails. Under the latter, teaching becomes routine, and the student, while learning elaborately that which is known, is not taught how to discover. He has little or no training in the art of solving unsolved problems, and that art is the mainspring of modern industrial growth. A teacher of science ought also to be an investigator, were it only for the inspiration that his example might give to the pupils in his charge. To impart knowledge is a good thing, but to reveal the sources of knowledge is better, and in that relevation is found the educational value of research regarded as a part of the teacher's essential duty.

The third agency for the advancement of investigation, the organization of scientific societies, shades imperceptibly into the other three. Private workers and university teachers here come together for purposes of coöperation; and in many countries the associations formed are aided by the State. As a rule the great European academies are directly or indirectly patronized by the government, and occasionally endowments are bequeathed to them by private individuals for the foundation of prizes or medals, or for the assistance of research. In our own country the societies and academies are sustained by private enterprises, but some of them hold endowments of considerable value. Partly through the latter, partly through the stimulus to effort given by awards of honor, and more largely as publishers of results they do their greatest good, and render to science services of unmistakable value. A large proportion of the leading scientific journals are published by organized societies, and without these discovery would oftentimes be dumb.

Of government aid, the fourth great means of furthering research, little need here be said. Ostensibly, such aid is given for selfish motives, since every modern government demands the help of science in return. Nowadays no government could long exist were it deprived of all the resources for defense and intercommunication which science has invented. The relation between science and the State, therefore, is a mutual relation, and each needs the assistance of the other. In Washington this fact is manifest; it is recognized in the organization of nearly every administrative department, and nowhere is it more apparent than under the Commissioner of Patents. From science the government is daily receiving benefits; to science, therefore, it is rightly a liberal giver; and through its patronage many investigations become possible which, because of their magnitude, would be beyond the reach of private undertaking. Doubtless the time will come when the scientific resources of the National Capital will be concentrated more than they are now, and so made more efficient; and sooner or later they should be crowned by the establishment of a National University in which the highest and most productive scholarship may find a fitting home.

So far my statements have been tinged with rose color. The great achievements of science command our admiration, and admirable also are the agencies by which it has been advanced. Still, much remains to be done, and many are the gaps in our knowledge. Take any important series of physical data, or any well-defined group of chemical compounds, bring the facts together in systematic form, and the strangest deficiencies will become manifest. Take for example those physical properties of the chemical elements which are capable of quantitative measurement, and not for one of them are the attainable data even approximately complete; even iron, copper, gold, silver, and mercury are but imperfectly known. Were it not for theory, that apprehension of natural law through which science can prophesy, reaching out from the seen to the unseen, a great part of our knowledge would be little more than bare empiricism, and research itself would lack its keenest implement. It is common among ignorant men—themselves wildly speculative—to affect a contempt for theory, and yet without theory science could not exist. All great discoveries begin with theory and lead up to wider generalizations, upon which new researches find a secure foothold. The history of science teaches no more certain lesson than this.

It is easy to find a reason for the incompleteness of our knowledge. Apart from the vastness of the field to be explored, itself a sufficient excuse for ignorance, the more obvious deficiences are due to excessive individualism in research. Thousands of earnest men are working independently, with insufficient reference to one another, each attacking that corner of the unknown which most attracts his fancy. All are ambitious to accomplish great results, each one hopes to make some discovery of signal importance; and so the drier and less attractive details of investigation are oftentimes neglected. The field is cut up in many fields, between which the ground is uncultivated, and there no harvest is gathered. To systematize research; to bring about coöperation; to erect a State out of a scattered people; to put the art of discovery itself more truly upon a scientific basis, is a problem for the future. In the final solution of this problem the practical inventor may help. The wealth created by invention should serve as the organizer. The law of mechanics, that action and reaction are equal and opposite, applies to human affairs as well as to the physical forces. Hence, since scientific discovery makes invention possible, it is clear that the inventor owes to science a return. That some of the harvest should go back to its source as seed is not an unreasonable expectation. Indeed, it is justified by history; and if we trace back to their origin the endowments of our universities we shall find that the successful inventors have done their fair share. What more is needed, and on what new lines?

In the science of astronomy this question is partly answered already. Every endowed observatory is an institution for research, and outside of that the observers have little else to do. They are employed primarily to gather and discuss data, the raw material of science, and all other duties are secondary. In the solution of large problems several observatories may co-operate, each taking a definite and prescribed portion of the field, and so the science grows symmetrically, with fewer gaps than exist in other departments of knowledge. Perfection of work, completeness in the absolute sense of the term, is, of course, unattainable, but to that ideal, within the limits of its province, astronomy approaches most nearly. By its example the other sciences may profit.

Now for chemistry and physics, institutions should be organized resembling in policy the astronomical observatories. I mean, of course, endowed laboratories for research in which the greater problems could be effectively handled, and important data determined with the highest accuracy. The more precise, and at the same time the most difficultly measurable physical constants are of direct value to industrial science, and their determination should not be left to the caprice or convenience of individuals. They represent routine work of the most tedious kind; their measurement involves the highest degree of skill and the most elaborate resources, and they are the foundation stones of exact theory. They are needed by pure and applied science alike; and yet, under existing conditions, their determination is but scantily encouraged. They yield to the investigator results more solid than brilliant; they do not give quick returns of fame; and so, other researches, more showy or more profitable, are in greater favor. With most men of science, unfortunately, research is a matter secondary to other duties; the professor must teach, the commercial chemist must analyze, and only the time left over, the occasional leisure hour, is available for higher studies. Many an able man, willing and enthusiastic, who might otherwise benefit mankind by investigation, is crowded out of the field by sheer necessity. He is loaded with labors which leave no time for research, and his capacities are exhausted in mere routine. For such men, opportunities should not be altogether wanting.

Sometimes the kind of work here indicated has been carried on at public expense; for example, the classical researches of Regnault upon gases and vapors were maintained by the French Government: but all such assistance has been sporadic; while the investigations needed should be continuous and systematic. In a laboratory endowed, equipped and manned for research only, a rich harvest of results would be sure, far exceeding in value the cost of the undertaking. No such laboratory, I believe, now exists in the civilized world, and the United States might well have the glory of being the first organizer. In its Patent Office it has led all other nations, and in the science which underlies invention it might lead also. To the manufacturers and inventors of America I offer these suggestions in the hope that they may be speedily realized.

GENERAL WASHINGTON AS AN INVENTOR AND PROMOTER OF THE USEFUL ARTS.

An Address delivered at Mount Vernon, April 10, 1891, by J. M. Toner, M. D., on the occasion of the Visit of the Officers and Members of the Patent Centennial Celebration.

It is fitting that on an occasion like the present, which reviews a past and forecasts a coming century, the friends of the great American Patent System should visit the tomb of Washington. For where rest the ashes, hovers, methinks, something of the spirit of the man whose genius and valor led the thirteen dependent American colonies[1] to independence; and whose influence, a century ago, formed them into one united Federal Government under a written constitution of exceeding wisdom, of which he was one of the principal authors, and under which our country, our patent system and our mechanical inventions have made such marvelous progress.

If it cannot be claimed that Washington originated the idea of recognizing property in inventions, he was, without doubt, the chief exponent of the views and sentiments which brought together the convention of delegates from the several States to consider their future well-being and to form a more perfect Union.[2]

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[1] New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia.

[2] Washington, from his position at the head of the army throughout the war for independence, and his frequent correspondence with the Governors of the States as well as with many of the more influential citizens of the several States, in the interest of the army and to secure supplies for the soldiers, was led to a more intimate knowledge of the feeling of the people, and to see the weakness of the confederacy more clearly than any other man of his day. Its want of cohesive as well as want of coercive power had, to his mind, demonstrated its defects for national purposes. After peace was restored its want of power to regulate commerce—foreign and domestic; to make treaties, and to provide for

By a unanimous desire of the convention General Washington was called upon to preside over the meeting. Through the protracted and careful deliberations of this equal-rights and liberty-loving conclave of statesmen was evolved our written Constitution which has welded the United States into a nation, and which has so admirably served us for a century.[3] This,

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the payment of debts contracted by the confederacy, was notorious and created great discontent. It was becoming evident to thinking men that an alarming crisis was near unless some effectual remedy could be devised. Washington's sentiments were often freely and strongly expressed upon the subject. "That we have it in our power," said he, "to become one of the most respectable nations upon earth, admits, in my humble opinion, of no doubt, if we would but pursue a wise, just and liberal policy towards one another, and keep good faith with the rest of the world. That our resources are ample and increasing, none can deny; but while they are grudgingly applied, or not applied at all, we give a vital stab to public faith, and shall sink, in the eyes of Europe, into contempt. It has long been a speculative question among philosophers and wise men whether foreign commerce is of real advantage to any country; that is, whether the luxury, effeminacy and corruptions which are introduced along with it are counterbalanced by the conveniences and wealth which it brings. But the decision of this question is of very little importance to us. We have abundant reason to be convinced that the spirit of trade which pervades these states is not to be restrained. It behooves us, then, to establish just principles, and this cannot, any more than other matters of national concern, be done by thirteen heads differently constructed and organized. The necessity, therefore, of a controling power is obvious, and why it should be withheld is beyond my comprehension."

The union, as at first organized, was fast losing respect, as it did not meet the exigencies or fulfill its purposes; and chaos was inevitable, unless reform was speedily effected. The mode of doing this engaged Washington's attention, and to him more than to any other man are we indebted for the Constitution which has united the States as one great union.

3 Sparks, in commenting upon this period of Washington's life and his part in the evolution of the Constitution, says: "He did not go to the convention unprepared for the great work there to be undertaken. His knowledge of the institutions of his own country and of its political forms, both in their general character and minute and affiliated relations, gained by inquiry and long experience, was probably as complete as that of any other man. But he was not satisfied with this alone. He read the history and examined the principles of the ancient and modern confederacies. There is a paper in his handwriting which contains an abstract of each, and in which are noted, in a methodical order, their

our *magna charta*, may be claimed as one of the most original and beneficent inventions in the art of government ever devised to secure to a people liberty, regulated by law, with equal justice to all.[4]

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chief characteristics, the kinds of authority they possessed, their modes of operation and their defects. The confederacies analyzed in this paper are the Lycian, Amphictyonic, Achæan, Helvetic, Belgic and Germanic. He also read the standard works on general politics and the science of government, abridging parts of them, according to his usual practice, that he might impress the essential points more deeply on his mind. He was apprehensive that the delegates might come together fettered with instructions which would embarrass and retard, if not defeat the salutary end proposed. 'My wish is,' said he, 'that the convention may adopt no temporizing expedients, but probe the defects of the constitution to the bottom and provide a radical cure, whether they are agreed to or not. A conduct of this kind will stamp wisdom and dignity on their proceedings, and hold up a light which sooner or later will have its influence.' Such were the preparations and such the sentiments with which Washington went to the convention." (Sparks' Washington, vol. I, p. 434.)

4 The attention which the Continental Congress, in the Declaration of Independence and the notable occurrences of the Revolution, merited and received from historians, biographers and painters, has been so absorbing as in a measure to obscure or cause to be overlooked the history and *personnel* of the equally important convention of 1787, which drafted the Constitution of the United States. The claims of these statesmen to the grateful remembrance of posterity, if judged from a proper estimate of the happy Constitution they formulated, rest on a broad, just and honorable basis. The beneficent results flowing from their judicious labors have proved of the highest importance to America and the science of government everywhere. Indeed, it required the constitutional and indissoluble union of the States, devised by this convention, to render the Declaration of Independence of practical value by the creation of a National Government, preserving at the same time the autonomy of the States. And yet, strange as it may seem, the names of the seventy-three delegates appointed to the convention, or even the thirty-nine members who signed this precions document, are to a great extent unfamiliar to the public. Properly enough the names and the portraits of the signers of the Declaration of Independence are known to nearly every person, because they have been treated in a popular manner by artists and historians, and placed before an admiring public. The same and even greater respect is due to the framers of the Constitution. The neglect of the *personnel* of the constitutional convention, as I apprehend, is accidental rather than intentional; and is, at least, undeserved, I am confident all will admit. This work has stood the test of a century and has proved

It is not certain who introduced the proposition regarding Patents and Copyrights; but, considering the *personnel* of the convention, it might have originated with either Washington or Franklin, and was certain of an earnest support from both.

This was the first assembly of law-makers in the history of the world to reduce this conception to a practical formula, or make it a fundamental principle that inventors and authors have rights in their inventions which should be recognized and protected, for a limited time at least, by law. This conclusion they embodied in the Constitution of the United States.[5]

The rise and development of the American Patent System and the immense influence that it and the Patent Office, as a repository of official records and inventions, have had in promoting improvements, not only in our own country but also throughout the world, you have heard from other and abler

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to be so nearly perfect as a charter of human rights as to create in the minds of some the belief that it has many of the qualities of an inspired instrument. It is to be hoped that some capable writer will produce a good, popular, illustrated history and summary of the principles of the Federal Constitution as crystalized by its authors, with the portraits and biographies of each of the members, so as to make them as familiar as household words to the people of the United States. An acceptable picture of the convention in session might, with great propriety, be extensively used to the same end as an object lesson by the Government of the United States on its legal documents, coins, medals, greenbacks, letterheads, etc. This highly interesting historical convention sat in the council chamber in the State House in Philadelphia, the same from which emanated the immortal Declaration of Independence. George Washington filled the chair and directed the deliberations of the body. His seat was placed beneath the carved coat of arms of the State of Pennsylvania which ornamented a high panel in the rear. The venerable Dr. Franklin, then in his 83d year and an invalid, but with vigorous intellect, was carried to and from the convention in his Sedan chair which he brought with him from Europe. His arm-chair was placed on the left of the President near the bar. Judge James Wilson sat near the bar on his left. The other members disposed of themselves as they found it convenient.

5 The following is the clause in the Constitution of the United States which secures the rights of inventors and authors: "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors exclusive Right to their respective Writings and Discoveries."

speakers. Here, at Mount Vernon, the duty has been assigned to me, near the close of this brilliant and, I trust, profitable Patent Centennial, to speak to you of the great Washington as an inventor and promoter of improvements in the arts.

In compliance with this complimentary assignment, I shall venture to claim your attention for only a brief period; not but that much could be said confirmatory of the fact that General Washington, who owned these broad acres, enjoyed this magnificent prospect, and for half a century dispensed a most bountiful hospitality in this revered mansion, was ever on the alert for bettering man's condition in life through education, and by improvements in all kinds of productive machinery and labor-saving devices.

While it may not be claimed that George Washington is descended from a line of inventors, sages or heroes, history confirms the fact that he sprung from an intelligent, enterprising, courageous, self-reliant, truth-and-labor-loving, God-fearing stock, who were in their day and generation leading citizens in the community in which they lived. The instances in which Washington gave encouragement to new inventions are numerous, and the fact is beyond question that he invariably provided the best machinery for his mills and farms, and everything considered, for all the industries under his control, as is testified in many letters.[6] He also had a kind word of encour-

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[6] The following letter to a correspondent, to which Sparks adds a note, in the following words, vol. x, p. 68: "The Baron de Poellnitz had a farm in the neighborhood of New York, where he tried experiments in agriculture He also wrote a pamphlet on the subject, and was the inventor of various agricultural machines and implements, particularly a threshing machine and the horse-hoe."

NEW YORK, 29 *Dec.*, 1789.

SIR: I have received your letter of the 26th and given such attention to the manuscript which accompanied it, as my obligations to public duties would permit. I shall always be happy to see experiments in agricultural machines, which can be brought into general use. Of those in your possession I was not able to form a decided judgment, except in the instance of the horse-hoe. Of the utility of that instrument I was fully convinced. I propose to take some farther occasion of seeing the manner in which the threshing machine operates, when you shall let me know it is in readiness for the purpose; and in the meantime,

I am with due consideration, etc.,

G^o^ WASHINGTON

agement for those working to the end of devising new methods and improved implements in any of the arts. This spirit, along with his official duty to see proper laws enacted by Congress under the authority of the Constitution which he had assisted in drafting, led him in his first annual message to commend measures to foster new and useful inventions and[7] doubtless gave him special pleasure in signing the first patent law enacted under the government of the United States,[8] as well as in attaching his name to the first patent issued shortly after[9] under an act of Congress.

Just one century ago, George Washington, then President of the United States, was for a week at Mount Vernon. He was then setting out on a tour through the Southern States, having made a similar semi-official one of the Eastern States in October and November, 1789. His Diary for this date, a century ago, is as follows:

"*Thursday, 7th April, 1791.*—Recommenced my journey with Horses apparently much refreshed and in good spirits.

"In attempting to cross the ferry at Colchester with the four Horses hitched to the Chariot by the neglect of the person

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He made many enquiries by letters to his correspondents relative to the practical efficacy of threshing machines, which had been experimented with both in Europe and America. In a letter to Governor Henry Lee of Virginia, October 16, 1793, he speaks hopefully of a threshing machine devised by Col. Taliaferro, but which he had not seen, but had heard good reports of its performance. He insists the machine must be simple in construction. "The model," he says, "brought over by the English farmers may also be a good one, but the utility of it among careless negroes and ignorant overseers will depend absolutely upon the simplicity of the construction, for if there is anything complex in the machinery it will be no longer in use than a mushroom is in existence."

7 "The advancement of Agriculture, Commerce and manufacture by all proper means will not, I trust, need recommendation; but I cannot forbear intimating to you the expediency of giving effectual encouragement as well to the introduction of new and useful inventions from abroad as to the exertions of skill and genius in producing them at home, and of facilitating the intercourse between the distant parts of our Country by a due attention to the Post-Office and Post-Road."—*Washington's first annual message, January 8, 1790.*

8 April 10, 1790.

9 July 30, 1790.

who stood before them, one of the leaders got overboard when the boat was in swimming water and 50 yards from the shore—with much difficulty he escaped drowning before he could be disengaged—His struggling frightened the others in such a manner that one after another and in quick succession they all got overboard harnessed & fastened as they were and with the utmost difficulty they were saved & the Carriage escaped been dragged after them, as the whole of it happened in swimming water & at a distance from the shore—Providentially—indeed miraculously—by the exertions of people who went off in Boats & jumped into the River as soon as the Batteau was forced into wading water—no damage was sustained by the horses, Carriage or harness.

"Proceeded to Dumfries where I dined—after which I visited & drank Tea with my Niece, M^{rs} Tho^{s} Lee.

"*Friday, 8th.*—Set out about 6 o'clock—breakfasted at Stafford Court House—and dined and lodged at my Sister Lewis's in Fredericksburgh.

"*Saturday, 9th.*—Dined at an entertainment given by the Citizens of the town. Received and answered an address from the Corporation [of Fredericksburgh].

"Was informed by M^{r} Jn^{o} Lewis, who had not long since been in Richmond, that M^{r} Patrick Henry had avowed his interest in the Yazoo Company; and made him a tender of admission into it wh^{h} he declined—but asking, if the Company did not expect the Settlement of the lands would be disagreeable to the Indians was answered by M^{r} Henry that the C^{o} intended to apply to Congress for protection—which if not granted they would have recourse to their own means to protect the settlement—That General Scott had a certain quantity of Land (I think 40,000 acres) in the Company's grant & was to have the command of the force which was to make the establishment—and moreover—that General Muhlenburg had offered £1000 for a certain part of the grant—the quantity I do not recollect if it was mentioned to me.

"*Sunday, 10th.*—Left Fredericksburgh about 6 o'clock—myself, Maj^{r} Jackson and one Servant breakfasted at General Spotswoods—the rest of my Servants continued on to Todd's Ordinary where they also breakfasted. Dined at the Bowling Green—and lodged at Kenner's Tavern 14 miles farther—in all 35 m.

Before entering upon the main subject of this discourse, I shall first endeavor to recall a few of the more notable traits of character in the boyhood and early manhood of him whose life and achievements make these ancestral possessions on the Potomac, the most noted and dearly loved homestead in the world.[10] A consensus of the most careful studies of the life of George Washington from his childhood, represents him as mentally and physically precocious—attaining almost his full stature in his 19th year, but throughout his youth, diffident almost to bashfulness—yet men of experience marveled at the maturity of his judgment and his knowledge of the details of business in general and public affairs. He seems to have had

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[10] The original patent for the land embraced in the Mount Vernon tract was granted March 1st, 1674, by Thomas (Lord) Culpeper to Col. Nicholas Spencer and Lieut.-Col. John Washington for 5,000 Acres, located at the mouth of Little Hunting creek on the Potomac. They made an equal division, and the part falling to John Washington descended by bequest without subdivision until it was devised in parcels by Gen'l Washington to his heirs. Mount Vernon has never known other owners than Washingtons until 200 acres of it, including the tomb and mansion, came into the possession of the "Mount Vernon Ladies' Association," which has secured the tomb and home of Washington for all time for the people—as a memento of the founder of the American Republic.

TEXT OF THE ORIGINAL PATENT.

To all to whome these p^{r}sents shall Come the Owners and propryet^{rs} of all that tract and Terrytory of land in Virginia in America mentioned in his Ma^{ties} Letters Pattent under the Broad Seale of England bearing date the Eighth day of May in the Nine and twentieth yeare of his . . . . Ma^{ties} Raigne send Greeting in our Lord God Everlasting KNOWE Yee that by Virtue thereof and for and in Consideration of the yearely Rent and Agreem^{ts} hereafter Expressed and Reserved Wee have Bargained Sold Released and Confirmed and doe by these p^{r}sents under our Co^{m}mon Seal Bargaine Sell Release and Confirme unto Coll: Nicholas Spencer and Le^{t} Coll: John Washington of Virginia in America ffive thousand Acres of Land Scituate Lying and being within the said Terrytory in the County of Stafford in the ffreshes of Pottomeeke River and neere oppositt to Piscatoway Indian Towne in Mariland and neere the Land of Cap^{t}: Giles Brown on the North side, and neere the Land Surveyd for M^{r} W^{m} Grein M^{r} W^{m} Dudley and others on the South side, being a necke of Land bounded betwixt two Creeks and the Maine River, on the East side & to by the said Maine River of Pottomeeke, on the North & to by a Creeke Called by the English Little Hunting Creeke and the maine Branch thereof on the south & to by a Creeke named and Called by the Indians Epsewasson Creeke and the maine Branch thereof which Creeke devides this Land of Grein and Dudley no frivolous or idle boy-life. When a lad he was noted for his punctual attendance at school, for his application to study, and his ability to master mathematical problems. He was strong and agile in play, and a leader in all the more difficult feats and sports of climbing, leaping, pitching, throwing, etc., indulged in by his playmates. A sense of exact justice was

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and others on the west side by a right Lyne drawne from the Branches of the afore-said Epsewasson and Little Hunting Creeke including the aforesaid Quantity, togeather with all Trees profitts Comodityes Emolum^{ts} and Additions whatsoever therein belonging All manner of Mines of Gold, Silver and Copper therein only excepted and foreprised To Have and to Hold all and singular the p^{r}mises (except before excepted) to the said Coll: Nicholas Spencer and L^{t}: Coll: John Washington their heires and Assignes forever Yieldinge and paying therefore yearely and every yeare the Rent of ffoure shillings of Lawfull money of England for every Hundred Acres and soe proportionably for a Bigger or Lesser Quantity to the said propriet^{rs} our heires and Assignes forever upon the ffirst day of November Com^{m}only Called the ffeast of all s^{ts}: att the Court house of the County where the said Lands are scituate, or such other place within our said Terrytory as wee or any one or either of us shall derect and appoynt from tyme to tyme The first paym^{t} thereof to bee made on the first day of November now next ensuing Provided allwayes that if the said Coll: Nicholas Spencer and L^{t} Coll: John Washington their heires and Assignes doe yearely and every yeare betweene the feast day of st. Michaell the Archangell and the said ffirst day of November pay or Cause to bee paid unto us the said Proprieto^{rs} our heires and Assignes forever the yearely Rent of two shillings sterling in specie for every Hundred Acres and soe p portionably for a Bigger or Lesser Quantity that it shal bee taken and accepted by us the said proprieto^{rs} our heires and Assignes in ffull satisfaccon of the ffoure shillings above mentioned Provided alsoe that if the said Coll: Nicholas Spencer and L^{t} Coll: John Washington their heires and Assignes shall not Plant or Seate the said Lands or Cause the same to bee planted or Seated within the terme of three yeares next ensuing the date hereof; that then this Grant & everything herein Contayned shall bee void and Null to all Intents & purposes whatsoever as if the same had never beene made And lastly it is Agreed that this Grant bee Registred in due forme in Virginia aforesaid by the said Coll: Spencer and L^{t} Coll: John Washington or their Assignes before the ffirst day of November now next ensuing In Witnesse whereof wee y^{e} S^{d} Proprieto^{rs} have here onto fixed our Com^{m}on seale and Caused the same to bee Countersigned by one or more of us in the Naime of the Rest this ffirst day of March In the 27th yeare of the Raigne of our Soveraigne Lord King Charles y^{e} second & Anno Dom 1674.

THO CULPEPER

It is probable that the first purchase of real estate made by George Washington was that of a tract of unseated land embracing 550 acres, which he selected on the Bullskin early in his visits to the Shenandoah Valley. He received a deed for this land in Frederick County, Va., from Lord Fairfax, the original proprietor, which bears date October 25th, 1750.

developed in him in his childhood which was recognized by his school-fellows, who, by common consent, on occasions of dispute, selected him to act as umpire, and unreservedly acquiesced in his decisions. This trait of weighing evidences and reaching justice he had, to an eminent degree, through life.

Among the early notable performances of Washington, which have come down to us, is his formula of maxims or "Rules of Civility and Decent Behaviour in Company and Conversation," the ground-work of which was probably derived, through Hawkins's translation, from the original French. The maxims, as recast, he recorded in his copy-book in 1745, which, with other school exercises, is preserved in the Department of State at Washington. These rules do honor alike to the head and heart of him who had the genius to adopt and improve them; and though Washington entered no claim to originality, they would to-day entitle him to a copyright which has actually been granted to two aspiring editors[11] who have recently published editions of them.

The consummate control which Washington habitually maintained over his feelings, so that judgment might be his guide, his never-flagging industry and strict attention to duty, together with his most inflexible principles of justice, enabled him as nothing else could to deport himself with undeviating propriety and dignity on every occasion, and made him the great leader he was.

An example which illustrates the early tastes and accomplishments of Washington is found in a few plots of surveys and topographical sketches made of the Potomac River and Little Hunting Creek, here at Mount Vernon, as exercises in surveying while visiting his half-brother, Major Lawrence Washington, in 1747, which have happily escaped the destructive hand of time, and may be found in the Department of State.

The practical acquirements, the disciplined habits, the energetic and intelligent application to business affairs, secured for George Washington the patronage of Lord Fairfax, the proprietor of the Northern Neck of Virginia, who had met him

11 The Rev. Moncure D. Conway and Dr. J. M. Toner.

repeatedly at "Belvoir" and Mount Vernon, and who, seeing from his work that he was a youth of unusual ability, engaged him as a surveyor and factor in his land office, which was then at "Belvoir."

Washington set out from "Belvoir" upon this, his first remunerated employment, when he was just one month over sixteen years of age, to associate with practical men of business in a business way and to discharge important and responsible duties. He kept a diary of this "journey over the mountains," as he termed it, and of the surveys he then made, which is full of interest and which is at present in course of publication. In this business, he acquitted himself to the entire satisfaction of Lord Fairfax, who found it to his interest to secure young Washington's services on a more permanent and extended scale in connection with the surveying and settlement of his lands in the Valley of Virginia, then in much demand by actual settlers. This congenial and profitable employment was, however, terminated in the fall of 1751 by the failure of Major Lawrence Washington's health, and the necessity of his seeking a milder climate in the island of Barbadoes, on the voyage to which place his brother George was induced to accompany him. The attachment of these brothers to each other had been especially strong from childhood, so that George did not hesitate, for a moment, to sacrifice a lucrative position to discharge a fraternal duty. This was the only occasion on which George Washington was ever beyond the territory of his own country. During this journey, as was his custom, he kept a diary which is replete with statesmanlike observations. This journal is also in the hands of a publisher.

During the summer of 1751, Major Lawrence Washington resigned the office of Adjutant Inspector of the Militia of Virginia with the rank of major, to which position he had his brother George appointed, with the pay of one hundred and fifty pounds a year. This was George Washington's first military commission. With his usual assiduity, he at once set to work to inform himself of his official duties, and to acquire, by study and drill, the knowledge necessary for their proper discharge. To this end he employed a practical drill-master and teacher of the sword exercise, and speedily mastered both manuals.

When, in 1753, the Governor of Virginia wanted a man of address, courage and perseverance to execute the difficult and hazardous task of penetrating for several hundred miles into a wilderness which sheltered many hostile savages and the armed forces of an unfriendly foreign nation, all voices counseled the appointment of Major George Washington to this embassy. I refer, of course, to the occasion of Governor Dinwiddie's serving a notice upon the Commandant of the French forces at Fort *La Bœuf* that they were trespassing upon the territory of His Majesty, the King of Great Britain, and warning them to depart.[12] Washington accepted the mission and set out to execute it the same day, October 31st, 1753. It should be borne in mind that, at that time, the whole region about the head-waters of the Ohio, and, indeed, nearly all the territory west of the Blue Ridge in Virginia and Pennsylvania was nearly an unbroken forest, the happy hunting grounds of hostile Indians. The French, it is true, had made a few but no very considerable settlements in the great Mississippi Valley, and claimed the territory by right of discovery. This mission, considering the time at which it was undertaken and the difficulties that had to be overcome, must be placed in the category of heroic enterprises, while the political effects flowing therefrom are among the most important in the history of our country. Major Washington performed this duty with such promptness and good judgment, as to receive the thanks of the Governor of Virginia and his

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[12] The estimation in which Major George Washington was held by Governor Dinwiddie then and for some time previous, may be shown by his letter to the Lords of Trade, written November 17th, 1753, in which the Governor said: "I have sent out a gentleman of distinction to the French Camp on the Ohio with my letter to the Commanding Officer, to know the reasons and by what authority he invades His Majesty of Great Britain's territory in the time of a solid peace subsisting between the two Crowns."

And in another despatch of the same date the Governor of Virginia writes: "I have commissioned Mr. Washington, a Major and one of the Adjutants of the Militia of this Dominion, to proceed to the French camp, etc." (Colonial Office Records of Virginia, 1750—1780).

Council. He kept notes of his journey from the time he left Williamsburg until he returned, with which, when referred to by Washington to refresh his memory, the Governor was so much pleased that he requested their author to write them out as a Report, which he did in one day, and they were immediately printed by public authority. The modesty of Washington throughout this journal is as conspicuous and characteristic of the man and his heroism as his diplomacy with the Indians and the French officers was admirable. The pretensions of the French, as set forth by the statements of their own officers and recorded in this journal, brought Major Washington's name into prominence in all the discussions in Great Britain, France and the several American Provinces relative to this trans-Alleghany territory. His reputation for sagacity, courage and diplomatic ability had thus acquired international celebrity. Henceforth he was a factor in the politics and policy of the nations which were engaged in maintaining colonial settlements in North America.

Washington declined the chief command of the armed expedition immediately set on foot by Governor Dinwiddie to build a fort or forts at the forks of the Ohio, as recommended in his journal or report to the Governor, but accepted the position of second to the Commander-in-Chief. In this service, as Lieutenant-Colonel, he won the distinction of having led the first body of armed American troops across the Alleghany mountains to reclaim the great West from the forest, the savage and the French. The death of the Commander-in-Chief, Col. Joshua Fry, occurred at what is now Cumberland, Md., May 31st, 1754, while he was *en route* to assume active command, whereupon the whole conduct of the expedition devolved upon Col. Washington, who was, at the time, at the head of a detachment of the Virginia Regiment on the west side of the Alleghany mountains. As is known to those acquainted with the early history of our country, the battle of the Great Meadows and the capitulation of Fort Necessity terminated this campaign to the discomfort of Virginia, the mortification of Washington, and the great disappointment of Governor Dinwiddie. Washington resigned from the service in the fall of 1754, on account of an army regulation which denied rank to Colonial officers when serving in commands along with British officers, the latter holding their commissions from the King.[13]

The failure of the Virginia troops to establish forts west of the Alleghany mountains, led the British Ministry to send General Braddock to America in 1755, with two regiments of regulars, which were largely reinforced by colonial troops, but with no colonial officer of higher rank than a captain, to drive

[13] Military rank in the Colonies at that time was not founded on either justice or sound policy, and was, therefore, at times the occasion of great irritation between Colonial and British officers. Fort Cumberland, for a considerable period the most advanced military post to the westward, while on the border of Virginia, was actually in Maryland, and, after Braddock's defeat, was garrisoned by thirty men under Capt. Dagworthy, under a commission from the Governor of Maryland. The captain had served in the Braddock Expedition, under a commission from the King, and, whenever opportunity offered, would claim this old commission to entitle him to rank any officer holding a commission from one of the Colonial Governors. When Washington had occasion to be at Fort Cumberland, this doughty captain would place himself upon this former commission and pay no attention to the orders of Col. Washington.

This was not only exasperating, but subversive of discipline and efficiency in the service, which Washington was determined to correct or to retire from the service. He accordingly, with the approval of all the officers of the Virginia forces, got the consent of Governor Dinwiddie to refer the whole matter of rank, as it affected the service in America, to Gen. Shirley, at the time Commander-in-Chief of His Majesty's armies in the American Colonies. By request of the Virginia officers, the petition was to be presented to Gen. Shirley by Col. Washington in person.

Accordingly, Washington with his aide-de-camp, Capt. George Mercer set out from Williamsburg for Boston February 4th, 1756, to present their petition on the question of rank. Washington was well received by Gen. Shirley, who examined into the matter on its merits, and responded by giving a pointed order that Capt. Dagworthy should be subject to Col. Washington's orders.

But this, while it corrected the immediate controversy, did not solve the real difficulty which existed in the army regulations, the amendment of which required the action of the Ministry. The subject, therefore, continued to be discussed, and petitions continued to be sent by other Colonial officers to the Home Government, representing the injustice of the rule as applied to the military service in America. William Pitt, while Secretary of State, in 1758, in a spirit of conciliation towards the Colonies, procured a modification of the regulations concerning the rank of British and Colonial officers on duty in the same service, putting them the French from Fort Duquesne, and hold that position at the head of the Ohio.[14] The eminently valuable service which Col. Washington performed while a volunteer aide in this expedition (for he held no command) in extricating Braddock's shattered forces after the engagement and their defeat on the Monongahela, July 9th, 1755, is a part of the history of our

in a position much nearer equality, but without fully reaching it. While this allayed somewhat the complaint of the Provincials, it served, nevertheless, to annoy the regulars.

The army regulations were specific, and in the language following: "That all such as were commissioned by the King, or by his general Commander-in-Chief in North America, should take rank of all officers commissioned by the Governors of the respective Provinces. And further, that the general and field officers of the Provincial troops should have no rank when serving with the generals and field officers commissioned by the Crown: but that all captains and other inferior officers of the Royal troops shall take rank over Provincial officers of the same grade having older commissions."

It is almost inconceivable, but it is nevertheless true, that up to the campaign which drove the French out of their North American possessions not a Provincial colonel had ever been asked by any British officer to join in a council of war. The Provincial officers, therefore, even to colonels, knew no more than a sergeant what was to be done before their orders came. In the nature of things, the Colonial officers were much better acquainted with the topographical features of the country and the difficulties to be overcome, than any British officer, or a stranger, could possibly be, as well as with the methods of warfare peculiar to the Indians. Yet, these and other potent reasons, and the further fact that the Colonial officers were fighting on their own soil and for their own firesides, were totally disregarded. It was, therefore, not to be wondered at that Col. Washington's sense of justice rebelled at such a regulation.

[14] E. D. Neill, quoting from Peyton's Reminiscences of General Braddock while at Williamsburg, Va., 1755, gives the following extract from a letter written to the General about this time, as follows:

"Is Mr. Washington among your acquaintances? If not, I must recommend you to embrace the first opportunity to form his friendship. He is about twenty-three years of age, with a countenance both mild and pleasant, promising both wit and judgment. He is of a comely and dignified demeanor, and at the same time displays much self-reliance and decision. He strikes me as being a young man of an extraordinary and exalted character, and is destined, I am of opinion, to make no inconsiderable figure in our country."

Mr. Neill says that Washington was at a dinner given to Gen. Braddock at Williamsburg, March 1755, by Gen. John St. Clair, his Quartermaster, just after his arrival in Virginia.—[*Washington Adapted for a Crisis—p. 7, by Edward D. Neill, D. D.*]

country. His conduct and bravery in the emergency met unqualified praise alike from British and Colonial officers and men. This disaster left the frontier of Virginia, Maryland and Pennsylvania, for a time, without any organized or adequate military protection, but speedily the praise bestowed upon Col. Washington for his generalship in the late engagement assumed the nature of a universal, popular demand to Gov. Dinwiddie for his appointment to a command of the Virginia troops for the protection of the frontier settlements. It was known to the Assembly, the Governor and his Council, that Washington had retired from the service solely on account of the military regulations discriminating in rank against Colonial officers. It was also known he would not again accept command unless his rank should be respected.[15] As the corps about to be organized was to consist wholly of

[15] Washington bore with dignity the slight the Governor perpetrated in reducing his command, which he knew at the time, would cause the Colonel to resign his commission. He had made great personal sacrifices to serve his country in the military line, but never received proper encouragement from Gov. Dinwiddie. The following extract from a letter to his brother Augustine, written August 2d, 1755, shortly after Gen. Braddock's defeat, shows both his courage and his sense of justice; he says: "I can nevertheless assure you, and others 'whom it may concern' (to borrow a phrase from Goverour Innes) that I am so little dispirited at what has happened, I am always ready, and always willing, to render my Country any Services that I am capable of but *never* upon the *Terms* I have done;—having suffered much in my private Fortune, besides impairing one of the best of constitutions.—

"I was employed to go a Journey in the Winter (when I believe, few or none would have undertaken it),—and what did I get by it?—My expences borne!—I then was appointed, with trifling Pay, to conduct a hand-full of Men to the Ohio:—What did I get by that? Why, after putting myself to a considerable expence, in equipping and providing necessaries for the Campaign, I went out—was soundly beaten—lost them all!—came in and had my Commission taken from me, or, in other words, my *command* reduced, under *pretence* of an Order from Home!—I then went out a Volunteer with Gen. Braddock, and lost all my Horses and many other things. But being a *voluntary* act, I ought not to have mentioned this; nor should I have done it was it not to shew that I have been upon the losing order ever since I entered the service, which is now nearly two years. So that I think I cannot be blamed should I, if I leave my family again, endeavor to do it upon such terms as to prevent my suffering—to *gain* by it being the least of my expectations."

Virginia Provincial forces, no controversy, it was thought, could arise as to rank; and with this understanding and an earnest desire on Washington's part to serve his country, he accepted the appointment. The Assembly promptly voted £40,000 to raise and equip troops. This was the largest sum Virginia had ever appropriated for this service.

Washington was commissioned by the Governor, August 14th, 1755, Colonel of the Virginia forces, to be immediately raised to build forts and protect the people on the frontier against the incursions of the Indians.[16] He accepted the appointment and continued at the head of the Virginia forces until the French were, by the Forbes Expedition, in which Washington took a conspicuous and honorable part, obliged to abandon Fort Duquesne in the Fall of 1758. I have dwelt somewhat in detail upon this early period of Washington's life because these were the years in which he was acquiring military experience and ripening, by study and reflection, into the grandest military character and philosophic statesman the world has ever produced.

In July, 1758, while with his regiment in the field, he was elected from Frederick county to a seat in the House of Burgesses of Virginia. His favorite project, the driving of the French from Fort Duquesne, having now been accomplished, he felt at liberty to resign his command in the army; which he did in December of this year.

Early in January, 1759, he was married, and in April, shortly after the adjournment of the Assembly, he brought

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[16] Washington's letter to his mother, at the time, on this subject fully represents his position, and is here given in full:

"TO M[RS] WASHINGTON,
Near Fredericksburgh,

HON[D] MADAM—

"If it is in my power to avoid going to the Ohio again, I shall; but if the command is pressed upon me, by the general *voice* of the country,—and offered upon such terms as cannot be objected against,—it would reflect dishonour upon me to refuse it; and *that* I am sure must or *ought* to give you greater uneasiness, than my going in an honorable command; for upon no other terms will I accept it—At present I have no proposals made to me, nor have I any advice of such an intention, except from present hands.

I am, D[r] Madam, &c.,

MOUNT VERNON,
August 14th, 1755."

From draft and transcript in the Department of State.

his wife to Mount Vernon.[17] It was not until after his retirement from the army and his marriage that Washington was able to give much personal attention to the management of his estate. His brother, John Augustine, in his absence, had looked after his servants and his plantations to the best of his ability.[18]

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[17] The following account of the personal appearance of Col. George Washington is given in a letter by Capt. George Mercer to a friend in England in 1760. This copy was taken by the writer, from a copy in the possession of Col. Lewis W. Washington, of "Bell-air," near Hall Town, Jefferson county, West Virginia, 1855:

"Although distrusting my ability to give an adequate account of the personal apearance of Col. George Washington, late Commander of the Virginia Provincial troops, I shall, as you request, attempt the portraiture. He may be described as being as straight as an Indian, measuring six feet two inches in his stockings, and weighing 175 pounds when he took his seat in the House of Burgesses in 1759. His frame is padded with well-developed muscles, indicating great strength. His bones and joints are large, as are his feet and hands. He is wide shouldered, but has not a deep or round chest; is neat waisted, but is broad across the hips, and has rather long legs and arms. His head is well shaped though not large, but is gracefully poised on a superb neck. A large and straight rather than a prominent nose; blue-gray penetrating eyes, which were widely separated and overhung by a heavy brow. His face is long rather than broad, with high round cheek bones, and terminates in a good firm chin. He has a clear though rather colorless pale skin, which burns with the sun. A pleasing, benevolent, though a commanding countenance, dark brown hair, which he wears in a cue. His mouth is large and generally firmly closed, but which from time to time discloses some defective teeth. His features are regular and placid, with all the muscles of his face under perfect control, though flexible and expressive of deep feeling when moved by emotions. In conversation he looks you full in the face, is deliberate, deferential and engaging. His voice is agreeable rather than strong. His demeanor at all times composed and dignified. His movements and gestures are graceful, his walk majestic, and he is a splendid horseman."

[18] The estate of Mount Vernon, or about 4,000 acres of it, was bequeathed by General Washington to his nephew, Judge Bushrod Washington, son of his brother, John Augustine, in the following language: "Partly in consideration of an intimation to his deceased father, while we were both bachelors, and he had kindly undertaken to superintend my estate during my military services in the former war between Great Britain and France, that if I should fall therein Mount Vernon, then less extensive in domain than at present, should become his property." On Justice Washington's decease, without children, he left it to his nephew, John Augustine, who, by will, left it to his widow, who conveyed it to her son John Augustine, who sold two hundred acres including the mansion and the tomb to "The Ladies' Mount Vernon Association of the Union." To them the country owes a debt of gratitude for the excellent condition in which everything relating to the home of Washington is kept. Perhaps it is not too much to say ladies only could manage Mount Vernon so as to keep it free from politics, faction and peculation. Under their care it is annually growing in the affections of a grateful and patriotic people.

From his youth, Washington was in the habit of taking notes and making memorandums in pocket note-books of whatever interested him, especially when engaged in expeditions or when making experiments. These memorandums assumed in time, but perhaps unconsciously to their author, the character of diaries. Of those which have escaped destruction, some are preserved in the Department of State, others in private and public libraries, and all are held as highly-prized relics. Copies of all the Washington Diaries and Journals, known to exist, have been transcribed with literal exactness for the writer and are now in his possession.

In his Diary for 1760, Washington notes, very briefly, the events occurring at Mount Vernon, and especially matters relating to the management of his plantations. These memorandums, brief as they are, show that he was giving close attention to the improvement of his estates. His personal supervision was only interrupted by occasional visits to Williamsburg to attend the meetings of the Assembly. The following extract from his Diary, at this period, gives a good example, not only of his love of agriculture, but in especial manner shows his ingenuity and fertility of invention and desire to improve the implements of husbandry.

"*Thursday, Mar. 6th. 1760*—Fitted a two-eyed plow instead of a duck-bill plow, and with much difficulty made my chariot wheel-horse plow."

"*Wednesday, Mar. 19th.*— * * * Peter (my smith) and I after several efforts to make a plow after a new model, partly of my own contriving, was feign to give it out, at least for the present."

March 21st. Washington records the fact that he had this day grafted 41 cherry-tree grafts, 12 magnum bonum plums and planted 4 nuts of the Mediterranean pine:—"The cherrys and plumb came from Col. Mason's, the nuts from Mr. Green's."

To the close of the month of March, the diary shows that he was daily grafting and planting fruit trees to the number of several hundred. For many years his diaries show that in the months of February and March he was much occupied in setting out and grafting choice fruit.

"*Monday, Mar. 24th.* * * * In digging earth for the purpose of repairing my mill-dam, great quantities of marle or Fuller's earth appeared. In the evening, in a bed that had been prepared with a mixture of dung on Saturday last, I sowed choice Lucerne and Rye grass seeds, in the garden, to try their goodness, doing it in the following order. At the end next the corner were two rows of clover-seed; in the 3^{d}, 4^{th}, 5^{th} and 6^{th}, rye grass; the last row thinnest. Sowed 7^{th} and 8^{th} barley (to see if it would come up,) the last also thinnest sown; 9^{th} 10^{th}, 11^{th}, 12^{th}, Lucerne, the next thicker and so on to the last, w^{ch} was very thick."

"*Wednesday, Mar. 26th.* * * * Spent the greater part of the day in making a new plow of my own invention."

"*Thursday, Mar. 27th, 1760.* * * * Set my plow to work and found she answered very well in the lower pasture, w^{ch} I this day began plowing with the large bay mare and Rankin. * * * Agreed to give M^{r} W^{m} Triplet £18 to build me two houses in the front of my house (plastering them also) and running walls for palisades to them from the great house and from the great house to the wash-house and kitchen also.[19]

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[19] The Mansion House, during Lawrence Washington's life, stood by itself. When George became its possessor but little improvement in buildings was made until after his marriage, then a number of out-houses were added and the grounds and gardens brought under the supervision of the Colonel's æsthetical eye. For the purpose of systematic management, the Mount Vernon estate was divided into the Mansion House Farm, of 450 acres and large bounds of woodland; the River Farm, of 1,800 acres; the Union Farm, of 841 acres; the Dogue Run Farm, of 1,076 acres, and the Muddy Hole Farm of 886 acres—a domain of nearly 4,500 acres.

The following memorandum, in General Washington's handwriting, is preserved among his miscellaneous papers in the Department of State, and gives the size and names of all of the detached buildings existing at Mount Vernon in 1799. The enumeration of windows and panes of glass in each of the houses would seem to have some relation to a tax levy:

"List of Houses at Mount Vernon, as taken by M^{r} Dulan (one of the Assessors), the 9^{th} instant on the Premises;

Dwelling House 96 feet by 32, of Wood; 2 Stories high.

No. of Windows.	No. of Paynes in each.	Total.
6	18	108
6	12	72
3	12	36
8	15	120
1	62	62
2	16	32
6	18	108
9	12	108
1	10	10
2	18	36
3	12	36

"*Saturday, April 5*. * * * Made another plow, the same as my former, except that it has two eyes and the other one."

"*Monday, April 14th*. Fine warm day, wind so'ly, and clear till the even'g, when it clouded ; no fish were to be catched to-day neither. Mixed my composts in a box with ten apartments in the following manner, viz. in No. 1 is three pecks of earth brought from below the hill out of the 46 acre field without any mixture. In No. 2 is two pecks of sand earth and one of marle taken out of the said field, which marle seem'd a little inclined to sand. 3 has 2 pecks of sd. earth and 1 of river side sand.

4 has a peck of Horse Dung.

5 has mud taken out of the creek.

6 has cow dung.

7 marle from the Gulleys on the hill side, wch seem'd to be purer than the other.

8 sheep dung.

9 Black mould taken out of the Pocoson on the creek side.

10 Clay got just below the garden.

All mixed with the same quantity and sort of earth in the most effective manner by reducing the whole to a tolerable degree of fineness and rubbing them well together on a cloth. In each of these divisions were planted three grains of wheat, 3 of oats, and as many of barley, all of equal distances in Rows and of equal depth done by a machine made for the purpose. The wheat rows are next the numbered side, the oats in the middle, and the barley on the side next the upper part of the garden. Two or three hours after sowing in this manner, and about an hour before sunset I watered them all equally alike with water

"Kitchen	+	40 by 20
Servants Hall	+	40 — 20
Gardners house		26 — 16
Store house		26 — 16
Smoke house		*16 — 16
Wash house		20 — 16
Coach house		20 — 16
Stable		84 — 36
Salt house		16 — 16
Spinning house		38 — 18
Negro Quarters / Green house	in one	170 — 18
Ice house	within arch	12 — 12

Go. WASHINGTON.

MOUNT VERNON,
13 March, 1799.

+ Measured since Mr. Dulan took the account.
* This building is added to the Assessors Report."

that had been standing in a tub ab^{t} two hours exposed to the sun. * * * Got a new Harrow made of smaller and closer teethings for harrowing in grain—the other being more proper for preparing the ground for sowing."

May 1st Washington records that he inspected the grain planted in the ten boxes, each containing a different compost, as a test. These experiments show how close an observer he was, but they are too extended to be given in full here. He concludes, all things considered, that boxes 8 and 9 promised the most satisfactory results.

His ever watchful attention to the matter of labor-saving machinery in the interest of the poorly-paid and over-worked farmer is apparent throughout the life and writings of Washington. He made it a duty to read the standard works and annual publications on agriculture to obtain useful hints which might be of service on the Mount Vernon plantations.[20]

Each one of the five plantations under the general supervision of the Mount Vernon estates, had its own overseer and its independent outfit or plant, with all the working people, stock and farm implements essential to its independent, economical management. A debit and credit account was kept by each overseer of the operations on his plantation—the

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[20]The following letter, the draft of which is preserved in the Department of State, is in point. The letter is here given in full, as it is only in part published by Sparks and by Ford:

To—Robert Cary Esq^{R} & C^{O}

Merch^{ts} London

Gent^{n}

The Inclosed is a Copy of my last of the 22^{d} Ult^{o}. We have been curiously entertained of late with y^{e} description of an Engine lately constructed (I believe in Switzerland, and undergone some Improvements since in England) for taking up Trees by the Roots.—Among other things it is related that Trees of considerable Diameter are forced up by this Engine—that Six hands in working one of them will raise two or three hundred Trees in the space of a day—and that an Acre of Ground may be eased of the Trees and laid fit for Plowing in the same time.—How far these assertions have been amply realy reallized by repeated experiment it is impossible for me at this distance to determine but if the Accounts are not greatly exaggerated such powerful assistance must be of vast utility in many parts of this wooden country where it is impossible for our Force (and labourers are not to be hired here) between the finishing of one Crop and preparations for another to clear Ground fast enough to afford the proper changes either in the planting or Farming business—The chief purport of this Letter therefore is to beg the favour of you Gentlemen to make minute enquiries into the Tryals that have been made by Order of the Society and if they have proved satisfactory to send me one of these Engines by the first Ship to this (Potomack) River.—If they are made of different sizes, I shoud prefer one of a middle size, capable of raising work done, the crops produced, their market value, implements bought, stock increased, sold or on hand, general improvements made to buildings, ditching, clearing up of new land, etc. At the end of the year a balance was struck for each, and the difference set down to profit and loss.

At this period, nearly all the trades essential to serve the wants of an independent community, were represented and carried on at Mount Vernon; such as milling, distilling, tanning, blacksmithing, wagon-making, shoe-making, tailoring, spinning, weaving, knitting, carpentering, coopering, harness-making, brick-making and laying, stone-masons, etc. To a limited extent the facilities of these departments of labor were extended to his neighbors. There were also gunners to supply game, and men whose business it was to daily supply fresh fish, from the Potomac, for the table; while all surplus of perishable articles brought to the home house was promptly sent to the overseers of the several quarters. The gangs of skilled workmen and farm-hands composing the different departments of laborers on the Mount Vernon Estate consisted in part of slaves owned by General Washington;—dower negroes—slaves owned by Mrs. Washington; slaves hired from their masters by the year;[21] transported convicts serving

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a tree of 15 or 18 Inches Diameter.—The Costs I am pretty much a stranger to—15—20 & 25 Guineas have been spoke of but the Price (were it d'ble that) I shoud totally disregard provided the Engine is capable of performing what is related of it, and not of that complicated nature to be easily disordered, and rendered unfit for use, but constructed upon so plain, simple, and durable a Plan that the common Artificers of this Country may be able to set them to rights if any accidents shou'd happen to them. If you should send one be so good as to let me have with it the most ample directions for the effectual using of it, together with a model of its manner of operating.

Mrs. Washington woud take it as a favour, if you woud direct M^rs^ Shelby to send her a fashionable Summer Cloak & Hatt, a black Silk apron, 1 p^s^ of penny & 1 p^s^ of two penny Ribbon (white) and a pair of French bead Earings and Necklace—and I should be obliged to you for sending me a dozen and an half of Water Plates (Pewter with my Crest engraved) I am Gent^n^

Y^r^ Most Obed^t^ H'^bl^e Serv^t^

G^o^ WASHINGTON

Mount Vernon
13^th^ February 1764

By Capt^n^ Dawson—for London.

[21] The following letter of Mrs. Corbin to Colonel Washington, found among the latter's papers, is illustrative of the business methods of the times and given in full—along with a receipt from Mr. Turberville.

ESSEX, Mch 31st, 1766.

Sir:—I am now favored with an opportunity of writing to you, to let you know that I shall be glad to be informed whether you will want the Bricklayer any longer. If you out their sentences;[22] persons voluntarily indenturing themselves for a sufficient time[23] to pay costs of transportation to

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do, you may keep him on the same Terms; (but if not) shall be obliged if you will send him down as soon as his Year is up, because I have lately had an offer for him. As the distance is so great & good opportunities scarce, shall take it as a favor if you will send the Cash down by Mr. George Turberville who is the bearer of this & am Sir

Your most obt. Servt.

(Signed) LETTICE CORBIN.

N. B. I have a good Gardener to hire; if you want, may have him on the usual Terms for such——L. C.

To Col^o. George Washington of Mount Vernon, Va.

Received from Geo: Washington for the use of Mrs. Lettice Corbin, Twenty five pounds Virga Curr'y for the hire of the Negro Bricklayer George one year.

(Signed) GEO. TURBERVILLE.

April 9, 1766.

22 The following, found among Washington's papers, is a copy of a certificate and transfer in the case of a convict whose term of service was assigned to George Washington:

In Pursuance, and by virtue of Acts of Parliament made and provided for the more speedy and effectual Transportation of Felons and convicted Persons out of *Great Britain*, into his Majesty's Plantations in *America*, We do hereby assign unto George Washington Esq^r for Value received one Man-Servant named Thomas Wight being a Transport and within the said Statutes for the Term of Seven Years, the Time to commence from the Arrival of the Brig, Swift Captain George Straker in the Province of *Maryland*, it being the Twenty Sixth Day of February 1774 As witness our Hands this Twelfth day of March 1774.

WILL^M LUX & BOWLY.

23 Copy of an Indenture for service as a mason for a term of years and a transfer to George Washington, in accordance with the law in force, at that period, in Virginia. Taken from among many manuscript indentures preserved among Washington's papers:

THIS INDENTURE Made the Thirty-first Day of January in the Fourteenth Year of the Reign of our Sovereign Lord George the third King of *Great Britain*, &c. And in the Year of our Lord One Thousand Seven Hundred and Seventy-four between Isaac Webb—Mason—of the City of Bristol of the one Part, and John Moorfield of the City of Bristol of the other Part, *WITNESSETH*, That the said Isaac Webb for the Consideration herein after-mentioned, hath, and by these Presents doth Covenant, Grant, and Agree to, and with the said John Moorfield his Executors and Assigns, That he the said Isaac Webb shall and will, as a faithful Covenant Servant, well and truly serve the said John Moorfield his Executors or Assigns, in the Plantation of Maryland beyond the Seas, for the space of four years, next ensuing his arrival in the said Plantation, in the Employment of a Mason And the said Isaac Webb doth hereby Covenant and Declare himself, now to be of the Age of Twenty-foure Years and no Covenant or Contracted Servant to any other Person or Persons, And the said John Moorfield for himself his Executors or Assigns, in Consideration thereof do hereby Covenant, Promise and Agree to and with the said Isaac Webb Executors and Assigns, that he the said John Moorfield his Executors or Assigns, shall and will at his or their proper Costs and Charges, with what convenient Speed they may, carry, convey or cause to be carried and conveyed over into the said Plantation, the said Isaac Webb and from henceforth and during the said Voyage, and also during the said Term, shall and will at the like Cost and Charges, provide for and allow the said Isaac Webb

America; others whose services for a stipulated period were sold by the shipping-masters to the highest bidder;[24] and mechanics, white and colored, engaged by the month or year, and generally upon a written contract. Washington's exactness in charging to each enterprise its just expense, is illustrated in his noting the number of days' labor it required of his carpenters and others in building his schooner at Mount Vernon, which we transfer in his own language from his diary.

"*Sept. 15, 1765*—To this day my carpenters had in all worked 82 days on my schooner.

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all necessary Cloaths, Meat, Drink, Washing, and Lodging, fit and convenient for him as Covenant Servants in Such Cases are usually provided for and allow'd.

And for the true Performance of the Premises, the said Parties to these Presents, bind themselves, their Executors and Administrators, the either to the other, in the Penal Sum of Ten Pounds Sterling, firmly by these Presents. *In witness whereof*, they have hereunto interchangeably set their Hands and Seals, the Day and Year above written.

JOHN MOORFIELD [SEAL]
his
ISAAC × WEBB [SEAL]
mark

Sealed and Delivered
in the Presence of
JOHN EVANS

I hereby Assign unto Col? George Washington all my Right & title to the within Named Isaac Webb his time to begin from the Arrival of the Restoration Capt. Thomas into the Province of Maryland it being the 22d. Day of March 1774 as witness my hand this 26th. Day of March 1774.

JOHN MOORFIELD."

[24] The original of this indenture is preserved among the Washington papers in the Department of State, and is illustrative of old English law:

THIS INDENTURE Made the Eighth Day of July in the Year of our Lord God One Thousand Seven Hundred & Seventy two Between Andrew Judge of the one Party, and Alexr. Coldclough Mercht. of the other Party, *WITNESSETH*, That the said Andrew Judge doth hereby Covenant, Promise and Grant to and with the said Alexr. Coldclough his Executors, Administrators and Assigns, from the Day of the Date hereof until the first and next Arrival at Baltimore or any port in America and after, for and during the Term of Four Years, to serve in such Service and Employment as the said Alexr. Coldclough or his Assigns shall there employ him according to the Custom of that Country in the like Kind. *IN CONSIDERATION* whereof the said Alexr. Coldclough doth hereby Covenant and Grant to and with the said Andrew Judge to pay for his Passage, and to find and allow Meat, Drink, Apparel and Lodging, with other Necessaries during the said Term. And at the End of the said Term, to pay unto him the usual Allowance according to the Custom of the Country in the like Kind. *IN WITNESS* whereof the Parties abovementioned to these *INDENTURES* have interchangeably set their Hands and Seals, the Day and Year first above written.

his
ANDREW × JUDGE [SEAL]
Mark

Signed, Sealed and Delivered,
in Presence of
JNO. MCDERMOTT } MAYOR

"*22d.* This week they worked 22 days upon her.

"*28th.* This week my carpenters worked 22 days upon my schooner—and John Askew 3 days upon her.

"*Oct. 5th.* This week my carpenters worked 24 days upon my schooner—and John Askew 4 days.

"*12th.* This week my carpenters worked 22 days upon my schooner—and John Askew 3 days.

"*19th.* This week ye. carpenters worked 18 days, which make in all 190 days & 10 of John Askew."

Washington was noted for owning fine horses, he also enjoyed, on proper occasions, extending their use to visiting friends for a dash after a fox and hounds over the Mount Vernon plains,[25] a sport of which he was fond and frequently indulged in himself. In the chase, on his fine horse, he was usually the foremost hunter.

He was a rapid rider in his ordinary business journeys, and his Diaries record the fact that on various occasions he rode as much as 60 miles a day.

The possession of the Mississippi valley by the British and its settlement by Virginia had engaged the attention of George Washington from his youth. His brothers, Lawrence and Augustine, were among the original members of the Ohio Company, organized in 1748 to settle lands on the Ohio river and trade with the Indians. He was, therefore, reared in an atmosphere of admiration for and conviction of the future greatness of this western territory. His Diary for July 1st. 1763, contains the following entry : "Went over to Stafford Court-House to attend a meeting of the Mississippi adventure, and lodged there." From the year 1754, the House of Burgesses, of

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25 The following observations on Washington's horsemanship are taken from de Chastellux, page 69:

"The weather being fair, on the 26th, I got on horseback, after breakfasting with the general—He was so attentive as to give me the horse he rode, the day of my arrival, which I had greatly commended—I found him as good as he is handsome ; but above all, perfectly well broke, and well trained, having a good mouth, easy in hand, and stopping short in a gallop without bearing the bit—I mention these minute particulars, because it is the general himself who breaks all his own horses ; and he is a very excellent and bold horseman, leaping the highest fences, and going extremely quick, without standing upon his stirrups, bearing on the bridle, or letting his horse run wild,—circumstances which our young men look upon as so essential a part of English horsemanship, that they would rather break a leg or an arm than renounce them."

Virginia, inspired by the report of Major George Washington in 1753, had annually before it, until the Revolution, some measure or report of committee to encourage and protect settlers on the waters of the Mississippi held to belong to Virginia. [*Journal of House of Burgesses.*] His cash book shows he was a generous contributor to measures to encourage settlement and take up land in the valleys of the Ohio and Mississippi.

Notwithstanding Washington's many engagements, he was not neglectful or unappreciative of the amenities of social intercourse. His home, even at this period, was scarcely a day without visitors of note from some of the Colonies, foreign travelers, his relatives, or gentlemen on business. He occasionally accompanied Mrs. Washington and the children to return calls and pay his respects to his neighbors. The following extract from his Diary is in point:

"*May 31st. 1769.*—* * * * * Set off with M^{r}. Washington and Patcy, M^{r}. W[arner] Washington and wife, M^{rs}. Bushrod and Miss Washington, and M^{r}. Magowen for 'Towlston,' in order to stand for M^{r}. B. Fairfax's third son, which I did together with my wife, M^{r}. Warner Washington and his lady."

In seasons of harvesting and seeding, or when any other important work was going on which required special attention, it was Washington's habit to visit several of his plantations, or all of them, to confer with his overseers before he ate his breakfast. When the full round of the plantations was made, the ride amounted to about ten miles. This ought to have given him, as it doubtless did, a good appetite. On his return to the mansion-house, he would immediately refresh himself with a wash, while the servant would place upon the table in the dining-room a fresh, warm breakfast. This meal usually consisted of fresh fish, breakfast bacon or ham, eggs, corn-cakes, fresh butter, honey and coffee or tea. Mrs. Washington, with her good taste and characteristic tact, even though the General was a little late, managed to join and cheer him at table.

The regular hour for dining at Mount Vernon was three, although the working-people dined at twelve o'clock.[26] It was the General's habit to make a toilet immediately before sitting down to table, whether he had been out riding or had remained in or about the house, was alone or had company. The opportunity was also afforded to all guests to refresh themselves before going into the dining-room.

The intense earnestness of Washington in the prosecution of his farming interests extended, in a degree, to all the employes on his estates. His people knew that he was just and considerate and that they and their work were constantly under his supervision. They also knew that he desired to have all his work done in the best possible manner. The versatility and never-flagging application which Washington exhibited in all his business affairs, must always excite admiration. His power of endurance and celerity of movement from place to place were marvelous. He had, too, that self-command which enabled him to pass from one occupation to another, or from the exciting sport of the chase immediately to the discharge of intricate business transactions, such as the drafting of a lease or deed and other papers requiring legal or expert knowledge, or the plotting of a survey, without the least flurry or confusion. It was a rule with him to be prompt in attending business engagements. The following extract from his Diary is fairly illustrative of this:

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[26] Washington was an early riser, out before the sun was up or engaged in his study writing. The breakfast hour at Mount Vernon, in summer, was seven o'clock and in winter, eight. During Colonial times dinner was served in the mansion house usually at two o'clock. After the Revolution the time for that meal was three o'clock the year round. His usual beverage was small beer, cider, and Madeira wine. Tea was served in the dining-room—or if the company was very large, handed round—between seven and eight o'clock. The hospitality at Mount Vernon was so generous as almost to amount to an open house. Washington was a most liberal provider and himself a hearty eater, but neither in his letters or diaries does he complain of the tables at which he ate in traveling nor record what he had upon his own. But on several occasions he states that he lived plainly. To a friend he wrote, "My manner of living is plain, and I do not mean to be put out by it. A glass of wine and a bit of mutton are always ready, and such as will be content to partake of them are always welcome. Those who expect more will be disappointed."

"*March 5, 1769*—Went up to Alexandria after Fielding Lewis and brought him down to dinner, where I found M^r^ Warner Washington, who returned after dinner.

"6^th^ Set out with Fielding Lewis for Fredericksburg, which we reached after dining at Peytons at Aquia, i. e. reached my mother's.[27]

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[27] Although this was a ride of about 45 miles, he rode over the same ground in less time on receiving a message of the dangerous illness of his mother and sister. His diary of April 27th, 1787, says: "About sunrise I commenced my journey as intended. Bated at Dumfries and reached Fredericksburg before two o'clock and found both my mother and sister better." Washington, from his childhood, had a most reverential love and respect for his mother, which continued unabated to the close of her life. The prevalence of ceremony in Colonial days led him to address his mother, in at least some of his communications to her, as "Honored Madam," and at the close subscribe himself "Your most dutiful son." Mary Washington, like her son, was in the conduct of life eminently practical and chose to manage and maintain her independent estate according to her own notions, having sufficient for her needs. She removed from her farm to the town of Fredericksburg in 1775 and resided in a comfortable house owned by her son George. It was within a hundred yards of "Kenmore" mansion, the residence of her daughter, Betty Lewis. As age advanced her children and grandchildren made her frequent visits and saw to it that she wanted for nothing that could add to her comfort. The General had repeatedly urged his mother to make Mount Vernon her home, which she declined. Her daughter, Mrs. Fielding Lewis, had also begged her to reside with her in "Kenmore," but she persisted in her determination to maintain her own independent establishment. Her son, John Augustine, had also often and earnestly entreated her to give up the cares of a house and live with him. February 15th, 1787, Washington wrote his mother a long and earnest letter on family affairs and in her special interest, looking to her comfort in her declining years. In this letter he urged her to make her home with one of her children, to rent her farm and take with her her horses and carriages and such servants as she desired; but this, like all former advice, of the kind was declined. Washington's account book from 1754 shows that he advanced considerable sums to his mother. In his letter of September 13th, 1789, to his sister, after their mother's demise, he says "I want no restitution of these sums." And on his ledger beneath the account of over £500-0-0 against his mother, he writes "Settled." His cash book under date of March 11th, 1789, has the following: "By my expenses on a visit to my mother at Fredericksburg, £1-8-0. By Mrs. Mary Washington advanced her 6 Guineas." His mother died August 25th, 1789, five months after this interview. It

"7th Went to Fredericksburg & remained there all day—din^g at Col^o Lewis's.

"8. Still there. Dined at the same place, spending y^e evening at Weedons at y^e club.

"9. Set off for Rob^t Ashby's, and after dining by the way, reached it a little after dark.

"10. Went out to run out the bounds of the land I bo^t of Carters Estate, but y^e weather being very cold & windy was obliged to return.

"11. Went out again on the same business & returned at night to Capt^n Ashbys.

"12. At Capt^n Ashbys all day—in the afternoon Capt^n Marshal came & spent y^e evening.

"13. Out a surveying till Night with sev^l attending.

"14. Out in like manner.

"16. Out again with many People attending.

"16. Ditto. Ditto. Ditto.

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is presumed that this was the last visit and interview the General had with his aged mother and supplied the incident for the pathetic parting as described by Lossing in "Recollections and Memoirs of Washington," by G. W. Park Custis, p. 145, and repeated in "Mary and Martha Washington," p. 66. He assigns the date of this visit as the 14th of April, 1789, when the President is said to address his mother in the following words: "The people, madam, have been pleased with the most flattering unanimity to elect me to the Chief Magistracy of these United States, but before I can assume the functions of my office, I have come to bid you an effectionate farewell. So soon as the weight of public business, which must necessarily attend the outset of a new government can be disposed of, I shall hasten to Virginia and"—here the matron interrupted with—"and you will see me no more; my great age, and the disease which is fast approaching my vitals warn me that I shall not be long in this world; I trust in God that I may be somewhat prepared for a better. But go, George, fulfill the high destinies which Heaven appears to have intended you for; go, my son, and may that Heaven's and a mother's blessing be with you always." In a letter to his sister, on learning of his mother's death, he says: "Awful and afflicting as the death of a parent is, there is consolation in knowing that Heaven has spared ours to an age beyond which few attain, and favored her with the full enjoyment of her mental faculties and as much bodily strength as usually falls to the lot of four score. Under these circumstances, and the hope that she is translated to a happier place, it is the duty of her relations to yield due submission to the decree of the Creator."

"17. Executing Leases to those who had taken Lotts—being at Capt^{n} Ashby's.

"18. Went up to Greenway Court where I dined and stayed all Night—met Col^{o} Lewis here.

"*Mar.* 19. Went with Col^{o} Lewis to his Plantations where I stayd all day & Night.

"20. Executing in the forenoon Deeds and settling with those who had purch^{d} Carters Land upon Opeckon—in the afternoon rid to Valentine Crawf^{d}

"21. Went and laid of 4 Lots at the head of Bullskin for several tenants.

"22. Filling up leases for them at Val Crawfords all day.

"23. Set of homewards—Breakfasted at M^{r} Ariss's—din'd at y^{e} Ridge & lodged at West's.

"24. Reached home before dinner—found Col^{o} Bassett, Lady & 2 Child^{n} Betcy & Nancy here also M^{r} W^{r} Washington & Jacky Custis.

"25. Went Fox hunting with Col^{o} Bassett & M^{r} Bryan Fairfax who also came here last night—started and run a fox into a hole after an hours chase—M^{r} Fairfax went home after dinner."

The intelligent supervision Washington gave to his plantations between 1760 and 1770, brought them into as fine condition as any land in the Mount Vernon region was susceptible of. He stopped the washes in the fields, drained the wet lands by proper ditching, made new clearings, refenced the fields, made roads, erected comfortable houses, barns and quarters for his people, rested the old fields in fallow, sowed clover, timothy and other grasses for hay pasture and for enriching the soil, and rotated his crops in the most judicious and practical manner. He was a good judge of the quality of land and knew as well as any man that the soil of his Mount Vernon estate was thin and capable of yielding but moderate crops. However, he seems never to have complained or expressed an inclination to remove to better land. He owned large tracts of first-class limestone land on the Bullskin in Frederick county, Virginia, which he cultivated with profit.[28] The facts are beyond ques-

[28] Received from George Washington the 18th. day of Aug. 1764 The Sum of two pounds three shillings for bringing down two Hhds of Tobo. in Joseph Thompson's Waggon from Frederick)

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tion that he was deeply attached to his home on the Potomac, and found his greatest enjoyment of life in the peaceful shades of Mount Vernon and in the cultivation of its soil.[29] From 1770 to the beginning of the Revolution he was gradually drawn to reflect upon public affairs, and especially upon the questions, then discussed, as to the rights of the Colonies under the Crown. His Diaries covering this period show the frequent visits to Mount Vernon of men of the first character in America who were interested in the politics of the Colonies.

In 1770 he visited the Ohio river bottoms to select land for the officers and men who were entitled to them under Governor Dinwiddie's proclamation of 1754, granting lands to those who volunteered and served that year in the expedition to the Ohio. Washington was among the first to call attention to the desirableness and, he hoped, the practicability of having a continuous water navigation by canal, or otherwise, to near the head of the Potomac and of the western rivers to the head of some branch of the Ohio river on the west which would leave but a short portage between. On the 20th of May, 1754, while in command of the expedition to build forts at the head of the Ohio, Washington, in a canoe, examined the Yougheny river for about fifteen or twenty miles above "Turkey Foot" and three below with a view of transporting his munitions of war down that river in boats. Although Washington did not find this stream in a condition to navigate boats that would serve his purpose, the possible improvement of the navigation so that craft of sufficient size to carry freight might eventually be used well up into the Alleghany mountains, remained a favorite project with him. His long military service on the Virginia frontier led him to converse much with traders, hunters and others familiar with the character of all the streams

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29 Washington wrote December 12th, 1793, to Arthur Young in the following words of Mount Vernon: "No estate in united America is more pleasantly situated than this. It lies in a high dry and healthy country; in a latitude between the extremes of heat and cold, on one of the finest rivers in the world, a river well stocked with shad, herring, bass, carp and sturgeon. The borders of the Estate are washed by more than ten miles of tide water."

At this time the Estate embraced in one compact body nearly 10,000 acres of land.

draining to the Ohio and Mississippi and all the passes in the mountains between the head springs of the streams draining to the Potomac and the James rivers, and to consider the question of a practical highway by some one of them. Although the difficulties seemed almost insurmountable, he nevertheless looked hopefully to such improvements in the art of navigation as to greatly assist in establishing a waterway for traffic with an easy portage between the East and what he saw would be the great and populous West in the near future. Washington had called such public attention to the subject that the House of Burgesses of Virginia, December 5th, 1769, took the following action, as their journal shows:

"*Ordered*, That leave be given to bring in a bill for clearing and making navigable the river Potomack, from the Great Falls of the said river up to Fort Cumberland; and that M^r. Richard Henry Lee and M^r. Washington do prepare and bring in the same."

In 1770, and again in 1784, Washington made something of of a personal inspection of a possible portage between the waters of the Monongahela and the Potomac during his return trip from inspecting the Ohio bottom lands, and records his observations in his diary. In 1784 he wrote a strong letter to the Governor of Virginia on the subject.[30] His interest in canal

[30] In a communication from Mount Vernon October 10th, 1784, to Gov. Harrison of Va., after discussing the question of the practicability on the score of policy, Washington uses the following language: "I need not remark to you, sir, that the flanks and rear of the United States are possessed by other powers and formidable ones, too; nor how necessary it is to apply the cement of interest to build all parts of the Union together by indissoluble bonds, especially that part of it, which lies immediately west of us, with the middle States. For what ties, let me ask, should we have upon these people? How entirely unconnected with them shall we be, and what troubles may we not apprehend, if the Spaniards on their right, and Great Britain on their left, instead of throwing stumbling blocks in their way, as they now do, should hold out lures for other trade and alliance? What, when they get strength, which will be sooner than most people conceive (from the emigration of foreigners, who will have no particular predilection towards us, as well as from the removal of our own citizens) will be the consequence of them having formed close connexions with both or either of those powers, in a commercial way? It needs not, in my opinion, the gift of prophecy to foretell.

navigation was well known, and when James Rumsey was, in 1786, experimenting at Shepherdstown on the Potomac with a boat to be propelled against a stream by machinery. Washington was invited to witness the performance of his boat, so widely was it understood that he was an influential promoter of new inventions.—(*See his letter to Rumsey in Sparks.*)

In 1774, when the discontent among the American Colonies became so great that a conference of representatives from the Provinces was resolved upon to secure unity of action, Washington was selected, with great unanimity, as one of the delegates sent by Virginia to the meeting at Philadelphia in September. He attended this one and also a second Congress, which assembled there the following year.

Washington's great and priceless services to America in the clash of arms which shortly after ensued between the Mother Country and the Colonies are, I am fain to believe, known to every American capable of enjoying civil liberty. For this reason the period of the Revolution is thus summarily passed over. It is also known that throughout that memorable struggle it was Washington's personal, magnetic patriotism, and the faith his soldiers had that he would devise means[31] to over-

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"The Western States (I speak now from my own observation) stand as it were upon a pivot. The touch of a feather would turn them any way. They have looked down the Mississippi, until the Spaniards, very impolitically I think for themselves, threw difficulties in their way; and they looked that way for no other reason than because they could glide gently down the stream; without considering, perhaps, the difficulties of the voyage back again, and the time necessary to perform it in, and because they have no other means of coming to us but by long land transportations and unimproved roads. These causes have hitherto checked the industry of the present settlers; for except the demand for provisions occasioned by the increase of population, and a little flour, which the necessities of the Spaniards compel them to buy, they have no incitement to labor. But smooth the road, and make easy the way for them, and then see what an influx of articles will be poured upon us; how amazing your exports will be increased by them, and how amply we shall be compensated for any trouble and expense we may encounter to effect it."

[31] Pen-pictures of Washington by capable hands at different periods of his life, possess an especial interest. The following description of the General's personal appearance in 1778 is taken from Dr. James Thatcher's "Military Journal of the Revolution," page 150:

come the apparently insurmountable difficulty of keeping him to his forces in the field against the enemy, in spite of an empty exchequer, a depleted commissary and a lack of

"The personal appearance of our Commander-in-Chief is that of the perfect gentleman and accomplished warrior. He is remarkably tall, full six feet, erect and well proportioned. The strength and proportion of his joints and muscles appear to be commensurate with the preëminent power of his mind. The serenity of his countenance and majestic gracefulness of his deportment, impart a strong impression of that dignity and grandeur, which are his peculiar characteristics, and no one can stand in his presence without feeling the ascendancy of his mind and associating with his countenance the idea of wisdom, philanthropy, magnanimity and patriotism. There is a fine symmetry in the features of his face indicative of a benign and dignified spirit. His nose is straight, and his eyes inclined to blue. He wears his hair in a becoming cue, and from his forehead it is turned back and powdered in a manner which adds to the military air of his appearance. He displays a native gravity, but devoid of all appearance of ostentation. His uniform dress is a blue coat with two brilliant epaulets, buff colored underclothes, and a three-cornered hat with a black cockade. He is constantly equipped with an elegant small sword, boots and spurs, in readiness to mount his noble charger."

The following appears as a note in the first volume of Sparks, page 110, relative to the stature of General Washington: "From an order, which he sent to a tailor in London, we learn the size of his person. He describes himself as 'six feet high and proportionably made; if anything rather slender for a person of that heighth,' and adds that his limbs were long. At this time he was thirty-one years old. In exact measure, his heighth was six feet, three inches."

An admirable delineation of General Washington's personal appearance the year before the Yorktown surrender was published in the London *Chronicle* in the following language: "General Washington is now in the forty-seventh year of his age. He is a tall, well-made man, rather large-boned, and has a genteel address. His features are manly and bold; his eyes are a bluish cast and very lively; his hair is a deep brown, his face rather long, and marked with the smallpox, his complexion sunburnt and without much color. His countenance sensible, composed and thoughtful. There is a remarkable air of dignity about him, with a striking degree of gracefulness. He has an excellent understanding, without much quickness; is strictly just, vigilant, and generous; an affectionate husband, a faithful friend, a father to the deserving soldier, gentle in his manners, in temper, reserved; a total stranger to religious prejudices; in morals, irreproachable, and never known to exceed the bounds of the most rigid temperance. In a word, all his friends and acquaintances allow that no man ever united in his own person a more perfect alliance of the virtues of a philosopher with the talents of a general. Candor, sincerity, affability, and simplicity seem to be the striking features of his character; and when occasion offers, the power of displaying the most determined bravery and independence of spirit."

clothing.[32] This was a period of extreme hardships and the deficiencies in necessary supplies put to a supreme test the greatness of Washington as a leader and a patriot; and required a fortitude and an inventive genius of the highest order to keep his army together. His virtues and rectitude from the beginning and his conduct at every stage of the contest determined the end and crowned the work. Washington was referred to by Lord Byron as the great Cincinnatus of the West, who, like his classic prototype, was called from his favorite pursuit, that of agriculture, to command the armies of his country, in defence of its liberty, against a formidable enemy. Having brought the struggle to a successful issue, Washington, like Cincinnatus, was tempted with a crown, and like him unconditionally laid down supreme power to become once more the private citizen; and returned, like Cincinnatus, to his plow and to peaceful pursuits.

Washington possessed, to an eminent degree, those special qualities which are characteristic of the most astute inventors, and had not his time been so fully taken up in the important affairs of his country, he would, in all probability, have given

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[32] The following extract from the "Travels of the Marquis de Chastellux in North America in the years 1780–'81–'82," forcibly illustrates this point:

"Four or five miles from Fishkill, I saw some felled trees, and an opening in the woods, which on coming nearer I discovered to be a camp, or rather huts inhabited by some hundred invalid soldiers. These invalids were all in very good health; but it is necessary to observe, that in the American armies, every soldier is called an invalid, who is unfit for service; now these had been sent here because their clothes were truly invalids. These honest fellows, for I will not say creatures, (they know too well how to suffer, and are suffering in too noble a cause) were not covered, even with rags; but their steady countenance, and their good arms in good order, seemed to supply the defect of clothes, and to display nothing but their courage and their patience."

Washington in writing Gov. Trumbull on the condition and needs of the army December 29th, 1777, says: "I assure you sir, it is not easy to give you a just and accurate idea of the sufferings of the army at large, of the loss of men on this account [want of clothing]. Were they to be minutely detailed your feelings would be wounded, and the relation would probably be received with a degree of doubt and discredit. We had in camp, on the 23d inst., by a field return then taken, not less than 2,898 men unfit for duty, by reason of their being barefoot and otherwise naked. Besides this number, sufficiently distressing of itself, there are many others detained in hospitals and crowded in farmers' houses for the same causes."

much attention to improvements in agriculture and the machinery and implements used in the domestic arts, which are so essential to the comforts of civilized life. Washington had made for him the first pump used in the town of Alexandria, and another at Mount Vernon, at a time when but few had been put in competition with "the old oaken bucket," the rope and windlass, or the balance lift, so common in wells throughout the South in early days. He had the genius to see things as they were and to appreciate their true relation. He eliminated accidental causes or other circumstances, whether as to time, men or things; make original observations and reflect upon what he saw. He could make combinations, or divide forces, and had a just sense of the bearing and influence of one thing upon another.

About the period of his return to Mount Vernon, after the war, he was in the enjoyment of his highest physical vigor and mental activity.[33] At this time circumstances had

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33 I am confident I will be excused in asking space, in a note, for this exquisite, though but little known, pen portrait of General Washington, drawn by the capable and appreciative hand of the Marquis de Chastellux, near the close of the Revolution:

"Here would be the proper place to give the portrait of General Washington, but what can my testimony add to the idea already formed of him? The continent of North America, from Boston to Charleston, is a great volume, every page of which presents his eulogium. I know, that having had the opportunity of a near inspection, and of closely observing him, some more particular details may be expected from me; but the strongest characteristic of this respectable man is the perfect union which reigns between the physical and moral qualities which compose the individual; one alone will enable you to judge of all the rest. If you are presented with medals of Cæsar, of Trojan, or Alexander, on examining their features, you will still be led to ask what was their stature, and the form of their persons; but if you discover, in a heap of ruins, the head or the limb of an antique *Apollo*, be not curious about the other parts, but rest assured that they all were conformable to those of a god. Let not this comparison be attributed to enthusiasm! It is not my intention to exaggerate, I wish only to express the impression General Washington has left on my mind; the idea of a perfect whole, that cannot be the product of enthusiasm, which rather would reject it, since the effect of proportion is to diminish the idea of greatness. Brave without temerity, laborious without ambition, generous without prodigality, noble without pride, virtuous without severity; he seems always to have confined himself within those limits, where the virtues, by clothing themselves in more lively, but more changeable and doubtful colours, may be mistaken for faults. This is the seventh year that he has commanded the army, and that he has obeyed the Congress; more need not be said, especially in America, where they know how to appreciate all the merits contained in this simple fact. Let it be repeated that Condé was intrepid, Turenne prudent, Eugene adroit, Catinat disinterested. It is not thus that Washington will be characterized. It will be said of him, AT THE END OF A LONG CIVIL WAR, HE HAD NOTHING WITH WHICH HE COULD REPROACH HIMSELF. If any thing can be more marvellous than forced upon him a very heavy correspondence, foreign and domestic, on a multitude of subjects. His social duties, too, had become exacting, in receiving and entertaining, at his own house, great numbers of visitors of note from the several States, and also from abroad. In this office he was ably assisted by Mrs. Washington.[34] He now planned extensive improvements to the Mount Vernon Mansion-house and its grounds. While he was strongly imbued with progressive ideas, he was by no means an iconoclast. He therefore endeavored to preserve whatever was serviceable in the old Mansion-house, which he did by extending it to the north and south, and raising the whole structure to two full stories with a finished attic, crowned with a cupola. He also erected a wide, open piazza[35] the full

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such a character, it is the unanimity of the public suffrages in his favour. Soldier, magistrate, people, all love and admire him ; all speak of him in terms of tenderness and veneration. Does there then exist a virtue capable of restraining the injustice of mankind ; or are glory and happiness too recently established in America, for envy to have deigned to pass the seas ?

"In speaking of this perfect whole of which General Washington furnishes the idea, I have not excluded exterior form. His stature is noble and lofty, he is well made, and exactly proportioned ; his physiognomy mild and agreeable, but such as to render it impossible to speak particularly of any of his features, so that in quitting him, you have only the recollection of a fine face. He has neither a grave nor a familiar air, his brow is sometimes marked with thought, but never with inquietude ; in inspiring respect, he inspires confidence, and his smile is always the smile of benevolence." [Pages 71–72.]

34 Although relieved from public office, Washington was not freed from care and the obligations that follow those who have filled important positions. The rest craved by the General and Mrs. Washington was not granted to them. Indeed, it may be doubted if they found any considerable retirement in their loved Mount Vernon home. Writing to General Knox, Washington said: "It is not the letters from my friends which give me trouble, or add aught to my perplexity. It is references to old matters, with which I have nothing to do ; applications which oftentimes cannot be complied with ; inquiries which would require the pen of an historian to satisfy; letters of compliment, as unmeaning perhaps as they are troublesome, but which must be attended to, and the commonplace business which employs my pen and my time, often disagreeably. Indeed these, with company, deprive me of exercise, and unless I can obtain relief, must be productive of disagreeable consequences."

35 The piazza is from end to end 96 feet long by 12 feet 8 inches wide with the border, and two stories high, supported on eight graceful square columns, the effect of the whole, whether viewed from the lawn or from the deck of a steamer on the river, is light and pleasing. The

height and length of the mansion on the river front; and while exercising proper economy, he did all the work of alteration in the most substantial manner after his own designs and drawings.

Washington's love of agriculture and a life in the open country led him to see beauty, to an unusual degree, in the forms and colorings of nature; so that in riding through the woods, he was frequently delighted with the grace and symmetry of some tree, a specimen of which he would instantly resolve to have on his lawn and note the fact in his diary, describing it by name and where it was to be found, af also where he desired it to be planted.[36] The following extracts from his diary illustrate his admiration for our forest trees:

"*Tuesday*, *Febr.^y 22.^d 1785* * * * * * Removed two pretty large & full-grown lilacs to the N.º Garden gate—one on

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enlarged and renovated "cottage" or "villa," as Washington occasionally called his old mansion, was nearly completed in 1785. Although both the General and his wife earnestly desired a quiet, peaceful home, the man who had laid the foundation of the republic was too great a personage to be left alone or in seclusion. The enlargement of his "villa" was practically forced upon him to enable him to give a respectable reception to the many visits he was daily receiving from his countrymen, strangers, soldiers, and civilians, who by a sort of intuition and sense of reverence, began pilgrimages to "Mount Vernon," which have never been interrupted, but are yearly on the increase. This broad piazza, during the General's lifetime, was a sort of trysting place in summer evenings where the family, guests and neighbors in their informal calls assembled for an hour's chat at the close of day. In the appraiser's list of household effects at Mount Vernon after the General's death, thirty Windsor chairs were enumerated as furniture on the piazza.

36 The ornamental lawn on the west front of the mansion, containing about 20 acres, with serpentine carriage drive along each side, was laid out by the General himself, the drawing of which, in his own hand, is still preserved. Directly in front of the center door of the house is a large circle with a sun dial in the center, it is an exact reproduction of the one placed there by the General. Along each side of the serpentine roadway, Washington planted a great variety of our most beautiful native forest trees for ornament and shade. A number of the trees planted by the General still flourish on this lawn. Extensive gardens border on these grounds. The flower garden on the north and the vegetable garden on the south, are both enclosed by massive brick walls. The flower garden and green house is maintained in nearly its original form and contains many of the same kinds of plants cultivated there by General Washington.

each side, taking up as much dirt with the roots as c^{d} be well obtained. * * * I also removed from the woods and old fields, several young trees of the sassafras, Dogwood & Red-bud, to the Shrubbery on the N^{o} side the grass plot.

"*Wednesday, 23^{d}* * * * * Brought down a number of young Aspen trees from one of Sam^{l} Jenkins's near the old Court House to transplant into the serpentine Avenues to the door.

"*Monday, 28th* * * * * * Planted all the Mulberry trees, Maple trees, & Black gums in my Serpentine walks—and the Poplars on the right walk. * * * Also planted 4 trees from M. Hole, the name unknown but of a brittle wood which has the smell of Mulberry.

"*Tuesday, March 1st 1785* * * * * Planted the remainder of the Poplars and part of the Ash Trees—also a circle of Dogwood with a red bud in the Middle close to the old cherry tree near the south garden H^{o}

"*Wednesday, 2^{d}* * * * * Planted the remainder of the Ash Trees—in the Serpentine Walks—the remainder of the fringe trees in the Shrubberies—all the black haws—all the large berried thorns—with a small berried one in the middle of each clump—6 small berried thorns with a large one in the middle of each clump—all the swamp red berry bushes & one clump of locust trees.

"*Thursday, 3^{d}* * * * * Planted the remainder of the Locusts—Sassafras—small berried thorns & yellow Willow in the Shrubberies as also the red buds—a honey Locust and Service berry tree by the south garden House—likewise took up the clump of Lilacs that stood at the corner of the south grass plot & transported them to the Shrubberies & standards at the South garden gate—the Althea trees were also planted."

Washington records in his "Journal of my Journey Over the Mountains," page 20:

"*Sunday, March 13th 1747–8*—Rode to his Lordship's Quarters; about 4 Miles higher up y^{e} River we went through Most beautiful Groves of Sugar trees & spent y^{e} best part of y^{e} Day in admiring y^{e} trees & richness of y^{e} land."

It would seem from his Diary, while at Mount Vernon, from 1783 to 1789, that he was endeavoring to have good representative specimens of all or most of our beautiful forest trees which would thrive in this climate transplanted to his grounds. He continued to give close, personal attention to this matter until he was called to assume the duties of President of the United States.[37] Even then he did not intermit his interest, as his letters of instruction to his overseers, and his shipments of

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37 The 4th of March, 1789, had been fixed for the meeting of the First Congress under the Constitution of the United States, and an election for President directed to be held in February, 1789. It had been announced that the people of nine of the thirteen States had approved and adopted the Constitution submitted through the Legislatures to them. Two, Rhode Island and North Carolina, had not come to a decisive action, but did within two years provided for. The absence of a quorum prevented the organization of Congress until the 6th of April. The votes of the electors were then opened and counted, and George Washington's election to the Presidency of the United States, which was duly declared, and a special messenger, Charles Thomson, dispatched to Mount Vernon with an official letter from the President of the Senate to General Washington notifying him of the fact and requesting his attendance. Washington was deeply sensible of the responsibility attached to the office, as the following extract from his diary written the day of his departure for New York, April 16, 1789, Mrs. Washington following him, leaving Mount Vernon 19th May: "About ten o'clock I bade adieu to Mount Vernon, to private life, and to domestie felicity, and with a mind oppressed with more anxious and painful sensations than I have words to express, set out for New York in company with Mr. Thomson and Colonel Humphreys, with the best disposition to render service to my country in obedience to its calls, but with less hope of answering its expectations." In a letter to General Knox April 1st, 1789, he wrote: "I feel for those members of the new Congress, who hitherto have given an unwavering attendance at the theater of action. For myself, the delay may be compared to a reprieve; for in confidence I tell *you*, (with the *world* it would obtain little credit) that my movements to the chair of government will be accompanied by feelings not unlike those of a culprit who is going to the place of his execution. So unwilling am I in the evening of life, nearly consumed in public cares, to quit a peaceful abode for an ocean of difficulties, without that competency of political skill, abilities, and inclination, which are necessary to manage the helm. I am sensible that I am embarking the voice of the people and a good name of my own, on this voyage, but what returns can be made of them, Heaven alone can foretell. Integrity and firmness are all I can promise. These, be the voyage long or short, shall never forsake me; although I may be deserted by all men; for of the consolations which are to be derived from them, under any circumstances, the world cannot deprive me."

shrubbery to Mount Vernon testify. A bill from Bartram's Nursery at Philadelphia, as late as 1792, of choice shrubbery to make good failures of plants in a former order, is preserved in the Department of State. The first has also been preserved, but is without date. They illustrate so well his taste and fondness for beautiful trees and shrubbery and his attention to the embellishment of his Mount Vernon grounds, that the latter order is given in full in a note.[38]

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38 The writer some years since gave a copy of this list of trees and shrubs, the original of which is preserved among the Washington papers in the Department of State, to one of the vice-regents of Mount Vernon, who, it is understood, is making an effort to have restored to the lawns and gardens as many specimens of the trees and shrubs, known to have been planted there by Washington, as is practicable. It is also reported that this lady submitted the list to one of the leading florists of our country and has already made progress in having specimens called for in this list, planted at Mount Vernon.

List of Trees Shrubs &ca had of Jno Bartram to supply the place of those of his catalogue of M: 92 which failed.

Novr 7th 1792.

No 2.d Ulex europeus E grows frm 3 to 4 feet high. Embellished with sweet scented flowers of a fine yellow colour.
a. 3. Hyperieum kalmeanum 3 to 4 ft. Profusely garnished with fine gold coloured blossoms—2 plants.
4. Hyperie: Angustifolium 3 to 6 ft. Evergreen, adorned with fine yellow flowers.
e. 5. Taxus procumbens 3 to 6 ft. Evergreen—of a splendid full green throughout the year—red berries.
6. Buscus aureus E 3 to 10 ft. Elegant, called gilded box.
7. Daphne mezerium E. 1 to 3 ft. An early flowering sweet scented little Shrub.
7. Calycanthus floridus 4 to 8 ft. Odoriferous, its blossoms scented like the Pine apple.
E. 10. Æsculus hippocastanum 20, 40, to 50 ft. A magnificent flowering and shady *tree*.
11. Evonimus atrapurpurius 6 to 8 ft. Its fruit of a bright crimson in the autumn (*burning bush*) 3 plants.
13. Franklinia 3, 15 to 20 ft. Flowers large, white and fragrant. Native of Georgia.
16. Kalmia angustifolia 1 to 2 ft. Evergreen garnished with crimson speckled flowers, 4 plants.
24. Halesia tetraptera 4, 10, to 15 ft. Flowers abundant, white, of the shape of little bells.
25. Viburnum opulifolium 3 to 7 ft. Of singular beauty in flower & fruit.
27. Virburnum alnifolium 3 to 6 ft. Handsome flowering shrub.
29. Sorbus Sativa E 10, 15 to 30 ft. It's fruit pear and apple shaped, as large and well tasted when mellow.
31. Sorbus aucuparia 8, 15 to 30 ft. Foliage elegant: embellished with umbells of coral red berries.

Washington was strongly inclined to engage in experimental tests and demonstrations, and on a wide range of subjects, as the following extracts from his Diary will evince:

"*December 1, 1785.* * * * * * * In order to try the difference between burning Spermaciti and tallow candles —I took one of each

"The 1st weighing 3 oz 10 p 6 gr
" 2d Ditto 5 " 2 p

and lighted them at the same instant—the first burnt 8 hours and 21 minutes; when of the latter there remained 14 pennyweights which continued to burn one hour and a quarter longer, making in all 9 hours and 30 minutes.—By which it appears (as both burnt without flairing) that, estimating spermaciti Candles at 3/ per lb & Tallow candles at 1/ pr lb the former is dearer than the latter as 30 is to nearly 13. In other words more than 2¼ dearer."

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e. 36. Stewartea malachodendron 5 to 8 ft. Floriferous, the flowers large and white, embellished with a large tuft of black or purple threads in their centre.

38. Styrax grandifolium 3 to 10 ft. A most charming flowering shrub, blossoms snow white, & of the most grateful scent (call'd Snow-drop tree.)

39. Philadelphus coronarius E 4, 6, 10 ft. A sweet flowering shrub (called mock orange).

40. Philadelphus inodorus 5, 7, 10 ft. His robe a silver flowered mantle.

e41. Pinus Strobus 50, 80, 100 ft. Magnificent! he presides in the evergreen Groves (White Pine), *4 plants.*

*f42. Pinus communis E 20, 40, 60 ft. A stately tree, foliage of a Sea green colour, and exhibits a good appearance whilst young. (*Scotch Fir.*)

*43. Pinus Larix E 40 to 60 ft. Elegant figure & foliage.

45. Robinia villosa 1, 2, 3, 5, 6 ft. A gay shrub enrobed with plum'd leaves and roseat flowers, *3 plants.*

52. Prunus chicasa 6, 8, 10 ft. Early flowers, very fruitful; the fruit nearly round, cleft, red, purple, yellow of an inticing look, most agreeable taste & wholesome. (chicasaw Plum.)

57. Æsculus alba 1, 4, 6 ft. The branches terminate with long erect spikes of sweet white flowers.

E 58. Juniperus sabina 1 to 5. Evergreen.

+ 54. Æsculus pavia 6, 8, 10, 12, 15 ft. It's light and airy foliage crimson and variegated flowers, present a gay & mirthful appearance; continually, whilst in bloom, visited by the brilliant thundering Huming-bird. *The root of this tree is esteemed preferable to Soap, for scouring & cleansing woolen clothes.* (*2 plants*).

c. 63. Myrica gale 2 to 4 ft. Possesses an highly aromatic, and very agreeable scent. (*3 plants*).

69. Mespilus pubescens 2, 3, 4 ft. An early flowering shrub of great elegance, produces very pleasant fruit. (*2 plants*).

It is not to be wondered at, perhaps, that in a new country, sparsely settled, and with but few skilled mechanics, early colonial farmers as a general rule continued to use the implements they found in use, and gave but little thought to their efficiency or made any effort to improve them. The use of fertilizers, too, was grudgingly and slowly resorted to by American farmers, who affected to have the most unbounded faith in the strength and endurance of the virgin soil of the country. The better farmers, however, gradually began to study the best methods of keeping up the tilth of their lands, and to experiment with different fertilizers and test the relative values of them for the various crops. The following extract from Wash-

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E. f. 72. Colutia arboroscens 3, 6, 10 ft. Exhibits a good appearance; foliage pinnated, of a soft pleasant green colour, interspers'd with large yellow papillionacious flowers in succession.

77. Prunus Divaricata 6, 8 ft. Diciduous, flowers white in raumes, stems diverging & branches pendulous.

78. Hydrangia arborescens 3, 5, to 6 ft. Ornamental in shruberies—flowers white in large corymbes.

79. Andromeda exilaris 1 to 3 ft. Evergreen.

80. Acer pumilum, s, montanum 4 to 8 ft. Handsome shrub for coppices foliage singular, younger shoots red.

84 Rubus odoratus 3 to 7 ft. Foliage beautiful; flowers of the figure, colour & fragrance of the Rose.

E. 92. Laurus nobilis 10, 20, 30 ft. Sweet Bay, a celebrated evergreen—leaves odoriferous.

c. 101. Arundo donax 5, 6, 8 ft. Maiden Cane.

In addition to the above,—

N^o 1. Mespilus pyracantha. Evergreen Thorn, a very beautiful flowering shrub; in flowers & fruit, evergreen in moderate climates, and not to be exceeded in usefulness, for hedge Fences &c^a

October 30^th 1792.

The following Letters in the margin serve to explain the natural soil & situation of the Trees, Shrubs &c^a

a. rich, moist, loose or loamy soil, in shade of other trees.
b. rich deep soil.
c. wet moorish soil.
d. Dry indifferent soil.
e. A good loamy moist soil in any situation.
f. Any soil and situation.
E. Exoticks.—

[The following in General Washington's handwriting is written on the same sheet.]

Directions for disposing of the Trees, Shrubs &c^a mentioned in the aforegoing list.—The intention of giving the heights to which they may grow, is, that except in the centre of the Six Ovals in the west Lawn;—and at each end of the two large Ovals; none of the tall, or lofty growing trees (evergreens) are to be planted.—But this I would have done in ington's Diary shows that he was also engaged in this class of experiments:—

In his notes and observations on agriculture, under date of April 7th, 1786, he records these experiments: "Cut two or three rows of wheat (cape wheat within six inches of the ground), it being near eighteen inches high, that which was first sown, and the blades of the whole singed with the frost."

"*Monday, Jan^y^ 30^th^ 1786* * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * *

On sixteen square rod of ground in my lower pasture, I put 140 Bushels of what we call Marle viz on 4 of these, N° W^t^ corner were placed 50 bushels—on 4 others S° W^t^ corner 30 bushels—on 4 others S° E^t^ corner 40 bushels—and on the remaining 4=20 bushels. This Marl was spread on the sod in these preportions—to try first whether what we have denominated to be Marl possesses any virtue as a manure—and secondly—if it does, the quantity proper for an acre."

In a letter to General Lincoln, dated Mount Vernon, 6th Feb., 1786, General Washington uses the following language in relation to a supposed important discovery:

"The discovery of extracting fresh water from salt, by a simple process and without the aid of fire, will be of amazing importance to the sons of Neptune, if it is not vitiated or rendered nauseous by the operation, and can be made to answer all the valuable purposes of other fresh water at sea. Every

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all of them whether any thing occupies these particular spots, or not:—removing them if they do, to some other parts of the aforesaid Ovals.—At each end of the 4 Smaller Ovals, trees of middling growth (for instance those which Rise to 15, 20, or even to thirty feet) may be planted.—My meaning is, that in the Centre of every Oval (if it is not already there) one of the lofty growing trees should be planted; and the same done at each end of the two large Ovals;—and at the ends of the 4 Smaller ones, trees of lesser size to be planted.—The other parts of all of them to receive the Shrubs—putting the tallest, always, nearest the Middle, letting them decline more into dwarfs towards the outer parts.—This was my intention when they were planted in the Ovals last Spring—but I either did not express myself clearly—or the directions were not attended to.—I now hope they will be understood, and attended to, both.—The two trees marked thus (*) in the Margin, I would have planted by the Garden gates opposite to the Spruce Pines.—I believe common pine are now in the places where I intended these, but they may be removed, being placed there merely to fill up the space.—If any of these tall growing trees are now in any other part of the Ovals, except those here mentioned (and that you may be enabled better to ascertain this, I send you maritime power in the world in this case ought, in my opinion, to offer some acknowledgment to the inventor." (*Spark's Washington*).

"*Feby. 6" 1786.* * * * * * * Planting pines in the wilderness on the left of the lawn and spading the ground there.

"*Friday 10 Feby.* * * * * * * Making up the banks round ye Serpentine walks to the front gate.

"*Saturday 11th.* * * * * * * Brought a Goose & Gander of the Chinese breed of Geese, from the Reverand Mr. Griffiths—and also two of the large white (or Portugal) Peach Trees;—and 2 Scions from a tree growing in his garden to which he could give no name—The last for my Shrubberies.

"*Tuesday Feby. 14th.* * * * * Employed all the women and weak hands (who on account of the snow) could not work out, in picking the wild onions from the Eastern Shore Oat for seed.

"*Monday March 6th* * * * * * * * * * * * * * * Returned to the erection of my deer Paddock, which the bad weather had impeaded, brought carts from the Plantation to assist in drawing in the materials for the work.

"*Monday March 13th.* * * * * * * Began to raise the Mound of Earth on the right of the Gate coming in.

"*Thursday March 16th* * * * * * * * * * * * Finished the Mound on the right and planted the largest

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a list of what went from Bartrams Garden last Spring) I would have them removed, so as to conform to these directions;—and if there be more with what are now sent, than are sufficient to comply with these directions, there may be one on each side of the two large Ovals, making five in each.—You will observe that these Pinus Strobus (or white Pines) are the loftiest of all the Tall trees which now are, or have been sent; and that it is these which are to form your centre trees—and the end trees of the two large Ovals.—

I must request also that except the large trees for the Centre & sides no regularity may be observed in planting the other in the Ovals.—This I particularly desired last Spring, but found when I got home it was not attended to.—

When you have disposed of all the trees & Shrubs agreeably to these directions return this Paper, and the general list which accompanies it, back again to me; as I may have occasion for them in procuring plants in future.

NOTE—If there are now growing in the Ovals, as many as 4 of the Hemlock Spruce (sent last Spring) let them be taken up when the ground is hard & deep frozen in the Winter, & placed on the sides of the two large Ovals instead of the white Pines, wch. you might have put there in consequence of the aforegoing directions.

weeping Willow in my nursery in the center of it—ground too wet to do anything to the other Mound on the left.

"*Saturday, March 18th.* * * * * * * Got the Mound on the left so far compleated as to plant the next largest of my weeping willows thereon.

"*Tuesday, March 28th.* * * * Replaced the following trees in my Shrubberies which were dead or supposed to be so viz 10 Swamp Magnolia 4 Red Buds—5 Black Haws—3 Locusts 1 swamp Red Berry.

"*Tuesday, April 4th. 1786* * * Planted 6 of the pride of China brought from Mr. Lyons by G. A. Washington in my Shrubberies in front of the House—3 on each side the Right & left Walks between the Houses & garden gates—and also the two young trees sent me some time ago by Mr. Griffith to which no name had been given—these latter were planted, one on each side the right & left walks,—near the garden gates on the hither or Et. side.

"*Thursday 6th.* * * * * * * Transplanted 46 of the large Magnolia of So. Carolina from the box brought by G. A. Washington last year—viz 6 at the head of each of the Serpentine Walks next the circle—26 in the Shrubbery or grove at the south end of the house & 8 in that at the No. end—the ground was so wet, more could not at this time be planted there."

The following extracts from Washington's Diary give the details of his experiments in making what he called a "Barrel Plow," to be attached to a harrow in such a manner as to deposit seed in the ground when in motion:

"*Friday April 7th. 1786* * * * * * Rid to Muddy hole Plantation and finding the ground which had been twice plowed to make my experiments in was middling dry in some places, though wet in others, I tried my drill or Barrel Plow, which requiring some alterations in the harrow, obliged me to bring it to the Smith's-Shop—this suspended my further operation with it to-day.

"*April 8th* Sowed oats to-day in drills at Muddy Hole with my barrel plough * * * * * * * * * *

"*April 11th* Sowed twenty-six rows of barley in the same field at Muddy Hole in the same manner with the drill Plough, and with precisely the same workings (culture) the Oats had—adjoining thereto—This was done with 12 q^{ts} of S^{d}.''

During the spring, summer and fall of this year he continues experiments with his barrel plough and says: ''Will try the experiment of sowing with a six foot barrel and with grain dropped six inches square apart.''

''*Saturday 8th.* * * * * * * Rid a little after sun rise to Muddy hole to try my drill plow again which with the alteration of the harrow yesterday I find will fully answer my expectation—and that it drops the grains thicker, or thinner in proportion to the quantity of seed in the Barrel—the less there is in it the faster it issues from the holes—the weight of a quantity in the barrel, occasions I (presume) a pressure on the holes that do not admit of a free discharge of the seed through them—whereas a small quantity (sufficient at all times to cover the bottom of the barrel) is in a manner sifted through them by the revolution of the barrel.

''I sowed with the barrel to-day in drills about 3 pints of a white well looking oat brought from Carolina last year by G. A. Washington in 7 rows running from the path leading from the Overseers H^{o} to the Quarter to the west fence of the field where the ground was in the best order.—Afterwards I sowed in such other parts of the adjoining ground as could at any rate be worked, the common oat of the Eastern shore (after picking out the wild onion) but in truth nothing but the late season could warrent sowing in ground so wet.

''*Monday 10th.* Began my brick work to-day—first taking the foundations of the Garden Houses as they were first placed, and repairing the damages in the walls occasioned by the removal—and also began to put my pallisads on the wall.—

''Compleated sowing with 20 quarts the drilled oats in the ground intended for experiments at Muddy hole; which amounted to 38 Rows ten feet apart (including the parts of Rows sowed on Saturday last)—in the afternoon I began to sow Barley, but finding there were too many Seeds discharged from the barrel notwithstanding I stopped every other hole, I discontinued the sowing until another Barrel with smaller holes c'^{d} be prepared.—The ground in which these oats have been sowed—and in which the Barley seeding had commenced—has been plowed, listed (as it is called, that is 3 furrow ridges) and twice harrowed in with the manure afterw^{ds}.

"Began also to sow the Siberian Wheat which I had obtained from Baltimore by means of Col Tilghman, at the Ferry Plantation in the ground laid apart there for experiments.—This was done upon ground which, some time ago, had been marked off by furrows 8 feet apart in which a second furrow had been run to deepen them.—4 furrows were then plowed to these which made the whole 5 furrow Ridges.—These being done some time ago, and by frequent rains prevented sowing at the time intended,—had got hard,—I therefore before the seed was sowed, split these Ridges again, by running twice in the same furrow, after w^{ch} I harrowed the ridges, and where the ground was lumpy, run my spiked Roler with the harrow at the tale over it,—w^{ch} I found very efficacious in breaking the clods & pulverizing the earth; and would have done it perfectly if there had not been too much moisture remaining of the late rains.

"After this harrowing & rolling where necessary, I sowed the wheat with my drill plow on the reduced ridges in rows 8 feet apart—but I should have observed that after the ridges were split by the furrow in the middle, and before the furrows were closed again by the harrow—I sprinkled a little manure in them.—Finding the barrel discharged the wheat too fast, I did, after sowing 9 of the shortest (for We began at the farthest corner of the field) rows, I stopped every other hole in the barrel, and in this manner sowed 5 rows more, & still thinking the seed too liberally bestowed, I stopped 2 & left one hole open alternately, by which 4 out of 12 holes only, discharged seed, and this, as I had taken the strap of leather off seemed to give seed enough (though not so regular as were to be wished)—to the ground.

"*Tuesday 11th.* * * * * * * * * * * * * * * * * * Sowing the Siberian Wheat to-day, as yesterday at the Ferry.

"And sowed 26 rows of Barley (except a little at each end w^{ch} was too wet for the ground to be worked) at Muddy hole below & adjoining the oats—This was done with 12 quarts of seed and in the manner, and in ground prepared as mentioned yesterday.

"*Wednesday 12th.* * * * * * * * * * * * * * *

"Rid to the fishing landing, Ferry, Dogue Run, and Muddy hole plantations.—Finished at the first sowing the ground intended for experiments with Siberian Wheat—this spot contained 16A. 1R. 24P. including the fodder H° &c. which would reduce the cultivated land to 10 acres at most.

"At Muddy hole, I sowed two rows of the Albany Peas in Drills 10 feet assunder (the same as the Oats and Barley) but conceiving they could not for want of support be prevented from falling when they shd. come near their growth I did not incline to sow any more in this way but to put all the ground between these two rows and the fence along the road in broad Cast.—The ground in which these Peas were sowed was managed exactly as that had been in which the Barley & Oats (at this place) was—

"*Monday May 8th. 1786* * * * * * * * * * * * * * *

Sent a Carpenter to put a new axle and do some other Repairs to the Barrel Plow at Dogue Run.[39]

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39 Washington in the following letter to his friend Theodoric Bland, Esq., to whom he sends one of his barrel plouws for a trial, in his letter gives a good description of the drill:

MOUNT VERNON, 28th. *Decembr.*, 1786.

Dear Sir,

I am now about to fulfill my promise with respect to the drill plow and timothy seed. Both accompany this letter to Norfolk, to the care of Mr. Newton. The latter I presume is good, as I had it from a gentleman on whom I can depend. The former it is scarcely necessary to inform you, will not work to good effect in land that is very full either of stumps, stones, or large clods; but where the ground is tolerably free from these and in good tilth, and particularly in light land, I am certain you will find it equal to your most sanguine expectation, for Indian corn, wheat barley, pease, or any other tolerably round grain, that you may wish to sow, or plant in this manner. I have sown oats very well with it, which is among the most inconvenient and unfit grains for this machine.

To give you a just idea of the use and management of it, I must observe, that the barrel at present has only one set of holes, and these adapted for the planting of Indian corn, only eight inches apart in the row; but by corking these, the same barrel may receive others, of a size fitted for any other grain. To make the holes, observe this rule; begin small and increase the size till they admit the number of grains, or thereabouts you would choose to deposit in place. They should be burnt, and done by a guage, that all may be of a size, and made widest on the outside, to prevent the seeds choking them. You may, in a degree, emit more or less through the same holes, by increasing or lessening the quantity of seed in the barrel. The less there is in it,

"*Tuesday 9th.* * * * * * * *
* * * * * * * * * *

Found the Flax in the Neck had come up and full thick;—and that the grass seeds (rather Millet) obtnd. from Colo. Cary had come up; but none of the Saintfoin, Burnet or Rib grass appeared to be springing,—finished planting, with the Barrel Plow, the early Corn in the farthest cut in the field for experiments in the Neck.—and not having enough to compleat another cut in the same field I ordered all the remaining part of it to be drilled with common corn—accordingly about Noon the intermediate rows in the middle cut which had been left for the early corn were begun to be planted with the other.

"*Saturday 13th.* * * * *
* * * * * * * * *

"Finished (yesterday evening) planting Corn with the Barrel Plow, in the cut intended for experiments at Dogue Run.

"*Tuesday 18th.* * * * * * At Muddy hole they finished planting Corn about 10 Oclock—At this place I tried a 3 hoed harrow which I had just made, with a single horse.—Upon the whole it answered very well—The draft seemed

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the faster it issues. The compressure is increased by the quantity, and the discharge is retarded thereby. The use of the band is to prevent the seeds issuing out of more holes than one at a time. It may be slackened or braced according to the influence the atmosphere has on the leather. The tighter it is provided the wheel revolves easily, the better. By decreasing or multiplying the holes in the barrel, you may plant at any distance you please. The circumpherance of the wheels being six feet or seventy-two inches, divide the latter by the number of inches you intend your plants shall be assunder, and it gives the number of holes required in the barrel.

By the sparse situation of the teeth in the harrow, it is designed that the ground may be raked without the harrow being clogged if the ground should be cloddy or grassy. The string when this happens to be the case, will raise and clean it with great ease, and is of service in turning at the ends of rows; at which time the wheels, by means of the handles, are raised off the ground as well as the harrow, to prevent the waste of seed. A small bag containing about a peck of the seed you are sowing is hung to the nails in the right handle, and with a small tin cup the barrel is replenished with convenience, whenever it is necessary without loss of time or waiting to come up with the seed-bag at the end of the row. I had almost forgot to tell you that if the hole in the leather band, through which the seed is to pass when it comes in contact with the hole in the barrel should incline to gape, or the lips of it turn out, so as to admit the seed between the band and barrel, it must be remedied by riveting a piece of sheet tin, copper, or brass the width of the band and about four inches long, with a hole through it, the size of the one in the leather. I found this effectual.

I am dear sir &

Go. WASHINGTON

To THEODORIC BLAND Esq

rather hard for one horse but the late rains had made the ground heavier than usual.

"*Monday May 22*^{d} * * Began to take up the pavement of the Piaza.

"*Tuesday May 23*^{d} * * *

* * * * * * * * * * *

Replanting the common corn which had been drilled at Muddy hole—finished planting peas with the Barrel in the Neck on Saturday last.—And listing the corn ground at the same place this day, for planting in the common way.

* * * * * * * * * * *

"And this day began to lay the Flags in my Piaza[40]—Cornelius and Tom Davis assisting.

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40 The following letter is given in a note by Sparks:

General Washington presents his compliments to M^{r} Rumney—would esteem it as a particular favor if M^{r} Rumney would make the following enquiries as soon as convenient, after his arrival in England; and communicate the result of them by the Packet, or any other safe and expeditious conveyence to this country. First. The terms upon which the best kind of Whitehaven Flag stone—Black and White in equal quantities—could be delivered at the port of Alexandria by the superficial foot, workmanship, freight and every other incidental charge included.—The stone to be 2½ inches, or thereabouts, thick, and exactly a foot square—each kind. To have a rich polished face, and good joints so as that a neat floor may be made therewith.

2nd Upon what terms the common Irish Marble (black & white if to be had)—same dimentions, could be delivered as above.

3rd As the General has been informed of a very cheap kind of Marble, good in quality, at or in the neighborhood of Ostend, he would thank M^{r} Rumney, if it should fall in his way, to institute an inquiry into this also. On the Report of M^{r} Rumney, the General will take his ultimate determination; for which reason he prays him to be precise and exact. The Piazza or Colonade for which this is wanted as a floor is ninety two feet eight inches, by twelve feet eight inches within the margin, or border that surrounds it. Over and above the quantity here mentioned, if the above flags are cheap—or a cheaper kind of hard Stone could be had he would get as much as would lay floors in the Circular Colonades, or covered ways at the wings of the House—each of which at the outer curve is 38 feet in length by 7 feet 2 inches in width within the margin or border as aforesaid.

The General being in want of a house Joiner & Bricklayer who understand their respective trades perfectly, would thank M^{r} Rumney for inquiring into the terms upon which such workmen might be engaged for two or three years; (the time of service to commence upon the ship's arrival at Alexandria) a shorter term than two years would not answer, because foreigners generally have a seasoning; which with other interuptions too frequently waste the greater part of the first year—more to the disadvantage of the employer than the employed.—Bed board & tools to be found by the former, clothing by the latter.

If two men of the above trades and of orderly and quiet deportment could be obtained for twenty five or even thirty pounds sterling per annum each (estimating dollars at 4/6) the General, rather than sustain the loss of time necessary for communication would be obliged to M^{r} Rumney for entering into proper obligatory articles of agreement on his behalf with them by the first vessel bound to this Port.

G^{o} WASHINGTON

MOUNT VERNON, *July 5 1784*

TO W^{M} RUMNEY of Alexandria Va

"*Saturday 27th* Finished laying 28 courses of the pavement in the Piaza—Weather very unfavorable for it.

Mr. Dodge, the efficient superintendent of Mount Vernon, has furnished me with a copy of the following unpublished letter of General Washington to John Rumney relative to the flagging used in paving the piazza:

MOUNT VERNON, VA. *June 22d, 1783.**

Sir

I stand indebted to you for two letters, one of the 8th of Sep., the other of the 9th of Feby The first should not have remained so long unacknowledged but for the expectation I had of the second. The second lead me to expect a third; upon the receipt of which I had laid my account to have given you but one trouble, by replying to them all at the same time.

Permit me to thank you Sir for your attention to my commissions. The Joiner arrived safe, and I believe will fully answer your description & expectation of him. He gives great satisfaction; and seems well satisfied himself. The expense of his passage, & your advance to him, has been paid to Mr. Sanderson. I delayed making choice of either of the samples of Flagstones until I had seen the Irish marble; and was made acquainted with the cost of it; but as it did not come in your last ship, and I like the whitest & cheapest of the three kinds which you sent me by Capt. Atkinson; I request the favor of you to forward by the first opportunity (with some to spare in case of breakage, or other accident) as much of this sort, as will floor the Gallery in front of my house which, within the margin, or border that surrounds it, (and which is already laid with a hard stone of the country) is 92 feet 7½ inches, by 12 feet 9¼ inches.

Having given the exact dimension of the floor, or space which is to be laid with flag-stone, I shall leave it to the workman to form them of such a size, not less than a foot square, and of the same dimensions as he thinks will answer best, and accord most with the taste of the times.

I take it for granted that 7½ or 8d is the price of the white stone in the prepared state in which it was sent; and that the shipping charges, & freight only, are to be added to the cost. If a rough estimate of the latter had been mentioned, it would have been more pleasing; as I then could have prepared accordingly. I am at a loss to determine in what manner these dressed flags can be brought without incurring much expense, or being liable to great damage. To put them in cases will involve the first, and to stow them loose, the other may be sustained; unless great care is used in the storage, which is rarely to be met with among Sailors,–even in Masters of vessels.

If the flags are well dressed, a little matter will chip the edges, and break the corners, which, by disfiguring the work would be hurtful to the eye.

I will give no direction therefore on this head, your own judgment on the spot, must dictate; at the same time, I have but little doubt, if they are placed in the Hold of the Ship, with Hay and Straw to keep them from rubbing, of their coming without damage.

I will soon follow this letter with a remittance from hence, or a draught on London for a sum to enable you to discharge the undertaker.

In the meanwhile, let me pray you to hasten the execution, and the shipping of them as my Gallery needs a floor very much.

With great esteem & regard
I am, Sir,
Your most obt. Hble Servt
[Signed.] Go. WASHINGTON.

Mr. JNo. RUMNEY.

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* This letter, it is apprehended, has either a false date or place where it was written. It is surmised 1785 is the proper year.

"*Tuesday June 27th 1786* * * * Finding the hoe Harrow did not do good work in the drilled Corn I ordered it to desist and the Bar Share plow to be used, till the common corn was all crossed after which to use it when the ground was worked the other way.

"*Wednesday July 26th 1786* * * * * * * * * * * * * * * * *

"Having fixed a Roller to the tale of my drill plow, and a brush harrow between it & the barrel, I sent it by G. A. Washington to Muddy hole and had the intervals between the corn which had been left for the purpose sowed with Turnips in drills and with which it was done very well."[41]

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[41] Throughout this summer, Washington had paid special attention to all the operations on his various plantations and to improving the implements of husbandry in use by his people. He, also, in a letter August 6th 1786, to Arthur Young, his English correspondent on improvements in agriculture, avails himself of the proffer of his services to fill an order for some seeds and two plows in the following words: "I will give you the trouble, Sir, of providing and sending to the care of Wakelin Welch, of London, merchant, the following articles. Two of the simplest and best constructed ploughs for land which is neither very heavy nor sandy; to be drawn by two horses; to have spare shares and coulters; and a mould, on which to form new irons, when the old ones are worn out, or will require repairing. I will take the liberty to observe, that some years ago, from a description or recommendation thereof, which I had somewhere met with, I sent to England for what was then called the Rotherham or patent plough; and, till it began to wear and was ruined by a bungling country smith, that no plough could have done better work, or appeared to have gone easier with two horses; but for want of a mould, which I neglected to order with the plough, it became useless, after the irons, which came with it were much worn."

In another letter to Mr. Young from Mount Vernon, November 1st, 1787, Washington says: "The grain Grass seeds, ploughs, &c. arrived at the same time agreeably to the list, but some of the former were injured, as will always be the case, by being put into the hold of the vessel; however upon the whole, they were in much better order than these things are generally found to be, when brought across the Atlantic. *

"I have tried the ploughs which yon sent me, and find that they answer the description which you gave of them; this is contrary to the opinion of almost every one who saw them before they were used; for it was thought their great weight would be an insuperable objection to their being drawn by two horses."

The Mount Vernon plantations were now all in good tilth, and Washington was picturing to himself the pleasure and comfort which he had long hoped to enjoy in their management, with time for studying the more scientific method of agriculture.

The question is often asked, "What is the elevation of the Mount Vernon Mansion-house above the level of the Potomac river?" I felicitate myself on being able to answer this inquiry from data ascertained by an actual leveling from the edge of the piazza opposite the centre door to high-water mark near the wharf, distant 660 feet, made by General Washington himself in 1786. The actual elevation of the pavement of the piazza above high-water mark, as ascertained by this survey, is 124 feet 10½ inches.[42]

The home-life of Washington at Mount Vernon and his efforts to embellish it, which are told with such ingenuousness in his Diaries, almost compel further quotations:

"*Monday May 29th. 1786*—About 9 o'clock Mr. Tobias Lear, who had been previously engaged on a salary of 200 dollars, to live with me as a private secretary, and preceptor for Washington Custis, a year, came here from New Hampshire, at which place his friends reside.[43]

"*Friday, June 16th. 1786.* Began about 10 o'clock to put up the book-press in my study."

Washington's Diaries show numerous instances of his kindness to and consideration for his servants; visiting them when sick and, if seriously ill, bringing them to the home house to be nursed. Frequently he denominates them, as in the following extract, "my people," in giving them a day to visit the Races, one-third each day; at suitable seasons giving them a

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43 The following receipt signed Wm. Shaw, the clerk who preceded Mr. Lear in service at Mount Vernon, in the handwriting of General Washington, is preserved among his papers in the possession of Lawrence Washington:

"MOUNT VERNON, *August 12th. 1786* Received from G. Washington the sum of Fifty-six pounds two shilling, Virga Curry equal to £42.16 sterling in full for services rendered him as secretary &c from the 26th. day of July 1785 when I came into the family, until the arrival of Mr Lear on the 29th. day of May in the present year.

WM. SHAW

42 The following record, in Washington's handwriting, of the line of survey, with the several benches used in leveling from the centre door of the Mansion House at Mount Vernon to near the present steamboat wharf is preserved among the Washington papers in the Department of State, and of which the following is a literal transcript:

Fall, from the level of the Piazza to high water mark in a Rectangular course from the centre door.—

.o	Length of Level.	Fall.			Total Fall.			Remarks.
		Ft.	In.	⅛	Ft.	In.	⅛	
1	12	2	4	.	. . .	. .	. .	Beginning on the pavement of the Piazza,
2	do.	. . .	9	1	3	1	1	at the edge thereof, next the Grass.
3	do.	. . .	1	2	3	2	4	
4	do.	. . .	2	1	3	4	5	
5	do.	. . .	2	2	3	6	7	
6	do.	. . .	4	6	3	11	5	
7	do.	1	2	4	5	2	1	
8	do.	1	11	1	7	1	2	
9	do.	2	8	4	9	9	6	
10	do.	2	6	2	12	4	0	
11	do.	3	9	2	16	1	2	
12	do.	4	3	2	20	4	4	
13	do.	6	5	4	26	10	0	To the level, at the foot of the low^r. step
14	do.	4	2	6	31	1	0	at Gate which is 156 feet from the pave-
15	do.	5	0	0	36	1	0	ment of the Piazza.
16	do.	5	0	0	41	1	0	
17	do.	5	5	0	46	6	0	
18	do.	2	1	6	48	7	6	To Post & Rail Fence—216 feet from the
19	do.	3	7	4	52	3	2	Piazza.
20	do.	2	6	4	54	9	6	
21	do.	2	3	6	57	1	2	
22	do.	2	11	4	60	0	6	
23	do.	2	3	2	62	4	0	To a small locust—276 feet from the
24	do.	2	3	. .	64	7	. .	Piazza.
25	do.	2	3	2	66	10	2	
26	do.	. . .	2	. .	67	. .	. .	To a Bank—312 feet from the Piazza.
27	do.	4	2	1	71	2	5	
28	do.	2	5	. .	73	7	5	To the level of the Spring—at the Dairy—
29	do.	2	2	. .	75	10	5	which is about 50 feet above high water
30	do.	2	3	1	78	1	6	mark—
31	do.	1	6	4	79	8	2	
32	do.	2	5	5	82	1	7	
33	do.	3	8	5	83	7	4	To the edge of the above Bank—396 feet
34	do.	3	3	6	86	11	2	from the Piazza.
35	do.	2	0	3	88	11	5	
36	do.	3	3	6	92	3	3	
37	do.	3	2	0	95	5	3	
38	do.	3	0	4	98	5	7	
39	do.	2	4	3	100	10	2	
40	do.	2	0	4	102	10	6	
41	do.	1	5	4	104	4	2	To a parcel of Briers—492 feet from the
42	do.	1	2	. .	105	6	2	Piazza.
43	do.	1	. .	1	106	6	3	
44	do.	Lev	el.		106	6	3	
45	do.	. . .	10	. .	107	4	3	
46	do.	1	10	. .	109	2	3	
47	do.	2	5	1	111	7	4	
48	do.	. . .	2	. .	111	9	4	
49	do.	. . .	9	6	112	7	. .	
50	do.	. . .	5	4	113	0	4	To a path up the Riverside—600 feet from
51	do.	. . .	7	6	113	8	2	the Piazza—
52	do.	. . .	9	2	114	5	4	
53	do.	1	. .	4	115	6	. .	
54	do.	1	1	. .	116	7	. .	To the edge of the River Bank—648 ft
55	do.	3	6	4	120	1	4	from the Piazza—
High	Water.	4	9	. .	124	10	4	To highwaterMark—660 ft.from the Piazza

☞The distance in a rectangular line from the level of the pavement of the Piazza, to high water mark, is 660 feet—or 220 yards—and the elevation of it above the water is 124 f^t. 10½ Inches.—

day's sport and lending them his seine to haul for fish, to do with their catch as they pleased, to sell or to keep.[44]

"*Monday October 9th 1786* * * * * * * * * *
Allowed all my People to go to the Races in Alexandria on one of three days as best comported with their respective businesses—leaving careful persons on the plantations."

Washington had faith in the progress of the human race and believed in making earnest efforts to improve not only man's surroundings and conditions, but also his methods of securing a livelihood, as well as the institutions and government under which they lived. To him is awarded the credit of the introducing into the United States the best breeds of that very useful animal, the mule. He also gave much attention to improving the breeds of sheep, hogs, horses, cattle and dogs.[45] The following extracts from his Journal relate to his importation of improved breeds of some domestic animals for his plantations.

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44 Washington, at the time of his death, had on his several estates 317 negroes, a list of which, with the names, ages, and sex, he had made a short time before. A literal copy of this memoranda has been deposited in the "Toner Collection" in the Library of Congress. He owned of these, in his own right, 124, and had 40 others leased from Mrs. French; while 153 were dower negroes, that is, were the property of Mrs. Washington in her own right and that of her children and their heirs. Washington in his will, after providing for the payment of his debts and for his wife, and before disposing of any of his property, directs in the following language the emancipation of his negroes: "Item Upon the decease of my wife, it is my will and desire, that all the slaves which I hold in my *own right* shall receive their freedom."—Then follows express provisions for the care of the old who were past work and the children unable to make a living, but as the will has been frequently printed, it can be consulted by all desiring to do so.

45 Washington was but little given to collecting about him a museum of things which were simply curious and without the merit of some use. He did, however, have some fancy fowls and unprofitable animals which were in the nature of the decorative and to entertain visitors. His deer Paddock and hounds he doubtless justified on the principle of entertainment and home amusements. His cash book for 1785, under date of March 17th, has the following: "by freight of a swan and 4 Geese from Nom'y 18/." And his cash book for 1788, December 13th, has this entry: "By Capt. Baine p'd him the freight of two Chinese pigs & 2 Geese from Norfolk to this place 7/4."

"*Thursday Nov^{r}. 16th 1786* * * * * * * * * * * * On my return home, found Mons Campoint sent by the Marq^{s} de la Fayette with the Jacks and two she Asses which he had procured for me in the Island of Malta, and which had arrived at Baltimore with the Chinese Pheasants &c had with my Overseer &c got there before me—these Asses are in good order and appear to be very fine—The Jack is two years old and the She Asses one three & the other two.—The Pheasants and Partridges will come round by Water.

"*Monday 27th Nov^{r}.* * * * * * * * * * * * Received my Chinese Pheasants &c from Baltimore by the Packet viz.—A Cock & Hen of the Golden Pheas^{t}. A Cock & Hen of the silver Pheas^{t}. A Cock & two hens of the French Pheas^{t} and a French Partridge the other French Partridge died coming round from Baltim^{e}."

The expedient adopted by Washington in sowing clover, timothy and other small seeds broadcast to insure an even distribution of the seed over the ground, was to mix them with dry sand or ashes, so that greater bulk might be taken in the hand for each cast. The following entry appears under date of

"*Monday, Febr^{y}. 5th 1787.* At the Ferry the Overseer had begun to sow timothy seed mixed with sand in the Rye field on the snow,—but the sand being too wet and Clamy to do it regular I ordered him to desist until the sand could be dried.—Three gallons of Timothy seed mixed with ashes was sown on Rye in the Neck on Saturday.

"*April 1st 1787* * * * * * * In the evening one Young who lives on Col^{o} Ball's place—a farmer, came here to see, he says my drill plow & staid all night.[46]

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[46] The Mount Vernon "Store Room Book" of this date shows the following entries bearing upon the making of Drill Plows:

"April 6th 1787 Gave out 200 4^{d} & 100 8^{d} brads to Matthew for making a drill Plow.

"April 13, 1787," Gave out a piece of Copper Sheating to Bradkin for the Drill plow, also 50 4^{d} nails to Bradkin 50 tacks and 100 4^{d} brass Do for Drill Plow."

Tradition credits Washington with having invented and patented a plow. I have not, however, found any testimony to sustain the claim. But I do find the following entry in one of the "Store Books of issue" at Mount Vernon under date of Sept 28th. 1787. "A packing box for a plow model one hundred and fifty nails used in making box." Query: Was the model here referred to one of Washington's own invention and being shipped to a manufacturer or to officials granting patents?

"*Saturday 7th.* * * * * * * * In my Botanical garden in the section immediately adjoining to & west of the Salt House I sowed first 3 rows of the Kentucke clover 15 inches apart—and next to these 9 rows of the Guinea grass in rows of the same distance apart.

"*April 20th.* * * * * * * In the Neck the grd. being rather hard and in places rough—two harrows could not prepare it sufficiently to keep the drill plow constantly at work. I therefore ordered the plowman who attended it to make good the work of covering the corn which the little harrow at the tail of it might leave unfinished and this he is well able to do, because where the ground is difficult to prepare he can outgo the harrows, and here it is assistance is wanted when the ground is light and the harrows prepare it sufficiently there is no occasion of the hoe to follow—this supercedes the necessity of the special hand ordered for this service on Wednesday last.—Where the grd. is naturally light, or well pulverized the drill plow plants with great dispatch regularity and to good effect where it is rough and hard manual labour as in the common mode must be applied."

The spirit of enquiry and desire for exact knowledge remained an active element in Washington's character to the close of his life,[47] but it is nevertheless wonderful that as late as 1788 he

47 While George Washington was a member of the House of Burgesses, a petition of Mr. Aaron Miller addressed to the Governor and Council was referred to the House, "setting forth that he had at great trouble and expense invented a new compass and protractor, by which an angle may be measured both in surveying and platting with greater Accuracy than by any other instrument hitherto discovered and praying such Bounty as the Legislature may think he deserves and the said petition was read. *Ordered* that the said Petition be referred to the consideration of Mr. Richard Bland, Mr. Richard Henry Lee, Mr. Wythe, Mr. Carey and Mr. Mercer; that they examine into the allegations thereof, and report the same with their opinion thereon, to the House." (*Journal House of Burgesses, Decbr. 6th, 1764*) "Mr. Richard Henry Lee from the Committee to whom was referred the Petition of Aaron Miller, reported that they had examined the Instruments mentioned in the said petition and were of opinion that surveys of Land may be made and plotted with them with greater accuracy than any instruments of the kind they had ever seen or heard of * * * * * * *Resolved*, that the said *Aaron Miller* ought to be allowed the sum of £30. as a consideration for his useful invention." (*Journal House of Burgesses, December 15th, 1764.*)

should take the pains to count the actual number of peas and beans there were in a pint measure of six varieties of them, that he might know the quantity of ground to prepare and the number of hills a bushel of each would plant, as will be noticed from the following taken from his Diaries :—

"*Monday May 12th. 1788* * * At home all day.—Counted the number of the following articles which are contained in a pint—viz.—of The small & round pease commonly called Gentlemans Pease 3,144. Those brot. from York Rivr. by Majr. G. Washington 2,268. Those brot. by Do. from Mrs. Dangerfields 1,375. Those given by Hezh. Fairfax 1,330. Large and early black eye Pease 1,186. Bunch hominy Beans 1,473. Accordingly—a bushel of the above, allowing 5 to a hill will plant the number of hills wch. follow.—viz

" 1st. kind	- - - - - -	40243
2 Ditto	- - - - - -	29030
3—Ditto	- - - - - -	17200
4—Ditto	- - - - - -	17024
5. Ditto	- - - - - -	15180
6. Ditto	- - - - - -	18854 "

Another inventor was rewarded by Virginia while Washington was a member of the Assembly for an improvement in the threshing machine. John Hobday of Gloucester county, Va., in 1774 by petition brought to the attention of the House the fact that "he had invented a Machine for getting Wheat out of the Ear clean and neat and with more expedition than could be done by thrashing, or treading with cattle, and that without loss of the chaff, or detriment to the straw ; and submitting it to the Liberality and Wisdom of the House to reward his endeavors to serve the community, in such manner as they may think proper. *Resolved* that the said Petition be referred to the consideration of the Committee of Trade ; and that they do examine the matter thereof and report the same, with their opinion thereupon to the House." (*Journal of House of Burgesses, May 19th., 1774.*) May 20th., 1774, Mr. [Benjamin] Harrison reported from the Committee of Trade, to whom the petition of John Hobday, praying to be allowed a reward for inventing a machine whereby wheat is got out neat and clean, &c. * * * * * * * *

"Resolved that it is the Opinion of this Committee that the petition is reasonable and that the said John Hobday ought to be allowed by the Public the sum of three hundred pounds as a reward for inventing the said Machine, and communicating to the Public the manner of erecting it."

The resolution was amended by inserting one hundred instead of three hundred, and it passed in the affirmative. Washington was a competent judge of the utility of both these inventions.

He also counted the number of clover, timothy and Saint Foin seed there was in a pint that he might estimate the quantity to sow upon an acre.

During the session of the Convention that drafted the Constitution of the United States, Washington kept a brief journal of events, but records nothing regarding the questions discussed in the sessions; thus evincing scrupulous adherence to his pledge of secrecy. The entries show, however, that he visited numerous institutions of learning, Bartram's botanical gardens, and the most noted farms in the vicinity of Philadelphia. His most lengthy notes, however, relate to agriculture, in which he never lost interest.[48] However, on Monday, 3d of September, 1787, his Diary has the following entry relating to a new machine:—"Visited a Machine at Doct^{r} Franklins (called a Mangle) for pressing, in place of Ironing, clothes from the wash—Which Machine from the facility with which it dispatches business is well calculated for Table cloths & such articles as have not pleats & irregular foldings and would be very useful in all large families."

It is probable that the activities of Washington's inventive genius found its favorite employment in the direction of labor-saving implements which ensured increased domestic comforts to the people. Yet his great catholic heart and enlightened humane sympathies led him to welcome and encourage every

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[48] Washington in a letter to Landon Carter, "of Cleve," written at Mount Vernon 17 October, 1796, uses the following language:

"It is true (as you have heard) that to be a cultivator of Land has been my favorite amusement;—but it is equally true that I have made very little proficiency in acquiring knowledge either in the principals or practice of Husbandry. My employments through life, have been so diversified—my absences from home have been so frequent, and so long at a time, as to have prevented me from bestowing the attention, and from making the experiments which are necessary to establish facts in the Science of Agriculture.—And now, though I mav amuse myself in that way for the short time I may remain on this theatre, it is too late in the day for me to commence a scientific course of experiments. Your thoughts on the mode of cultivating Indian corn, appear to me, to be founded in reason,—and a judicious management of the Soil for different purposes, is as highly interesting too, as it has been neglected by the People of this country. * * * * *

"I shall always feel myself obliged by your communicating any useful discovery in Agriculture; and for the favorable Sentiments you have been pleased to express for me, I pray you to accept the thanks of

"Sir

"Your most obed^{t} and very H^{ble} servn

"G^{o} WASHINGTON."

measure which gave promise of lessening the heavy load resting upon the shoulders of the poor and the overworked and poorly-paid tillers of the soil. Intimately blended with his genius for leadership and for improving man's condition, was his taste and respect for the esthetics to be observed in every-day life which he believed not only improved habits but elevated character. This at times may have led some to consider him as reserved and overfond of ceremony. This was not the fact. But to a mind like his, attuned to exact justice, individual rights and the orderly observance of the proprieties of social life were sacred.

To President Washington we are indebted for the graceful and convenient device of the dinner wine coaster. The history of its invention and first introduction may be found in a foot-note.[49] The harvest horse-rake for gleaning meadows and also

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49 Mr. Lossing in his admirable book on "Mount Vernon and its Associations," page 263, gives in substance the following history of this invention. The President on the removal of Congress from New York to Philadelphia furnished his residence in a manner to make it comfortable to the close of his term of office, and to do this added much new furniture and household belongings. In his efforts in this direction he ordered a bill of goods through Gouverneur Morris, who was then in Paris. In this order was some silver-plated wine coolers, an article that he had never used at Mount Vernon. The invoice had reached him in Virginia. In a letter to his secretary, Mr. Lear, Washington wrote, I quote from Mr. Lossing:

"Enclosed I send you a letter from Mr. Gouverneur Morris, with a bill of the cost of the articles he was to send me. The prices of the plated ware exceed—far exceed—the utmost bounds of my calculation; but as I am persuaded he has done what he conceived right, I am satisfied, and request you to make immediate payment to Mr. Constable if you can raise the means. As the coolers are designed for warm weather, and will be, I presume, useless in cold, or in that in which the liquors do not require cooling, querie, would not a stand like that for castors, with four apertures for so many different kinds of liquors, each aperture just sufficient to hold one of the cut decanters sent by Mr. Morris, be more convenient for passing the bottles from one to another, than the handing each bottle seperately, by which it often happens that one bottle moves, another stops, and all are in confusion? Two of them—one for each end of the table, with a flat bottom, with or without feet, open at the sides, but with a raised rim, as caster-stands have, and an upright, by way of handle, in the middle—could not cost a great deal, even if made wholly of silver. Talk to a silversmith, and ascertain the cost, and whether they could be immediately made if required, in a handsome fashion.

"Perhaps the coolers sent by Mr. Morris may afford ideas of taste; perhaps, too (if they prove not too heavy, when examined) they may supersede the necessity of such as I have described, by answering the purpose themselves. Four double flint bottles (such as I suspect Mr. Morris has sent), will weigh, I conjecture, four pounds; the wine in them when they are filled will be eight pounds more, which, added to the weight of the coolers, will grain fields after the grain had been cut and gathered came into use about the time General Washington was President. He ordered two for his Mount Vernon farms. (*See letter to C. Biddle.*) And in 1797 he had a thrashing-machine erected at Mount Vernon. (*See cash book.*)

Under date of August 2^{d}, 1788, we find the following:—"Visited all the Plantations—At the Ferry—six plows were turning in B [uck] Wheat Three of them from Frenches—Tried the Patent Plow sent me by Major Snowden wh^{ch} run easy and did good work."

It would seem from this that there were plows patented and in use in Virginia before the assembling of the First Congress under the Constitution of the United States. This paragraph bears testimony also to the fact that Washington was known to merchants and progressive farmers as being ready and anxious to test new and improved implements of husbandry; hence, no diplomacy was necessary to bring to his attention a new patent plow.[50]

"*Sunday November 2^{d} 1788.* M^{r} George Mason came here to dinner and returned in the Evening—After dinner word was bro^{t} from Alexandria that the Minister of France was arrived there and intended down here to dinner—Accordingly, a little before Sun setting, he (the Count de Moustiers) his Sister the

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I fear, make these latter too unwieldy to pass, especially by ladies which induces me to think of the frame in the form of casters."

After quoting the President's letter descriptive of the device, Mr. Lossing adds the following:

> "Mr. Lear was pleased with Washington's suggestions and ordered a silversmith to make two of the caster-like frames of solid silver, and these were used upon the President's table on the occasion of the first dinner which he gave to the officers of the government and their families, foreign ministers and their families and other distinguished guests. Their lightness and convenience commended them, and from that time they became fashionable, under the appropriate title of coasters. Thenceforth the wine-cooler was left upon the sideboard and the coaster alone was used for sending the wine around the table. For more than a quarter of a century afterward the coaster might be seen upon the table of every fashionable family in Philadelphia. Few persons, however, are aware that Washington was the inventor of it. A roller was placed under the center of each basket by which the coaster is more easily sent around the table."

An engraving showing a specimen of each of the wine coolers and the coaster may be seen in the work of Lossing referred to.

[50] Prior to the Federal union under the Constitution, patents were granted by the Assemblies of the several Colonies, as well as by Parliament.

Marchioness de Breton[51]—the Marquis her Son and M^{r} du Ponts came in.

"*Monday 3^{d}* Thermometer at 50 in the Morning—70 at Noon—and 70 at Night.—A thick fog until 8 or 9 o'clock—Clear, Calm & exceedingly pleasant afterwards.—

"Remained at home all day.—Col^{o} Fitzgerald & Doct^{r} Craik came down to dinner—& with the copy of an address (which the Citizens of Alexandria meant to present to the Minister) waited on him to know when he would receive it.

"Mr. Lear went to Alexandria to invite some of the Gentlemen and Ladies of the Town to dine with the Count & Marchioness here tomorrow.

"*Tuesday—the—fourth.* Thermometer at 58 in the Morning—75 at Noon—and 72 at Night.—Morning clear, calm and very pleasant.—as the weather continued to be thro' the day.

"M^{r} Herbert & his Lady, M^{r} Potts & his Lady, M^{r} Ludwell Lee & his Lady, and Miss Nancy Craik came here to dinner and returned afterwards.

"*Wednesday 5th* Thermometer 63 in the morning—75 at Noon and 73 at Night, very clear, calm, warm and pleasant all day.

"The Minister & Madam de Bretan expressing a desire to walk to the new Barn—we accordingly did so—and from thence through Frenches Plantation to my Mill and from thence home compleating a tour of at least seven miles.—Previous to this, in the morning before breakfast I rid to the Ferry, Frenches D[ogue] Run and Muddy hole Plantations.

"At the Ferry some of the People were clearing up the Rye which had been tread out the day before, others were digging Potatoes—the Plows were at work in No. 5.—

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51 Marchioness de Brienne was an enthusiastic admirer of America, a writer of spirit and an amateur artist of considerable skill. While at Mount Vernon she painted a miniature of the General from life which she presented to Mrs. Washington, making a duplicate for herself. (*See Portraits of Washington by Miss E. B. Johnston.*) The General in his Diary of October 3^{d}, 1790, says: "Walked in the afternoon and sat about two Oclock for Madam Brehan [Brienne] to complete a miniature profile of me which she had begun from memory and which she had made exceedingly like the original."

"At Frenches the People were preparing the yard to tread out Oats which had remained in Shocks at the yard.—At Dogue Run—some hands were Clearing up Rye, and preparing to lay down a bed of Wh^t —and others digging Cellar to store Irish Potatoes in.—The Plows yesterday & this day being stopped to tread out grain.—At Dogue Run—The people were Raising Mud for Manure—the Rye would be all in and covered to day—

"*Thursday 6th* Thermometer 63 in the morning—73 at Noon and 72 at Night. Clear calm, warm, and exceedingly pleasant.

"About Nine Oclock the Minister of France, the Marchioness de Bretan and their suit left this on their return for New York. I accompanied them as far as Alexandria & returned home to dinner,—the minister proceeded to Georgetown after having received an Address from the Citizens of the Corporation.

"In the afternoon M^r Ferdinand Fairfax came in and stayed all Night."

In his Diary January 22d, 1790, will be found the following entry: "Called in my ride on the Baron de Poelnitz to see the operation of his (Winlow's) thrashing machine. The effect was the heads of the wheat being seperated from the straw, as much of the first was run through the mill in 15 minutes as made half a bushel of clean wheat. Allowing working hours in the 24, this would yield 16 bushels per day. Two boys are sufficient to turn the wheel, feed feed the mill and remove the thrashed grain after it has passed through it. Two men were unable by winnowing, to clear the wheat as it passed through the mill, but a common Dutch fan, with the usual attendance would be more than sufficient to do it. The grain passed through without bruising and is well seperated from the chaff. Women and boys of 12 and 14 years of age are fully adaquate to the management of the mill or thrashing machine."

From intimations in letters and other parts of the journal it is almost certain the President sent one of these thrashers to his Mount Vernon Plantations.

It would be easy to multiply examples of General Washington's hospitality to distinguished visitors as well as experiments to promote agriculture and to devise better methods and implements than were then in use in agriculture and the domestic arts, but I have exhausted the time at my disposal and, I fear, your patience; besides which I think enough evidence has been adduced to make it apparent that the mind of Washington was pre-eminently efficient in devising expedients and all the essential machinery to accomplish in the shortest time and in the best manner, his purposes whether in the management of a farm, the command of an army, or the inauguration of a new form of Government and the administration of the affairs of a nation.

The parentage, the disciplined mind, the associations and the pursuits of Washington, from his cradle to his grave, were all so admirable as to fully satisfy the most exacting requirements of the highest standard of excellence in human character; and each gives assurance that he was pre-eminently deserving of the admiration of mankind above that of any mortal who has ever lived.[52] Each act of his eventful life, the purer grows as studied, freed from the passions of the times in which he lived. Is it not lamentable, then, and to be deeply regretted that the name of George Washington, the central figure in all history, is not held as too sacred to be mentioned except with reverential praise? He should, at least, be exempt from coarse and inconsiderate gibes and pert, unsavory inuendoes having no foundation except in the depraved imagination of the vulgar, incapable of appreciating the virtues they profane.[53]

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[52] A delicate and appreciative mark of respect to the memory of Washington is "the tolling of the bell" by all vessels passing Mount Vernon. This special manifestation of regard, I learn, originated with a French merchant vessel passing just after General Washington's death and before the interment of his remains. The barque placed its colors at half-mast and tolled its bell while passing the home of Washington, then a house of mourning. This unique but impressive testimony of respect seemed to all sea-faring men so appropriate that it was at once taken up by crafts of every character on the Potomac, and has been continued, without abatement, to this day.

[53] The Hon. George Bancroft, our most eminent student of American history, has left us a comprehensive and just analysis of the character of the Father of our Republic, based upon a study of his life and times, such as but few writers are capable of giving to the subject. He says:

Mount Vernon must ever have a peculiar fascination to the lovers of civil liberty, to all who admire genius and have faith in human progress. To climb its hills, traverse its walks and pass the portals which sheltered the man who amplified and fashioned this Mansion, planned its gardens, fields and lawns and embellished all with choicest trees and flowering shrubs, seems now and ever will in some mysterious way to bring the appreciative visitor near the great Washington. For it was here the youthful surveyor, the courageous explorer, the commander of armies, the presiding officer of conventions and the first President of the United States, pursued his favorite employment of cultivating the soil. Here, the purest patriot of all the ages occupied his splendid talents and kept his heart in sympathy with the latest improvements in everything which tended to advance the happiness of the people and his country. Here lived and labored the most felicitous letter-writer in history, the greatest exponent of liberty guided by law, the defender of the inalienable rights of man, the possessor of all the virtues. The vitality of the *Pater Patriæ* seems sentient and perpetual here—the patriot's Mecca—once the home, now the tomb of the Immortal Washington!

"The character of Washington's greatness may be described, in its unity, as the highest wisdom of common sense ; that is to say, the largest endowment of the power that constitutes the highest part of the nature of man ; or, it may be described as in action the perfection of reflective judgment. That common sense or reflective judgment, was combined with creative and executive capacity. If he spoke, or if he wrote, he came directly to the point on which the matter in discussion depended ; and pronounced his thoughts in clear, strong and concise words ; if he was to act he suited his means, be they scanty or sufficient in the best way to his end. When America assembled its best men in a first Congress, Patrick Henry said: 'For sound judgment Colonel Washington is unquestionably the greatest man on the floor.'"

The following appreciative estimate of Washington's character is from the pen of that astute French statesman, Talleyrand:

"History affords few examples of such renown. Great from the outset of his career, patriotic before his country became a nation, despite the passions and political resentments that desired to check his career, his fame remained imperishable. His public actions, and unassuming grandeur in private life were living examples of courage, wisdom and usefulness."

THE EFFECT OF OUR PATENT SYSTEM ON THE MATERIAL DEVELOPMENT OF THE UNITED STATES.

BY HON. BENJAMIN BUTTERWORTH, OF OHIO, U. S. HOUSE OF REPRESENTATIVES.

In defining the powers conferred upon Congress, Section Eight of Article One of the Constitution contains, among others, the following Clause "To promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

In the execution of the power conferred, Congress devised our present Patent System, not in a single Act, but by such legislation from time to time as experience suggested. The law is a growth, and our present laws are the result of progressive development. Has the action of our fathers in making provision in the Constitution for encouraging inventors and authors been approved by results deducible therefrom? Has the influence of our Patent System upon the prosperity of the nation justified its adoption? I answer these questions in the affirmative, and call attention to the evidence that no other answer can properly be given.

Our fathers builded even better than they knew. I do not know what they hoped for or anticipated as possible under the System, the foundation of which they laid in the Constitution, but this we may believe, that neither the most profound thinker nor the wildest dreamer could have anticipated such marvelous changes and improvements as have been wrought out under our Patent System.

Mr Chairman, if some member of the immortal Convention that framed our Constitution, endowed with the gift of prophecy, had arisen in his place, and in plain speech disclosed what their children would behold at the close of the first century as a result of the power conferred upon Congress in the clause I have read, his associates would at once have felt an anxious concern in regard to his mental health, or else have suspected that the spirit of Baron Münchausen was upon him. And if in candor he had persisted in his predictions, his seemingly obvious mental halucinations would have invalidated any will he might have written while his intellect continued thus disturbed.

If Benjamin Franklin, sage and philosopher as he was, were to come back to the earth with only such scientific knowledge as he possessed on the date of his death, he would not be able to pass a civil service examination for appointment as a Fourth Assistant Examiner in the electrical division of the Patent Office.

I need not go to those who walked the earth an hundred years ago to find unbelievers touching the possibilities that waited upon the progressive and aggressive spirit of the last fifty years of the nineteenth century, as it finds expression in the development of the industrial arts and applied sciences. The wise men in Congress fifty years ago found pleasure in ridiculing and laughing at the "crank," Morse, who hung about the lobby of the House, insisting that he could use the lightning to transmit messages. And to-day, ninety per cent. of the people of the United States would not credit the truth of a plain recital of actual facts concerning the progress we have made in the field of human activity I have mentioned. Even the individual who has struggled to keep posted, at least as to the rate of progress made, would be startled at the exhibit of what has been accomplished along the line of evolution during the last five decades.

Until recently, the Patent Office was regarded by the mass of people as a clearing house for cranks. Inventors and authors, especially poets, were looked upon as a class of long-haired, dreamy-eyed persons suffering in a greater or less degree from some mental obliquity, and the Patent Office was supposed to contain the materialized evidence of mental contortion. How little the world realized that to these cranks it is in large measure indebted for its progress. They were the avant couriers of a higher and better civilization. As the result of their labor, old things have passed away and all things become new. We have a new earth, or at least it can be truly said that the old earth has put on new conditions, such as to create wonder even among the most learned.

The wisdom of giving to authors and inventors the exclusive right for a limited time to their writings and discoveries has been frequently questioned by able men, and even as late as during the last Congress one of its oldest and wisest members asserted that our present unequalled and unexampled prosperity in the arts and sciences would not have been lessened by the absence of the Patent System, asserting also that such encouragement to authors and inventors is wholly unnecessary and cannot be justified.

It is urged also, that the influence of the System has been to build up monopolies and to impose needless burdens upon the people. I desire to take a few moments of your time to answer these criticisms, and in doing so, to call the attention of this Congress to what has been accomplished under the inspiration and encouragement afforded by our Patent System.

Our fathers affirmed, and all experience confirms the correctness of their conclusion, that no individual would devote weeks, months and years, and possibly decades, to patient study, investigation and experiment for the mere purpose of lightening his own labor or securing better results merely from his individual efforts. Obviously *not even a crank*, mad with the love of invention, would struggle through the years to invent a steam engine, a sewing machine, a telegraph, a telephone, or a reaper and mower, solely for his personal use. It was essential that there be reserved to the inventor or author for a time such exclusive ownership in the thing invented, discovered or written, as would enable him to derive pecuniary profit from its manufacture, use, publication and sale.

It would seem clear that there would be no inducement to invent or construct a harvester or mower merely to reap one's own field. No one would invent a sewing machine for the purpose of doing the family sewing. And it is equally clear that there would be very few inventions if others have the equal right, without the permission of the inventor and discoverer, to manufacture, use and sell the thing invented or discovered. Few books would be written unless there was in the author for some period an exclusive ownership of the work. In every walk and avenue of life there must be the hope of gain or other positive advantage to induce men to labor.

The framers of the Constitution, therefore, wisely conferred upon Congress the power to secure to authors and inventors for a limited period, an exclusive right to their respective writings and discoveries, the compensation in each case being contingent upon the advantage or pleasure the public derived in substituting the new device or machine for the old, or in perusing the works from the pen or inspiration of the author. The consideration to the public is found in the advantage, pleasure or profit derived by the community from the discovery or writing. The steam engine, the cotton gin, the printing press, the machinery for spinning, each paid to the world ten thousand-fold, yes a million-fold, more than the inventors received as a reward for their labor. The community have no right to take the result of my labor without compensation. Whitney's cotton gin contributed more for the convenience and comfort of mankind than was derived from the aggregated labor of every workman in his State in five years. The idea that this work of Whitney's should be confiscated to the use of the public without suitable reward to him, smacks of grand larceny.

The difference between civilization and barbarism is not more marked in anything than in the means of communicating thought, and in the character of the instrumentalities and agencies provided for utilizing the forces of nature and adapting material resources to the necessities and wants of man.

This inventive genius I regard as one of the godlike qualities given to man, with which to solve the problem of his existence. Nor does the influence exerted by this divine attribute have relation merely to the physical conditions about us, but to our moral, social and political condition and surroundings. Place a philosopher in the midst of poverty and squalor, and he will gravitate towards corruption and beastiality. The men who are compelled to endure an unceasing round of drudgery in order to subsist or exist become, ultimately, little better than mere beasts of burden.

I do not intend to intimate by this that labor is in itself degrading. Far from it. I do not speak of labor in its proper sense, but of toilsome, wearing drudgery, sometimes called labor. Labor itself is ennobling, dignifying and refining, even as idleness has a tendency to the reverse.

It would be well for us to look for a moment still further into the causes which led to the insertion of the clause in the Constitution which is the foundation of our Patent System. We must study cause and effect together, and to do so, we must look a little farther back through the pages of time than that gathering of the fathers which framed our Constitution.

States have been carved out upon the battlefield or created in the counsel chamber, or have grown up in the process of time without feeling that necessity for a power, welded into the fundamental law, to remunerate inventors and authors as public benefactors. But a century ago the world was just entering upon its inventive period. Scientists and philosophers were groping after the natural laws, dragging them one by one from their obscurity and revealing them to the wondering eyes of the people. Invention, that is the utilization of the powers and principles of nature, was in its infancy, being without encouragement or hope of reward.

In the Constitutional Convention sat Benjamin Franklin, aged and near his end, but fresh from his intercourse with the brilliant band of philosophers and scientists at Paris whose audacious theories and researches were the fit harbinger of the awful regime about to be ushered in. The world was ripe for wondrous changes, some silent and scarcely felt, others resounding through the world with their momentous and dread import. We cannot pause to measure the relative importance of these different changes. Suffice it that all of them hurled themselves against the inertia of the past, that all of them proclaimed in the ears of the startled world "The order changeth, give place to new."

Liberty was awake and was stretching her pinions for an awful flight. Invention was but half awake and beholding in dreamy visions the children that were soon to be born of her. Her flight was at first more gradual, but increased in speed so wondrously that of late it had been beyond the power of mortal man to accurately mark her course.

The Patent System was the offspring of the inventive genius of the age. Invention in turn was fostered and vindicated the Patent System. This has gone on until the two have become entwined with one another and inseparable.

But for the Patent System only an infinitesimal part of the triumphs of inventive genius, which crowd about us in such numbers that we are wholly unable to appreciate their extent and magnificence, would have been accomplished, and if we would cut the ground from beneath the material prosperity of the age, there is no way in which it could be so effectively done as by a repeal of our patent laws.

Now, what has been the effect of the system upon the condition of our country? Does it levy unjust and onerous tribute upon the people? Do we realize that of all the patents issued *not ten per cent.* pay the *inventor or his assigns the actual cost of perfecting the invention and obtaining letters* patent therefor? Nor must it be inferred from this that these several inventions are worthless to the community. Far from it. Each marks a step in the line of progressive development and is of value as such, and for every cent paid to inventors, more than one thousand are realized by the general public in the use of inventions with or without paying proper compensation therefor.

It is true that fortunes are made out of single inventions and the price charged for the right to use the device or machine may appear, and often is, extravagant. But, do we stop to reflect that we need not use it? We have still at our command the old way, and it would seem obvious that the new device would not be used unless, notwithstanding the tax, it were better and cheaper, for after all the advantage or disadvantage to the user is what controls.

We stick to the old way unless we see a positive advantage in substituting the new. So the profit is shared in by the many. It is susceptible of demonstration that if the inventors of the past century could have a just balance struck between what they have contributed to the pecuniary advantage and general prosperity of the community and the pecuniary profit which they have received themselves, there would be found due the inventors a sum in excess of the national debts of England and the United States

I will briefly call attention to what the inventive genius of man, prompted and encouraged by our Patent System, has accomplished in comparatively few years. In the history of nations centuries are brief periods. And here I may stop to say that if I should draw a sharp contrast between the possibilities under the old order of things prior to the adoption of our Constitution, and that which is not only possible, but commonplace to-day, I should be deemed even in the presence of known facts as having great powers of imagination, and taking too much liberty with truth.

But for this influence boot and shoemakers would still toil fifteen hours a day instead of ten, and by reason of the increased demand shoes might now be a luxury beyond the reach of many.

The great famines of history have become no longer possible on account of the improved means of transit and transportation. All the people of the United States in 1840, with all the means then at their command, could not have harvested one of our present annual corn or wheat crops, and had they succeeded in doing so it would have rotted in the barns for lack of means of transportation to spots where at the same moment famine was reigning.

I have often called attention to the fact that one day's wages of a Boston mechanic would pay the cost of transporting the year's supply for his family from Chicago, the great Western market, to Boston. Fifty years ago one month's salary would not have been sufficient for that purpose.

The Hon. David A. Wells, in his most admirable book entitled "Recent Economic Changes," tells us that five acres of wheat can be brought from Chicago to Liverpool for less than the cost of manuring one acre in England. And that Indian corn, which has been extensively raised in Italy, can be brought from the Mississippi Valley and sold in Italy at less than the home product, although the Italian laborer receives but one-third of the wages of the American. A few years ago five million people perished in one district in China from starvation because the bountiful harvests of other districts could not be conveyed to their relief.

Without the perfected railroad and telegraph systems, as Mr. Wells justly observes, the war for the maintenance of the Federal Union under the existing Constitution, could not probably have been prosecuted to a successful conclusion, and even if no domestic strife had intervened, it is more than doubtful whether a federation of numerous States, sovereign in many particulars, flowing down the stream of time like an elongated series of separate rafts linked together, could have been indefinitely perpetuated when the time necessary to overcome the distance between its extremities and the mere transmission of intelligence amounted to from twenty to thirty days. So much for improvements and transportation.

Nearly, and probably fully, one-half of all those who now earn their living in industrial pursuits do so in occupations which not only had no existence, but which had not even been conceived of one hundred years ago. When Arkwright invented his cotton spinning machinery in 1760, there were in England about eight thousand persons engaged in the production of cotton textiles. The introduction of his invention was opposed on the ground that it threatened the ruin of these working people. This was equally true of many labor-saving machines, and is an argument that is still used in spite of the facts. Results, however, vindicated the claim that the labor-saving machine is a most beneficent friend of labor. Note what followed the invention of Arkwright. I quote largely from the work of Mr. Wells: "Twenty-seven years subsequent to the invention the Parliamentary inquiry showed that the number of persons actually engaged in the spinning and weaving of cotton had arisen from seven thousand nine hundred (7,900) to three hundred and twenty thousand (320,000), an increase of four thousand four hundred (4,400) per cent., and now, including those engaged in subsidiary industries, such as calico printing, the number is two million five hundred thousand (2,500,000)."

Mr. Wells remarks upon the singular anomaly that while the increasing cost of labor is the greatest stimulant to invention, the laborer who finds employment in connection with the new inventions generally commands higher wages than was possible under the previous conditions, and, what is quite as important to the laborer, each invention creates a new industry, in which the higher and nobler faculties of the mind are employed.

In the manufacture of certain kinds of tinware seventy-five pieces are now produced at the cost of producing one fifty years ago, and in every department of the tin manufacture the cost of production has been greatly cheapened, prices to consumers reduced, consumption more than quadrupled, and yet the number of men employed in the factories has constantly multiplied and their wages constantly advanced.

Again, I am indebted to Mr. Wells for the information that since 1870 the price of articles of glassware, such as goblets, tumblers, wine-glasses, etc., has been reduced seventy or eighty per cent. in consequence of methods which encourage labor and improvement in quality of the manufacture. At the same time the wages of the workmen have advanced seventy to one hundred per cent., with a considerable reduction in the hours of labor. On the Illinois Central Railroad the cost per mile run for locomotive service has fallen from 26.52 cents in 1857 to 13.93 in 1886, and in the same period the wages of engineers and firemen have arisen from 4.51 cents to 5.52 cents per mile run. In other words, the engineers and firemen who received in 1857 seventeen per cent. of the entire cost of locomotive service received in 1886 forty per cent., the reduction in the cost per mile run being wholly effected by invention and improvements in machinery.

The truth is really more startling than fiction. If the stories of the writers who have regaled us by descriptions of the deeds wrought by the supernatural powers of the mythological period of the world were true, they would still be eclipsed by the actual possibilities of to-day. Let me see whether I am correct in this. We read of what the heroes and demigods accomplished at the siege of Troy and in the battles in which the upper powers were said to have taken part. Would Agamemnon and Archiles, leading the armies of Greece, with Mars and Pallas fighting by their side, have been able to sustain a seizure against Helen of Troy and her hand-maids, if the latter had stood upon Trojan battlements supplied with the modern implements of war, the Greeks fighting with the weapons of their day? It will be obvious to this convention that the fickle Helen, aided only by her maids, could have destroyed the armies of Greece and driven the Grecian fleets from the Trojan Coast, or sunk them in the sea.

It is truly said that time and space have been annihilated, but what are the illustrations? Could the fleet Mercury, with his winged sandals, keep pace with the messenger of Morse? Could Jupiter hurl thunderbolts as terribly destructive as our 16-inch cannon or our 20-inch mortars? Could Neptune hold his own on the Sea against such navies as now ride the deep, supplemented by our system of torpedoes and submarine mines? There is not a skillful blacksmith in the United States who would consent to use the crude appliances of Vulcan's fabled shop. Every youth familiar with mythology has wondered at the malvelous feats performed by the gods and demigods. The inventor has taught us how to surpass everything they did, whether in the arts of peace or war.

The twelve labors of Hercules would be undertaken by any contractor in the United States in good standing, and he would give bond with approved security to complete the work within half the time required by the son of Jupiter. This statement may sound startling and exaggerated, but it is indeed the truth. The powers we exert now are not of mythological origin, but from the inspiration of the living God.

Those who censure the Patent System too often assume that the inventor puts forth no effort, and that the wonderful productions of authors and inventors involve little thought, slight study and reflection, and next to no labor. Nothing could be farther from the fact. Let it be borne in mind that those whose names appear upon the records in the United States and other countries as patentees do not comprise the list of inventors, even approximately. Neither would this list of inventors, could it be accurately compiled, disclose the entire number of those who are busy in the various fields of study, investigation and experiment, endeavoring to solve some important problem in art or science, to benefit mankind. The *patentees* are those who reached the goal first, but a mighty army was moving to occupy the ground, and each one of the host may have contributed by thought or act to the ultimate success attained, no matter to whom the first honor may have been awarded. Each hoped to be the first, and, encouraged by the provisions of our Patent Laws, he labored on to the end.

A greater number of men gave time, labor and money to the task of inventing and perfecting the reaper and mower as we see it to-day in the harvest fields than were employed in constructing the several Pacific railroads.

Cæsar conquered Gaul with a force numerically less than was employed in inventing and perfecting the parts of the sewing machines that are used in the homes of our country to-day. Sewing machines are more than two centuries old.

The roll of all those who have given earnest study and labor to the invention and perfection of the printing press and the steam engine would be longer than that which contains the names of all the soldiers who fought the battles of the Revolution. In short, the war to subdue the forces of nature, to make them submissive and obedient to the human will requires a more numerous and better trained army than was mustered to conquer the warlike tribes of men.

A revolution in the industrial arts and applied sciences proves of greater advantage and is more permanent and farther reaching in its influence for good than the most successful political and social revolutions. The revolution in the arts is silent though potent. It goes forward with constantly accelerated speed and yet so noiselessly that we are unconscious of it except as we witness results.

The influence of the revolution wrought by the author and inventor, through the inspiration and encouragement of the Patent and Copyright System, is about us on every hand. It is constantly before our eyes and palpable in fact to all our senses. Of this we are sometimes, in fact generally, forgetful. In conclusion, I submit that there is not a home, not a shop, mill or factory, not a highway of travel nor an artery of commerce, not a field, river, lake or ocean which does not bear irrefutable testimony of the great value of this system, and abundantly attest the foresight of our fathers in planting in the Constitution the seed of this fruitful harvest of rich blessing for their children.

THE RELATION OF INVENTION TO THE COMMUNICATION OF INTELLIGENCE AND THE DIFFUSION OF KNOWLEDGE BY NEWSPAPER AND BOOK.

By Hon. William T. Harris, Commissioner of Education.

By reason of his physical nature man is hampered by three wants—he needs food, clothing and shelter. In his first and lowest stage of civilization man lives in a state of enthrallment to nature. He dreads and worships the cruel forces of matter. But by the aid of science, and invention which flows from science, man attains domination or control over things and forces and directs them into the service of humanity for use or for beauty. The soul conquers nature by science and machinery, and then next it desires to see this conquest over nature reflected in works of art. Hence it creates architecture, sculpture, painting, music, and poetry—all of these fine arts portraying man's victory over wants and necessities.

If the spectacle of pauperism and crime—the savagery that still lingers in the slums of our cities sternly reminds us of the yet feeble hold which our civilization has obtained even in cities—if the census of mankind proves that three-fourths are yet counted as below the line that separates the half-civilized from the civilized—yet we are wont to console ourselves by the promise and potency which we can all discern in productive industry aided by the might of science and invention. This view is always hopeful. We see that there is a sort of geometric progress in the contest over things and forces. The ability of man to create wealth continually accelerates. The more he obtains the more he can obtain. The more each one gets the more his neighbor also can get. Even the weaklings of society—the paupers or beggars, the insane, and the criminals all fare better in the centres of wealth than they do at a distance from them where there is no wealth to beg or steal, and no asylums created and sustained by wealth to shelter and heal their diseased bodies.

Wealth in the modern sense of the word, far more than in its ancient sense, is self-productive. It is capital, and capital is wealth that generates wealth. Capital represents conquered forces and things—conquered for the supply of human wants. Capital consists of natural forces yoked and set to work for food, clothing, shelter and the facilities of human culture. The three physical wants (food, clothing and shelter) are produced by Nature—they are the chains and fetters whereby Nature asserts her right to enslave humanity—to keep man in a state of thraldom.

But the Promethean cunning of man, realized first in science and next in useful machines, has succeeded in subduing the powers of nature and imposing on them the task of supplying and gratifying the very needs which nature creates in us. Nature has chained man to the task of daily toil for food, clothing and shelter. But man turns back upon nature and compels her to take the place of human drudgery and produce an abundance of these needed supplies and bring them wherever they are needed for consumption. This is accomplished by mechanical combinations that secure the service of steam, electricity, and various forms of earth, air, fire and water.

This self-generating wealth that exists in the shape of capital is so much on the increase that it fills all classes of our population with hopes, or if not with hopes, at least with discontents—and discontent is certainly the product of hope struggling up from the depths of the soul. Without the vivid preception of a higher ideal and without the feeling that it is attainable, there would not be any such thing as discontent. The average production of each man, woman and child in the United States increased, in the thirty years between 1850 and 1880, from about 25 cents per day to 40 cents—an increase of 60 per cent. This means the production of far more substantial improvements for human comfort. Much more wealth is created that possesses an enduring character and may be handed down to the next generation. Finer dwellings, better roads and streets, fences for lands, drainings, levelings, and the processes necessary to bring wild land under cultivation, artificial supplies of water and gas, the warehouses and elevators and the appliances of commerce—and finally the buildings and furnishings of culture, including churches, schools, libraries, museums, asylums, and all manner of public buildings.

If science progresses and its concomitant, useful invention, progresses as fast for the next hundred years as it has done for the past forty years, the vision of Edward Bellamy of comfort for all will be realized without the necessity of any form of socialism. There will be comfort and even luxury for all who will labor a moderate amount of time.

Science inventories nature and discovers properties and possible combinations. Invention uses these combinations to meet mechanical problems. Can any one doubt who looks into the state of science and its continually improving methods that the conquest of nature will be more rapid in the coming century than it has been in the past century?

But we are challenged by the question, What is the good of annihilating the necessity for bodily toil? Will not man degenerate spiritually as he comes to possess luxury at cheaper and cheaper rates? These material advantages gained by useful invention which create a steady and permanent supply of food, clothing and shelter, are they not mere sumptuary provisions and do they imply real progress in civilization?

To this challenge we reply by pointing out the "Relation of Invention to the Communication of Intelligence and the Diffusion of Knowledge by Newspaper and Book."

In the first place it is obvious that the three classes of employments devoted chiefly to the supply of the physical wants, namely, agriculture, manufactures, and commerce are undergoing change by aid of mechanic invention in such a manner as to bring the laborer everywhere more and more into relation with his fellow men. In other words, commerce increases more and more, and becomes a part of all employments. In exchanging goods each gets something that he needed more than what he parted with. But the best result of the exchange is the acquaintance formed between the buyer and seller. Each has learned something of the other's ideas, and modes of looking at the world, and habits of action. Each one's life is enriched by the knowledge of the life of another.

Man as a spiritual being has for his problem the exploration of the two worlds—the worlds of nature and of man. The problem is too great for the individual and he must avail himself of the work of others. Each man may inventory a small portion of nature different from all others. Each one may live a life different from another's. But the individual gets a very small glimpse of nature by the aid of his own senses, and he gets a very small arc of the total of human life in his survey of his own biography.

But by intercommunication each one may extend and supplement his own observations of nature and of the experience of life by aid of the sense perceptions of others and still more by aid of the thoughts and reflections of others.

We see at once that man is man because he possesses and uses this means of re-enforcing his individual observations and reflections by those of the race. Man as individual is endowed with the power of absorbing the results of the race. We have with this a definition of civilization and a standard of measurement by which we may determine the rate of progress.

Advancement implies that there are improved means realized by which each individual can give to the rest of mankind the results of his living and doing and thinking, and at the same time share in the lives, thoughts, and deeds of all others.

Looked at in the light of this definition, we shall be able to see something more hopeful in the material progress promised us in the coming century than a cheap supply of bodily comforts. We see a progressive increase of intercommunication which will enable each individual to command the results of the rational intelligence of all mankind.

Man is first a speaking animal and next a writing animal. Each word that he uses expresses a general meaning. Each word therefore stores up an indefinite amount of experience. All men may pour into it their experience and by it recognize the experience of others. The art of writing at once increases infinitely the possibility of intercommunication, because it preserves the experience recorded for persons widely separated in space and far removed in time. It renders every *where* in some sense a *here* and every *when* a *now*. But mechanic invention comes to the aid of speech and the elementary arts of writing by printing with moveable types. Printing and gunpowder are two great elementary arts both attributed to the Germanic race—the two wheels of modern civilization, so to speak. But the Anglo-Saxon has added the steam-engine and the telegraph. The one makes locomotion possible to an increasing degree, and the other makes instantaneous intercommunication with all places possible.

Armed with these instrumentalities, our modern civilization lives on a sort of spiritual borderland. It looks across its frontier and is in a constant process of interaction with all other nations. The great instrument of this process is the daily newspaper. People are becoming from year to year a traveled people—in a short time the per cent. of the population that has crossed the ocean has doubled. The per cent. that has visited the Western borderland has quadrupled. But the per cent. of people who live in constant daily inter-relation with all mankind by aid of the daily newspaper has increased a hundred-fold within a single generation.

This single fact is the most significant one in all modern history. By a glance into its meaning we see to what an extent our civilization has become a constant miracle.

There go to the making up of the newspaper of to-day a vast congeries of mechanical and intellectual appliances. It is so complete in its instrumentalities that it realizes many of the conceptions cherished in the childhood of the race as mythological fancies. Odin's ravens, the wishing-cap of Fortunatus; the cloak of invisibility, the "seven-league boots," the winged feet of Mercury—in short, all appliances whereby a then becomes a now and whereby a there becomes a here, are well-nigh realized in the modern daily newspaper, so far as the presentation to each man of the spectacle of the activity of his entire race is concerned. The consequences of this fact are momentous. It is obvious that there is an immense shrinkage in the importance of near events, of events that concern small transactions. The consequent enlargement of the views of ordinary men, who form the masses of mankind, follows as a result.

It follows also that urban life—the life of the inhabitant of the city, with its social advantages—penetrates the country wherever the railroad and telegraph make possible the daily newspaper. It follows, moreover, that the mind of the average citizen becomes habituated to thinking of the great individualities of the world, such as corporations, states, vocations, social organizations, institutions, commercial enterprises, national undertakings; to seeing, in short, the activity of his fellow-men under the form of vast processes, instead of that former narrow view of mere individual exploits of mere commonplace people.

Another consequence of this is the gradual elimination of mere local peculiarities, the limitations of caste and narrow self-interest, and the consequent approach of the ideas of each and every people—that participates in civilization and supports its daily newspapers — towards a common ideal standard of humanity. This is not a reduction of all to one insipid standard on a lower level; it is the elevation of the members of the human race to the higher level of its ideal.

The daily glimpse of the spectacle of the human race, which our generation is becoming accustomed to, combines in one all the educative virtues of the means and appliances heretofore employed by the four forms of education furnished by the institutions of civilization, namely: the family, civil society, the state, and the church.

In proportion as the spectacle of the whole world of humanity becomes an adequate one, and its presentation a complete one, it becomes wholesome and moral.

The growth of prose fiction in modern times is a marvelous phenomenon that is not to be explained apart from the fact of the newspaper and periodical which has furnished the vehicle for its transmission to the public that reads it.

Not only does the well-equipped daily newspaper represent on its editorial staff the topics of commerce and transportation, the courts, the local gossip, the telegraph news, the political movements, the new discoveries in science and the useful arts, and the new productions in the fine arts, but it gives its department of fiction, in which the manners and morals of society are reflected, the virtues and vices and their consequences, and especially the habits of polite society.

If we but consider it, even the so-called "trashy novel" has a side of usefulness. It is condemned because of its description of empty trifles, the ceremonies and civilities of polite society; it expends much space in giving the outermost appearance of things, and its characters are mere "dummies" like those which the clothier and the milliner use to support and display their costumes. But even these empty externalities are interesting and valuable to the youth who is trying to rise from a low condition into polished society by industry and the acquirements of wealth. The boorishness of manner which hinders him in his progress of ascent is in process of removal through familiarity with the ways of society which he finds described in his "trashy" novel.

Whatever may be the causes of crime, whatever may be its prevention or cure, there is force in the argument that the tendency of stories of crime is to become more true to the realities, and to present the career of the criminal in its native hideousness. All literary art progresses toward completeness of representation, and even the depraved taste soon tires of stories which always describe the criminal as successful against the law; and the moment that the history of the criminal is given with truth, and his deed is shown to involve its own dreadful consequences, then even the criminal novel becomes moral in its tone.

There is an element of revolt against what is rational in every one of us, as unregenerate or as merely natural beings, *i. e.*, as animals. It is only as we gradually learn to recognize in the law a correct statement of our essential being that we become reconciled to it, and take sides against the violator of justice and right. Until then we are prone to feel interest in the outlaw, as in one who raises the banner of individual freedom. Liberty is confounded with license.

It is here that we approach the question of punishment as it is involved in the newspaper. For not only is the newspaper infinitely great as an instrumentality for education and the widening of intelligence, but in its function of punisher of sin and crime, it is the most terrible engine yet invented.

The urban or city civilization is a newspaper civilization, if we characterize it by the most important instrument that it has invented. Into the daily newspaper as into a magic mirror the modern citizen looks and sees the spectacle of the doings of the entire world. The movements of commerce; the transactions of the various nations in so far as these are outside of routine; extraordinary crimes and retributions; the events of society; the doings in science, art, literature, the drama, and an indefinite domain of personal gossip—all these are presented to the citizen, and he regularly adjusts himself each morning to his world environment.

Formerly, before the railroad and telegraph had rendered possible the daily newspaper, each person adjusted himself to his narrow environment through village gossip which he heard at the neighboring inn or at the clubs. Now, instead of village gossip, he reads world gossip without leaving his fireside or breakfast-table.

In the past civilization each section grew more sectional, except in times of great wars that mingled the soldiery of different localities. In the modern civilization the daily newspapers of all lands have substantially the same presentation of the world, and reflect more nearly the same views. The newspaper is therefore a sort of world court, in which passing events are brought up daily for judgment.

Under these circumstances there arises into power the majestic presence of public opinion, a might which controls the actions of kings, the deliberations of parliaments, and the ballots of electors. Public opinion is become the educator of nations. Formerly, through ignorance of the effect that overt acts might have, nations were often precipitated into war. Now it is easy for statesmanship to feel the pulse of nations in advance, and by prudent diplomacy avoid extreme issues.

The newspaper is the organ of public opinion, and in this capacity it tries and judges criminals, and it punishes all manner of sin that escapes the whip of the law. It rewards good deeds, and sounds the trumpet of fame before the favorites of public opinion. The newspaper popularizes science and literature. It has a page of fiction, in which the modern literary artist paints the ideals of society with halos of glory or with satire and caricature.

When each human being beholds the same spactacle beheld by all others, and assists all in forming the high court of public opinion, there is realized at once the most powerful educational means ever invented for uniting men in thought and sentiment. Even the old-fashioned village gossip was a powerful means in its way to eliminate from the individual his whimsicalities and idiosyncrasies. The modern public opinion is based on world gossip, and is far more potent for good. Mrs. Grundy's opinion becomes dignified and oracular when it voices the verdict of nations.

One consequence of this new realization of the magic mirror in which all humanity is reflected is the rise of the true cosmopolitan spirit—a mutual toleration of all peoples. A profounder habit of considering one's fellow-men enables us to see the same humanity under strange disguises of costume and diverse language.

By the printed page, now universally diffused and the possible possession of every member of society, the humblest individual has access at his own pleasure and convenience wherever time and place find him, to the wisest and most gifted of his race. He may penetrate by his industry during his leisure hours their deep solutions of the problem of life, and become himself wise like them.

Not only the printed book affords this access, but the printed page of the newspaper comes more and more to serve up each morning for the people of every urban population *i. e.*, every city and town and every village on the railroad, a spiritual breakfast, with many courses; a few thoughts of the wise, a poem or two, some popular statements of the recent results of science, some pieces of biography and history and, chiefly, a complete picture of the movement of the world of humanity far and near—so complete a picture that from day to day the events seem to march forward from inception to denouement, before our eyes, with the consequence and necessity that we see in the dramas of Æschylus and Sophocles. Through the prose reality of everyday life as seen in the newspaper column there shines the great purpose of history.

We find the printed page in its myriad forms the most potent agency for the realization of the high spiritual being of man in the image of God, and the most perfect means for the emancipation of man from slavery to his own ignorance and passions, and from his dependence on others for guidance and direction. He becomes less dependent on a fellow-man for master—one brain to govern two pair of hands — and more independent and self-directive, more rational, and more participative in the wisdom and goodness of the human race.

This participation has been rendered possible by the inventions which have brought the art of printing to what it is and by the other inventions that have facilitated transportation and rapid communication.

THE BIRTH OF INVENTION.

BY PROFESSOR OTIS T. MASON, PH. D., OF VIRGINIA, CURATOR U. S. NATIONAL MUSEUM.

"What a plastic little creature man is! so shifty, so adaptive! his body a chest of tools, and he making himself comfortable in every climate, in every condition."—*Emerson.*

In this apotheosis of invention and inventors, to me has been assigned the pleasing task of leading you back for a few moments to the cradle of humanity. Those are happy hours to most of us when we recall the days of childhood. To trace the lives of celebrated men and women to the springs of their moral and intellectual power brings never-fading delight. To study the rise and progress of a nation or any social unit is worthy of exalted minds. But the most profitable inquiry of all is the search for the origin of epoch-making ideas in order to comprehend the history of civilization, to conjure up those race memories in which each people transmits to itself and to posterity its former experiences.

Every invention of any importance is the nursery of future inventions, the cradle of a sleeping Hercules. But my task is to speak of primitive man and his efforts.

It will aid us in prosecuting our journey backward to orient ourselves with reference to the present. For two days we have listened to the eloquent papers of my predecessors, written to glorify the nineteenth century. Through this faculty of invention the whole earth is man's. There is not a lone island fit for his abode whereon some Alexander Selkirk has not made a home. Every mineral, plant and animal is so far known that a place has been found for it in his *Systema Naturæ.* Every creature is subject to man; the winds, the seas, the sunshine, the lightning do his bidding. Projecting his vision beyond his tiny planet, this inventing animal has catalogued and traced the motion of every star.

But his crowning glory (which always fills me with admiration) is his ever-increasing comprehensiveness. After centuries of cultivating acquaintance with the discrete phenomena around him, he has now striven to coördinate them, to make them organic, to read system into them. He has learned by degrees to comprehend all things as parts of a single mechanism. Sir Isaac Newton and Kepler conceived all objects and all worlds to be held by universal gravitation. And thus, in our century, von Baer and Humboldt taught that the world, in all its forces and materials, is an integrated cosmos. Any one who is the least familiar with the progress of philosophy will recall that since the dawn of written history the thoughts of men were tending to this unification. Shortly after this first effort at comprehensive unity Mayer, Rumford and Joule invented the methods of demonstrating the oneness of physical forces, the conservation of energy. Wollaston, Kirchoff and Bunsen devised the delicate apparatus to prove the chemical identity of all worlds. Lamarck, Geoffroy St. Hilaire and Darwin taught the consanguinity of all living beings. Helmholtz and Meyer coördinated nervous excitation with mental activity. Comte and Spencer grasped the unity of all sensible phenomena. Newton, Leibnitz and Hamilton projected their minds beyond phenomena and invented mathematics of four or more dimensions, conceiving of worlds and systems that under the present order of nature can have no objective reality. Over all this, into many great souls, have come the notions of infinite space and time and causation. The idea of limitation to thought or achievement no longer enters the imagination. The depth of the sea, the distances of the stars, the concealment of the earth's treasures, the minuteness of the springs of life and sense, the multiplicity and complicity of phenomena are only so many incitements to greater achievements. The daring souls of this decade are determined at any risk to answer the inquiry of Pontius Pilate, What is truth? With sympathetic enthusiasm we wave them on, bidding them god-speed.

But, I ask you now to forget all this and go with me to that early day when the first being, worthy to be called man, stood upon this earth. How economical has been his endowment. There is no hair on his body to keep him warm, his jaws are the feeblest in the world, his arm is not equal to that of a gorilla, he cannot fly like the eagle, he cannot see into the night like the owl, even the hare is fleeter than he. He has no clothing, no shelter. "Foxes had holes, and the birds of the air had nests, but this man had not where to lay his head." He had no tools or industries or experience, no society or language or arts of pleasure, he had yet no theory of life and poorer conceptions of the life beyond.

All nature laughed at him. The sun said, I will blister his skin. The storm said, I will spit upon him. The sea said, I will drown him. The noxious malaria said, I will parch him with fevers. The lion, the wolf, the tiger said, I will devour him. The mountain sheep withheld her fleece and lambs. The wild ass and the wild horse fled away in scorn. The silly fish said, I know you not, and the birds skimmed the air around him in mockery. There were no waving grain fields, nor golden cornfields, nor tempting vineyards, nor fragrant orchards.

> "Poor naked wretches, on the edge of time,
> That bide the pelting of this pitiless storm,
> How shall your houseless heads and unfed sides defend you
> From seasons such as these?"
>
> *King Lear*, *iii*, *1*.

Whatever we may say of our own golden age, surely his was not around him nor above him. If he had one at all it was within him.

> "Heaven flowed upon the soul in many dreams of high desire."
> —*Tennyson*, "THE POET."

The road from that condition to our own lies next to the infinite. The one endowment that this creature possessed having in it the promise and potency of all future achievements, was the creative spark called *invention*. The superabundant brain over and above all the amount required for mere animal existence, held in trust the possibilities of the future, and stamped upon man the divine likeness. This naked ignoramus is the father of the clothed philosopher, looking out into infinite space and time and causation. It may give you pleasure to know something about the connections between these two and the witnesses to these connections.

There are five guides whose services we have to engage on our interesting journey. The first is History, who does not know the way very far back—not over three thousand years—with much certainty. The second is Philosophy, the study of which in our own century has enabled us to find the cradle-land of many peoples. The third is Folk-Lore, the survival of belief and custom among the uneducated. The fourth is Archæology, history written in things. The fifth is Ethnology, which informs us that in describing this arc of civilization some races have only marked time, while others have moved with radii of varying lengths. The result of this is that we now have on the earth types of every sort of culture it has ever known. At the present moment, within hailing distance of yonder most beautiful dome in the world dwell all these witnesses—the relics of the stone age, the Indian village of Nacochtank or Anacostia, the folk-lore of both continents, and the literatures of the world. While you are listening to the encomiums of our decade, palæolithic man sends in the testimony of his handicraft, the Smithsonian Institution treasures the inventions of the most primitive races, and the Bureau of Ethnology unravels the mysteries of savage tongues.

As the fragment of a speech or song, a waking or a sleeping vision, the dream of a vanished hand, a draught of water from a familiar spring, the almost perished fragrance of a pressed flower, call back the singer, the loved and lost, the loved and won, the home of childhood, or the parting hour, so in the same manner there linger in this crowning decade of the crowning century bits of ancient ingenuity which recall to a whole people the fragrance and beauty of its past.

From the testimony of these five witnesses we learn that there never was a time when man was not an inventor—never a time when he had not some sort of patent on his invention. They affirm that every art of living and all the arts of pleasure were born in the stone age; that graphic art, sculpture, architecture, painting, music and the drama, had their childish prototypes in that early day; that language is one of the very earliest of inventions, the vehicle of savage oratory, philosophy and science. They affirm that society has been a series of inventions from the first; that legislation, justice, government, property, exchange, commerce, have not sprung out of the ground but within our definition are inventions. And even the creeds and cults of mankind, whatever view you may take of the divine element underneath them, have been thought out and wrought out with infinite pains from time to time by earnest souls. But they had their origin in the cradle-land and in the infancy of our race. What we enjoy is only the full-blown flower, the perfected fruit of which they possessed the germ. Let me enforce this idea, as we glorify the material prosperity of the nineteenth century, that many centuries ago men sat down and with great pains and sorrow invented the language, the art, the industries, the social order which made our machines feasible and desirable.

There is no conflict between the testimony of these witnesses and the doctrine commonly taught that men do not invent customs and languages, but fall into them. Reflect a moment upon your own daily life and you will recognize two sets of activity, those which you originate and those in which you follow suit. Animals can learn to follow suit, and to a very limited extent can originate. But it is the divine spark of originality which underlies every thought or device in this world. As one man invents a machine and others by thousands fall into the use of it, as the musician composes a song and millions sing it, so was it in the cradle-land of humanity, the inventor, touched with fire from the divine altar, set new examples to be followed. If we were to interrogate our five witnesses particularly with reference to the ancestry, the family tree of the notable inventions of the nineteenth century, their answer would be somewhat as follows. We ought to remember, however, that an invention is not always a thing; but that it may be any series of actions conducing toward some new end. Keep in mind, also, that all our activities involve tools, processes and products, and that invention may take place in any or all of these.

The ancestor of the steam plow is the digging-stick of savagery, a branch of a tree sharpened at the end by fire; the progenitors of the steam harvester and thresher were the stone sickle, the roasting-tray, or, later on, the tribulum.

The cotton gin and power loom are among the wonders of our age. Yet in that day of which we are speaking human fingers wrought the textile from first to last. They gathered the bark or wool, colored them to suit the primitive taste, spun and wove them with simple apparatus and left upon the fabric patterns that are the despair of all modern machine-makers—patterns that are a pleasure to the eye by their infinite variety, replaced in modern fabrics by a dreary monotony that awakens pain instead of pleasure.

The first sewing-machine was a needle or bodkin of bone, with dainty sinew thread from the leg of the antelope, and for thimble a little leather cap over the ends of the fingers. Coarse, indeed, the apparatus, but the hand was deft, the eye was true, the sense of beauty was there, and so that needle-woman of long ago wrought in fur from the mammals, feathers from the birds, grasses from the fields, shells from the sea, wings from the beetle and skins of snakes, with tasteful geometric figures. You do err who think those ancient needlewomen had no taste. It would be hard to invent a pattern now that was unfamiliar to them.

The first engine was run by man power, then man subdued the horse, the ass, the camel and invented engines for those to propel. He next domesticated the winds, the waters, the steam, the lightning, but the first common carriers and machine power were men and women. The first burden train was women's backs; the first passenger car was a papoose frame. And even now, while I am speaking to you, more heavy loads are resting on human shoulders than upon all the pack animals in the world. Hence our nursery rhyme—

Rock a by baby on a tree top,
When the wind blows
The cradle will rock.
When the bough bends,
The cradle will fall.
Down will come cradle,
And baby and all.

The poetry of to-day is the fact of yesterday, the dream of yesterday is the fact of to-day. When the savage woman a century or two ago, upon this very spot, strapped her dusky offspring to a rude frame, hung it upon the nearest sapling for the winds to rock, or lifted the unfortunate suckling from the ground to which it had been hurled by the bending of an unsafe bough, that was a fact, a stage in the history of invention. In our now-a-days couches of down, swung from gilded hinges, we have got far ahead of the papoose cradle, the memory of which we perpetuate in nursery rhymes sung to children, who wonder why babies should be hung in the tops of trees and think, doubtless, that the falling cradle was a just retribution on the silly parents.

What is more beautiful than an ocean steamer, with skin of steel drawn over ribs of steel and closed above against the intrusion of the waves. Have you never seen the picture of the Eskimo, still in the stone age, who, over a framework of drift wood or whale's rib, stretches a covering of sealskin and learned therein to defy the waves hundreds of years ago?

Only now and then the angry sky was lighted for the primitive man by electricity, and even then it filled him with terror. But it was he that invented the apparatus for conjuring from dried wood, by a rude sort of dynamo, the Promethean spark. It was our Aryan ancestors that paid their devotions to the rising sun by kindling fresh fire every morning as the orb of day flashed his first beam across the earth.

Who has not read with almost breaking heart the story of Palissy, the Huguenot potter. But what have our witnesses to say of that long line of humble creatures that conjured out of prophetic clay, without wheel or furnace, forms and decorations of imperishable beauty, which are now being copied in glorified material in the best factories of the world? In ceramic as well as in textile art the first inventors were women. They quarried the clay, manipulated it, constructed and decorated the ware, burned it in a rude furnace and wore it out in a hundred uses.

He had no printing press, but he could tie knots in a marvelous fashion and write letters on bark or on bits of raw hide and leave memorials of himself in the book of stone. He made words and sentences, invented language, developed artistic forms of speech handed down to us in the eloquent harangues of his sages. He breathed his thoughts in poetry, a kind of childish rhythm.

In the time of which we now are speaking the telegraph was a series of signal fires and a marvelous code of signs, which a distinguished scholar of our city has just unraveled.

Primitive man developed the art of war, means of offense and defense; weapons of percussion, for cutting and thrusting; projectiles, armor, fortification, strategy.

Nowhere has man pressed his hand so effectively upon nature as in the domestication of animals. It is almost incredible that ravening wolves and merciless felines should become faithful dogs and purring cats; that the wild sheep and goat should descend from their inaccessible fastnesses, and yield their fleece and flesh and milk; that horses, asses, camels, elephants, should be induced to lend their backs and limbs to lighten the loads of the first common carrier. This process of impressing his own qualities on wild creatures began very early in history and has continued uninterruptedly from first to last.

In the uncertainty of the marriage relation and of paternity, he provided every woman with support and every child with a home, through his ingenious gentile system.

His affairs of state were managed through his patent system. The great inventors were made the rulers of the people, and his highest title to nobility was a most puissant and ingenious one.

He had courts of justice, heard witnesses, executed his laws. It is true that the methods were summary, when a chancery suit was settled by an execution on the same day as the death of the devisor. But out of his struggles came our methods, and the greatest drawback to securing justice now is the survival of his antiquated customs into our new practices.

He invented philosophies and sciences, explained the universe and himself to himself. This seems puerile now, but it was the beginning of all our own speculations, necessary to us at present, but which will to-morrow become folk-lore. Over and over again, those who preceded me on this platform have pointed to James Watt as the true deliverer of mankind. Far be it from me to take one leaf from his laurel crown; but the inventor of the alphabet, of the decimal system of notation, of representative government, of the golden rule in morality, were greater than he.

For the dream in stone and carving and decoration called a cathedral,

> "Where, through long-drawn aisle and fretted vault,
> The pealing anthem swells the notes of praise,"

that early day has only to offer wild shouts in unison under the starlit dome, touched by the first childish aspirations after the divine or hopes of immortality.

While you look with admiration upon these panoramas of progress you cannot have failed to observe on the canvas that the art, the process of inventing itself, has undergone the very same development and improvement as the things invented. There is in this a marvelous similarity to the life processes of animals and plants. The homogeneous yolk of the egg during incubation becomes wonderfully complex and heterogeneous; but all of these diverse parts come together into a higher unity, in which each organ ministers to the good of all. The earliest invention was a single homogeneous act, an original suggestion, a happy thought. The patent on this was an immediate and individual benefit. A sharper knife of flint, a better scraper, a longer spear, a stouter thread wrought better, and the reward was more execution. Now, the man who made the best weapons killed the most game, from that game he got better food, that food made him stronger, that strength made him chief, that chieftaincy gave him more wives, more children, more cohorts to support his throne. The best woman to cook or sew or carry loads got the best husband; that was her patent. From these simple methods of inventing and rewarding invention we come on to the Olympic games, the monopolies, the patent system. And now, in the inventor's laboratory of Graham Bell or Edison the climax is reached, where one machine is the coöperative result of any number of trained minds, and the reward is meted out to each by the manufacturer; or, in this Patent Congress itself, we may have a still more highly organized unit, wherein the inventors of America become a body social, and together shake hands under the sea with the Emperor of Germany, who sends his congratulations to-day on the occasion of our meeting.

We are assembled to glorify the first century of American patents. A few months ago the disciples of Daguerre met in our city and set up in the National Museum a monument to the inventor of photography. I do not know that there is another memorial in America to an inventor. There is no better way to insure for posterity the recollection of this day than by stimulating among the great industries the desire to continue this good work of memorializing their founders. Perhaps you may not build your monument of stone or bronze, you may set up a library, you may solicit a corner in the National Museum or Congressional Library, or you may secure a better Patent building.

In our public places we set up statues of the destroyers of mankind and erect monuments in our national cemeteries to the anonymous dead. When we go to hang garlands upon the eulogium-bearing tombs, we do not forget to scatter flowers upon the mausoleum of the unknown.

We cannot gather from the four corners of the world the bones of all the great inventors and honor them with a costly burial. Even their names have perished from the records of mankind, but their works endure. What better can we do than to gather these and guard them in our great museums, mute witnesses of antiquated arts. I can imagine these anonymous inventors looking upon us to-day and glad of this tardy recognition of their vicarious sufferings.

With loving recollection of your labors I pluck a flower from my heart and strew its petals over your neglected graves:

> "In freta dum fluvii current, dum montibus umbræ
> lustrabunt convexa, polus dum sidera pascet,
> semper honos nomenque tuum laudesque manebunt,
> quæ me cumque vocant terræ." *Aneid 1, 607.*

AMERICAN INVENTIONS AND DISCOVERIES IN MEDICINE, SURGERY AND PRACTICAL SANITATION.

BY JOHN S. BILLINGS, M. D., SURGEON U. S. A., CURATOR, UNITED STATES ARMY MEDICAL MUSEUM.

In connection with this celebration of a century's work of the American Patent System, I have been requested by the Advisory Committee to prepare a brief paper upon inventions and discoveries in medicine, surgery and practical sanitation, with special reference to the progress that has been made in this country in these branches of science and art.

It would be impossible to present on this occasion such a summary as would be of any special interest or use, of the progress which has been made in medicine and sanitation during the century, either by the world at large or by American physicians and sanitarians in particular; and I shall therefore confine my remarks mainly to the progress which has been made in these branches in connection with mechanical inventions and new chemical combinations devised by American inventors—which will require much less time.

The application of the patent system to medicine in this country has had its advantages for certain people, has given employment to a considerable amount of capital in production (and to a much larger amount in advertising), has contributed materially to the revenues of the government, and has made a great deal of work for the medical profession.

So far as I know, but one complete system of medicine has been patented in this country, and that was the steam, Cayenne pepper and lobelia system—commonly known as Thomsonianism—to which a patent was granted in 1836. The right to practice this system, with a book describing the methods, was sold by the patentee for twenty dollars, and perhaps some of you may have some reminiscences of it connected with your boyish days. I am certain I shall never forget the effects of "Composition Powder," or of "Number Six," which was essentially a concentrated tincture of Cayenne pepper, and one dose of which was enough to make a boy willing to go to school for a month.

From a report made by the Commissioner of Patents in 1849, it appears that eighty-six patents for medicines had been granted up to that date; but the specificatons of most of those issued before 1836 had been lost by fire. The greater number of patents for medicines were issued between 1850 and 1860. The total number of patents granted for medicines during the last decade (1880–1890) is 540.[1]

This, however, applies only to "patent medicines," properly so-called, the claims for which are, for the most part, presented by simple-minded men who know very little of the ways of the world. A patent requires a full and unreserved disclosure of the recipe, and the mode of compounding the same, for the public benefit when the term of the patent shall have expired; and the Commissioner of Patents may, if he chooses, require the applicant to furnish specimens of the composition and of its ingredients, sufficient in quantity for the purpose of experiment. The law, however, does not require the applicant to furnish patients to be experimented on, and this may be the reason why the Commissioner has never demanded samples of the ingredients. By far the greater number of the owners of panaceas and nostrums are too shrewd to thus publish their secrets, for they can attain their purpose much better under the law for registering trade-marks and labels, designs for bottles and packages, and copyrights of printed matter, which are less costly, and do not reveal the arcanum.

These proprietary medicines constitute the great bulk of what the public call "patent medicines."

The trade in patent and secret remedies has been, and still is, an important one. We are a bitters-and-pill-taking people; in the fried pork and salæratus biscuit regions the demand for such medicines is unfailing, but everywhere they are found. I

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[1] For these figures, and other data used in this paper I am indebted to my friend Mr. H. H. Bates, Chief Examiner in the Patent Office.

suppose the chief consumption of them is by women and children—with a fair allowance of clergymen, if we may judge from the printed testimonials. I sampled a good many of them myself when I was a boy. Of course, these remarks do not apply to bitters. One of the latest patents is for a device to wash pills rapidly down the throat.

According to the Census of 1880 there were in the United States 592 establishments devoted to the manufacture of drugs and chemicals, the capital invested being $28,598,458, and the annual value of the product $38,173,658, while there were 563 establishments devoted to the manufacture of patent medicines and compounds, the capital invested being $10,620,880, and the value of the product $14,682,494.[2]

A patent automatic doctor, on the principle of "put a quarter in the slot and take out the pill which suits your case," has been proposed, but this patent is said to be of Dutch and not of American origin. The idea of this may have come from Japan, for an old medicine case from that country which I possess, has four compartments filled with pills, and the label says that those in the first compartment are good for all diseases of the head, those in the second for all diseases of the body, those in the third for all diseases of the limbs, and those in the fourth are a sure vermifuge.

From the commercial and industrial point of view the great importance of patent and proprietary medicines is connected with advertising. The problem is to induce people to pay twenty-five cents for the liver-encouraging, silent-perambulating, family pills, which cost three cents. Some day I hope that the modern professional expert in advertising will favor us with his views as to the nature and character of those people who were induced to buy Jones's liver pills or Slow's specific by means of a huge display of these names on the sides and roofs of barns and outbuildings, which display forms such a prominent feature in many of our American landscapes, as seen by the traveler on the railway. I suppose there must be such people, for I have a high estimate of the business shrewdness of the men who pay for these abominations. I should also like

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[2] See the *Lancet*, October 5, 1889, p. 683.

to know how much a farmer gets for allowing his buildings to be thus defaced. He must be hard-up ; indeed such a display indicates that the place is probably mortgaged and that the poor man is heavily in debt.

Even the soap advertisers are not as guilty as the nostrum-makers in this particular style of nuisance, although they far exceed the latter in viciousness when it comes to applying art to ignoble purposes. The connection between progress in medicine and soap advertisements may not be clear to you, but it exists nevertheless, for many of these soaps make work for the doctors by producing skin troubles.

Upon the whole, I should think that the number of people who would take some trouble to avoid purchasing an article which is thus advertised must be rapidly increasing, so that such displays will soon be no longer profitable. The great importance of advertising does not relate to the placard or chromo business, but to its relations to periodical literature—to the daily and weekly press and the monthly magazines and journals.

To the establishment and support of some of our newspapers and journals, medical as well as others, these proprietary and secret medicines, cosmetics, food preparations, etc., have no doubt contributed largely.

I am sorry to say that I have been unable to obtain definite information as to the direct benefits which inventions of this kind have conferred on the public in the way of the cure of disease or preventing death. Among the questions which were not put in the schedules of the last census were the following, namely: Did you ever take any patent or proprietary medicine? If so, what and how much, and what was the result? Some very remarkable statistics would no doubt have been obtained had this inquiry been made. I can only say that I know of but four secret remedies which have been really valuable additions to the resources of practical medicine, and the composition of all these is now known. These four are all powerful and dangerous, and should only be used on the advice of a skilled physician. Most of such remedies have little value as curative agents, and some of them are prepared and purchased almost exclusively for immoral or criminal purposes.

In France the sale of secret and patent medicines is not allowed unless they have been examined and approved by the National Academy of Medicine, and the same general rule holds good in Italy and Spain.

The Japanese have followed the French method, and their experience is interesting. The Central Sanitary Bureau established a public laboratory for the analysis of chemicals as a medicine. The proprietors of each of such medicines were bound to present samples, and the names and proportions of the ingredients, directions for its use and explanations of its supposed efficacy. According to a report in the *British Medical Journal*, during the first year there were 11,904 applicants for license to prepare and sell 148,091 patent and secret medicines. Permission for the preparation and sale of 58,638 different kinds were granted, 8,592 were prohibited, 9,918 were ordered to be discountenanced, and 70,943 remained to be reported on. The great majority of those which were authorized were of no efficacy, but few being remedial agents; but their sale was not prohibited, as they were not found to be dangerous to the health of the people.[3] I do not vouch for these figures, which throw our records entirely in the shade.

In 1849 a special committee of the House of Representatives reported to the House a bill to prevent the patenting of medicines, accompanied by a report. This bill provided that after the passage of the act letters-patent shall not be granted for any article whatever as a medicine, provided that this shall not apply to machines, instruments or apparatus. When the matter came before the House for consideration the bill was laid on the table.[4]

You are all aware that the great majority of the medical profession consider it to be improper and discreditable for a physician to patent a remedy. The Medical Code of Ethics declares that it is derogatory to professional character "for a physician to hold a patent for any surgical instrument or medi-

3 *British Medical Journal*, July 3, 1880, vol. ii, p. 24.

4 *Congressional Globe*, March 3, 1849, p. 697.

cine ; or to dispense a secret nostrum whether it be the composition or exclusive property of himself or others. For if such nostrum be of real efficacy, any concealment regarding it is inconsistent with beneficence and professional liberality ; and if mystery alone give it value and importance, such craft implies either disgraceful ignorance or fraudulent avarice. It is also reprehensible for physicians to give certificates attesting the efficacy of patent or secret medicines, or in any way to promote the use of them." Like all legislation, this is a formal declaration of the customs of the profession, which customs are of great antiquity. The principle upon which it is founded is thus expressed by Lord Bacon : "I hold every man a debtor to his profession ; from the which, as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto."

The rule, however, is not always adhered to by physicians, the most notable exception having been, perhaps, the use of Koch's lymph before its composition was revealed. As regards the patenting of surgical instruments and apparatus, the opinion of the great majority of physicians is in accordance with the rule just stated, but there are some who question its propriety, although they obey it—and there are few who would not use a patented instrument in a case to which they thought it was applicable.

The total number of surgical instruments and appliances patented during the past decade has been about 1,200, the patents having been in almost all cases taken out by manufacturers. With these may be classed dentists' tools and apparatus, of which about 500 have been patented during the last ten years, and in this field of invention the United States leads the world. The same may be said with regard to artificial limbs, of which our great war gave rise to many varieties.

As you know, the law prescribes that a patent may be given for a "new and useful art, machine, manufacture or composition of matter." I used to think that the word "useful" in this law had its ordinary meaning, and, therefore, wondered exceedingly as to why the Patent Office examiners allowed patents to certain things which came under my notice. One day, however, I received an article from the Patent Office, with the request for a report as to whether it was useful in the sense in which that word was used by the Office, namely, "not pernicious or prejudicial to public interests—capable of being used"—and then for the first time I understood one of the first principles of the patent law of the United States, that is, that it does not take into consideration the degree of utility in the device, or, in other words, that "useful" means "harmless."

If a patent is granted to a medicine, it must be as a composition of matter as a special article of manufacture. The practice of the Patent Office in these matters is not generally understood. It does not now consider that medical prescriptions are inventions within the meaning of the law, or that a mere aggregation of well-known remedies to obtain a cumulative effect is a patentable composition of matter. A certain number of claims for Government protection in the form of patents or trade-marks are made for medical compounds or for apparatus, under false pretences; that is to say, the claim is for a new remedy for rheumatism or dyspepsia or displacement, with a warning against their use under certain conditions, the real design being that they are to be used under precisely these conditions in order to procure abortion, etc. These are sometimes difficult cases for the Patent Office to treat properly, for the law does not allow a large discretion for refusal on mere suspicion, and where there is ostensible and possible utility (in the Patent Office sense) it can hardly reject the claim on the ground that the invention *might* be used for immoral purposes.

I said in the beginning that I cannot on this occasion give any sufficient account of the progress of invention and discovery in medicine and sanitation during the century just gone. The great step forward which has been made, has been the establishment of a true scientific foundation for the art upon the discoveries made in physics, chemistry, and biology. One hundred years ago the practice of medicine, and measures to preserve health, so far as these were really efficacious, were in the main empirical—that is, certain effects were known to usually follow the giving of certain drugs, or the application of certain measures, but why or how these effects were produced was unknown. They sailed then by dead-reckoning, in several senses of this phrase.

Since then not only have great advances been made by a continuance of these empirical measures in treatment, but we have learned much as to the mechanism and functions of different parts of the body, and as to the nature of the causes of some of the most prevalent and fatal forms of disease ; and, as a consequence, can apply means of prevention or treatment in a much more direct and definite way than was formerly the case. For example, a hundred years ago nothing was known of the difference between typhus and typhoid fevers. We have now discovered that the first is a disease propagated largely by aerial contagion and induced or aggravated by over-crowding, the preventive means being isolation, light and fresh air ; while the second is due to a minute vegetable organism, a bacillus, and is propagated mainly by contaminated water, milk, food and clothing ; and that the treatment of the two diseases should be very different.

The most important improvements in practical medicine made in the United States have been chiefly in surgery, in its various branches. We have led the way in the ligation of some of the larger arteries, in the removal of abdominal tumors, in the treatment of diseases and injuries peculiar to women, in the treatment of spinal affections and of deformities of various kinds. Above all, we were the first to show the uses of anæsthetics—the most important advance in medicine made during the century. In our late war we taught Europe how to build, organize and manage military hospitals ; and we formed the best museum in existence illustrating modern military medicine and surgery. Our contributions to medical literature have been many and valuable ; and our government possesses the largest and best working medical library in the world. We have more doctors and more medical schools, in proportion to the population, than any other country, and while this is not good evidence of progress, I am glad to be able to say that the standard of acquirements in medical education has been, and is now rising, and our leading medical schools are now being equipped with buildings, with apparatus, with laboratories, and most important of all, with brains, which enable them to give means of practical instruction equal to any to be found elsewhere.

As regards preventive public medicine and sanitation, we have not made so many valuable contributions to the world's stock of knowledge—chiefly because, until quite recently, we have not had the stimulus to persistent effort which comes from density of population and its complicated relation to sewage disposal and water supplies; nor have we had the information relative to localized causes of disease and death, which is the essential foundation of public hygiene, and which can only be obtained by a proper system of vital statistics. We can, however, show enough and to spare of inventions in the way of sanitary appliances, fixtures and systems for house drainage, sewerage, etc.; for the ingenuity of inventors has kept pace with the increasing demands for protection from the effects of the decomposition of waste matters, as increase of knowledge has made these known to us. The total number of patents granted for sanitary appliances during the last decade (1880–1890) is about 1,175. If good fixtures necessarily involve good plumbing work, we could easily make our houses safe so far as drainage is concerned; but a leaky joint or a tilted trap makes the best appliance worthless. The impulse to improvements in this direction has come mainly from England, where most of the principles of good work of this kind have been developed; but we have devised some details better adapted to our climate and modes of construction, and while many of the patent traps and sewer-gas excluders are only useful in the patent law sense, and some not even in that, it is nevertheless true that the safety, accessibility and good appearance of plumber's work has been largely increased during the last few years by patented inventions. Much the same may be said with regard to heating appliances, including ventilating stoves and fireplaces, radiators, etc., but I am unable to express any enthusiasm with regard to what are commonly called patent ventilators.

No doubt the greatest progress in medical science during the next few years will be in the direction of prevention, and to this end mechanical and chemical invention and discovery must go hand in hand with increase in biological and medical knowledge. Neither can afford to neglect or despise the other, and both are working for the common good. If the American patent system has not given rise to any specially valuable inventions in practical medicine or in theology, it must be due to the nature of the subjects, and not to any fault of the system.

ADDRESSES AT THE BANQUET OF THE BOARD OF TRADE OF WASHINGTON, D. C.

APRIL 10, 1891.

The honorable M. M. Parker, President of the Washington Board of Trade, made the following address of welcome to the guests assembled in the banquet hall at the Arlington Hotel on the evening of April 10, 1891:

ADDRESS OF WELCOME.

The Washington Board of Trade appreciate the compliment of being able to contribute to the entertainment of those representing the inventive genius of progressive Americanism.

Rarely ever has our city been permitted to entertain a more distinguished gathering than that which has been in attendance upon the ceremonies incident to the beginning of the second century of the American patent system. When I say this, I pay you no idle or empty compliment, since it must be remembered that during the past five years national and international conventions have been held here.

I do not think it possible to overestimate the importance of the congress just held. Its benefits will be far-reaching, and it will mark an important epoch in our country's progress. It is hoped that one of the results will be the erection in Washington of a magnificent building in which can be displayed our working models. In the Treasury to-day are nearly $4,000,000 covered in by the inventors of the country through the Patent Office. Congress could well afford to appropriate this money for the erection of this building. [Great applause.] I want to say that if our influence is needed, I will pledge you the support of the Washington Board of Trade in the accomplishment of this purpose. [Great applause.]

Gentlemen, the world moves as a result of your lives. Electricity lights up the universe and is fast becoming the motor power. Edison, in Melno Park, jogged the world a hundred years. You whisper in your telephone and you sympathize with your friend in Chicago, or you buy stocks in Wall street. You drop a nickel in the slot and you listen to the voices of loved ones that have long since gone over the river. [Applause.] Alexander Graham Bell has annihilated space and cuddled the cities of the Republic around a single fireside. I refer to the application of these great inventions, not for the purpose of discriminating against the celebrated universal clothes-wringer [laughter] or the barbed wire combination safety mouse-trap and a thousand other inventions.

We recognize with pleasure the presence of the honorable Commissioners of the District—gentlemen of the highest integrity, gentlemen whose administration meets with the approval of the people of our city.

We cannot forget, nor would you have us, that to-night we celebrate the centenary of the Capital of our country, our home, your home, the nation's home. When we shall have listened to one of our esteemed citizens address himself to this question at the proper time, I know you will raise your glasses and join with me in such enthusiasm as is proper to an American.

We also feel greatly honored by the presence of the Cabinet Ministers, the advisers of the President in the administration of good government, and I want to say to you that so long as you are our guests you will not be importuned for office. [Applause.] I want to say further that so far as I know not one single member of the Washington Board of Trade holds a public office, nor do I think he would accept one, save as a compliment to the administration. [Great applause.]

It is for this organization, representing not only hundreds of millions of dollars, but the most generous people and beautiful city on earth, that I have the distinguished honor of welcoming you to our hearts, our homes and to our hospitable board. [Great applause.]

Gentlemen, the first regular toast of the evening, which is always drunk standing, and which every American drinks with enthusiasm, is to the President of the United States.

The third* regular toast, "The Supreme Court of the United States, as Related to the American Patent System," will be responded to by Mr. Justice Harlan.

RESPONSE BY MR. JUSTICE HARLAN.

Mr. President, looking over this programme, I observe that every possible phase of the patent system, the establishment of which has been celebrated in this city during the present week, has been covered. The distinguished gentlemen who have consented to address you will say all that occasion requires. Surely then, sirs, nothing more is expected of me than that I shall acknowledge, as I do most cordially, the courtesy shown to the Supreme Court of the United States.

Congress, invested by the Constitution with power to promote the progress of science and the useful arts, by securing for limited times to inventors and authors the exclusive right to their discoveries and writings, exerted that power shortly after the organization of the government by appropriate legislation, and the courts have given effect to that legislation.

The decisions of the Supreme Court of the United States bear testimony to the fidelity with which that tribunal has endeavored to carry into effect the provisions of the Constitution and the enactments of Congress. I take leave, sir, to say this much, nothwithstanding those whose patents which have not been sustained quite naturally believe that the court has not always decided correctly. [Laughter.] It is the misfortune of the courts that they cannot please everybody. All that they can do is to decide rightly as they see it, regardless of the consequences to individuals.

I cannot take my seat, Mr. President, without congratulating the army of inventors who have come to the National Capital to celebrate the inauguration of a system which has done so much for our own people, and, indeed, for all mankind. I must congratulate the Washington Board of Trade upon the interest which this royal banquet has added to the occasion. You, sir, and your associates of that board, are worthy repre-

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*The addresses at the banquet which were upon topics not related to the American patent system are omitted.

sentatives of the business, the trade and the prosperity of Washington. We all, and indeed the whole country, owe a debt of gratitude for what you and they have done towards accomplishing the task, which is near to the hearts of every American, of making this beautiful city the most attractive spot in all the world. [Great applause.]

The CHAIRMAN. The fourth regular toast, "The Future of the American Patent System," will be responded to by Secretary Noble.

RESPONSE BY HON. JOHN W. NOBLE, SECRETARY OF THE INTERIOR.

Mr. President and gentlemen, my first duty and my great pleasure is to acknowledge to you, and the Board of Trade you represent, and to those distinguished gentlemen who are your guests, the very high compliment of calling upon me so early to respond to a sentiment so full of significance and hope as "The Future of the American Patent System."

We stand at the opening of a new century, both for the inventive genius of our land and for the Capital of our country. It is an occasion worthy of the deepest patriotism and of the freest expression of approbation as to the past and hope for the future.

That I should have been particularly called upon is, I feel, and I have felt during the past week, a little out of place. I am not after all so very familiar with patents, although the Secretary, officially, of the Department of the Interior. In fact, a gentleman, an old soldier friend of mine, came in the other day in deep indignation after he had been through the different bureaus of my department, and among the rest had seen the Commissioner of Patents, with his vast array of clerks and the great business which he was performing with that signal ability that marks the present incumbent of that office. [Applause.] And he said; "General, it is a shame; it is a shame, that you should be the Secretary to all these Commissioners around here." "You ought to be a Commissioner yourself; confound it, you have earned it." [Laughter.] Well, I have earned it, there is no doubt about that.

But, gentlemen, I wish to say another thing before I enter upon the future of the patent system, and that is that there is a man I believe already existing that has discovered the greatest patent, yet unknown to fame, that history has recounted. I was in Russia a few years ago (I used to travel some before I became Secretary; but then it stopped), and while there I heard of a man, who in early days had emigrated from Moscow to St. Petersburg; he had wended his way over bog and hill until he arrived at the place where he could make a substantial living. After he had grown in years there came a railroad laid down by the rule, without regard to commerce or anything else except the necessities of the military—straight as a line could be drawn between St. Petersburg and Moscow. The old man heard that prices were cheap and the time was short in which he could go to his old home, and he determined one day to go. And packing up a great valise, thinking that possibly he might be longer than he expected, he got on the train and started for his old home. The train coming from Moscow met that from St. Petersburg about half way. They have a drink there—I do not think that we have anything here to-night quite as strong as it is. It is called Vodka, and it is a little stronger than alcohol. [Laughter.] When the old man got off the train he met an old friend from Moscow who saluted him and they went into a restaurant and sat down, and as is the custom among these people, they had a glass or two of Vodka. When he came out his train had gone on to Moscow. He got on the train on which his friend was traveling, sat down and had a good old time. As the train went on towards St. Petersburg, from whence he had just come, he began to notice certain familiar objects on the way, and at last he awoke to a realization of the situation. "Now," he says, "is not this a wonderful age?" "They cannot only invent railroads, but they have got a train here that is carrying you to St. Petersburg, while I am going to Moscow, at the same time." [Great laughter.] So, we have got something left to attend to yet, gentlemen.

I have been listening over here at the Music Hall to a number of very able papers, and I will say, without exaggeration, that I heard the most eloquent and at the same time instructive papers (although I have been conversant with men who talk and with conventions throughout this country) that I have ever listened to, and I think the most conducive to the prosperity of this country. [Great applause.]

After I had listened a few hours and understood that I had to deliver a toast, as they call it—it means a speech—I thought I would go and get some books because I needed them, and I sent a note to the librarian of the Patent Office to send me some books about this patent business, and he said : They are all out ; these men who are in the convention have consumed them all ; and, Mr. Secretary, we cannot send you a volume. [Great applause.]

Thereupon I addressed myself to my own consciousness and tried to evolve and invent a speech. Now, gentlemen, in order to measure that great and glowing future of this noble land of freemen, let us for a moment turn our glance backward and see from whence has come this mighty progress ; this great enlightenment ; this great enlightenment beneath the Constitution of the United States. There was a time beyond this century that has just been finished when institutions that man had created were such that they subjugated man, both body and soul, within their confines. There was no such thing as personal liberty. There was no such hope as human aspiration had a right to expect. The time grew on until at the beginning of the century now just closed the agitation of the people, and the aspirations of the souls of the land of other nations and of our own were such that the shackles were broken, the thorns that existed before were cast in the dust, and the spirit of man, in all its nobility and possibilities, stood upon the surface of this earth with no confines beyond those of the utmost liberty, and no controller but the Almighty who made him. When that time came, invention, the power to conceive and bring into action formed, along with all other intellectual faculties that have made history illustrious, and from that day it arose as from a virgin soil, and sought, even in distant lands, as our country then was, the opportunity upon a new field to make new efforts in behalf of humanity. It was then and not before that the inventive genius of our race, strong in its physical power, with the gray matter in its brain greater than that of any other people, found an opportunity to do and to imagine what it were well to do and to accomplish it. If you take the history of the Patent Office you will find that when it was initiated there was no great rush of patents. In 1790, the anniversary of which you celebrate on this 10th day of April, in the whole year there were but three patents granted. Was the mind of man awake to the opportunity? Had the spirit of this land been cultivated so that it could understand a patent? No; the truth is, and you men, I think, will bear me out in the statement, it takes almost as great intelligence in a people, for whom a patent is intended, to understand it, as it does in the man who makes it to invent it.

If you go to China you can have imitation perfected. If you ask a Chinese to make a retort that is broken on the neck, he will bring you back a dozen in exact imitation, even to the break. While they aspire to the claim of being the inventors of gunpowder, it was not until a member of the Jesuit order had introduced it that they understood the use of a cannon. If you take the telescope to them as a people who claim to know the mysteries of the stars and the secrets of astronomy, they place it, as an ornament, to be admired as a toy. It is in vain, my friends, to look for success to the inventor except he be, with his free thought and his far-striking intelligence, among a race equal to him and capable of making the application of his invention when it comes to daily use. [Great applause.]

Let me say another thing, among the very few things that I shall address you upon. I have heard it discussed how far the love of gold is the incentive of the inventor. Its pros and cons have been presented on yonder stage with ability. Now for myself let me say that for honest effort and labor and all that wins gold, nobody will advocate a reward more generously or more emphatically than myself. The man that has earned it ought to be able to enjoy it. But when you come to tell me that the genius which presides in the human soul, born of the spirit of the age, which age is the age of liberty, is stimulated by the spirit of avarice, I deny it, and I say that that earth-born spirit never inspired a noble thought or created a single invention. Go to Benvenuto Cellini, who cast the statue of Perseus, and who while in its clay in the furnace, was stricken down with a fever. He arose debilitated, and threw the implements of his household into that furnace to make the flux which eventually evolved that sublime work of genius, and then tell me that he was stimulated by the love of gold, and I deny it, in the spirit of genius and art. Tell me that Pallissy, when he was attempting to discover the enamel for pottery, and in the last extremity, when the furnace was about to cool and his compound yet had not received the glaze necessary he seized the furniture of his house and cast it into the furnace, was stimulated by the love money, and I deny it, in the name of trade and commerce. [Applause.] If you tell me that Goodyear, when he, at the last extremity was still seeking to vulcanize the rubber that had become a new element in the productive arts and a new article in commerce, sold the school books of his children that he might carry his experiment to its conclusion, did it in the spirit of avarice, and I deny it, in the name of the intelligence of the race to which I belong. [Applause.] If you tell me that Benjamin Franklin, when he stood day by day questioning the clouds, while his soul was filled with patriotism and the love of liberty and man, was seeking a pecuniary fortune, I deny it, in the sentence that has become immortal, that "He seized from the clouds the lightning and from the King and tyrant his sceptre." [Applause.]

Let us not, inventors and gentlemen, in this age, when presumption has grown gigantic, but when, thank God, intellect in congresses like this have proved the Ulysses that can master the giant with one arm—as he always is—let us not introduce the golden calf into the temple of the Almighty God. [Applause.]

What more shall I say? From this spirit of the past, the increasing, all generalizing spirit of the age of freedom, of liberty and constitutional government, what may we not expect for the future? He would be a vain man who in a presence like this were to attempt in detail to announce what he supposed the inventions of the future might be. If he could do it, he should immediately resign from the office that I hold and go upon the field of invention and make his fortune. That thing is impossible. But gathering from the thoughts that I have thus inefficiently and poorly expressed, may we not say this for our land, for our home, for our people and its leaders in thought, that its institutions are broad enough, that its intellect is strong enough, and that the hidden forces of nature and the opportunities of art have enough yet undeveloped within them for that spirit under such institutions to develop yet more and more as the years roll by, until this nation, as it has been distinguished in the past for liberty and invention, will become more and more marked among the nations of the earth for the labors of those who, while they may pursue an individual ambition, like their country and their country's laws, seek more the great good of all humanity than any individual attainment. May we not hope that here, in the great city of Washington, whose possibility as a capital has been made by your inventions that have shrunk the globe and made the center and the circumference the same, both those from the inland and from the far distant coasts, may yet come to view, either in the Department of the Interior, or something that shall relieve that heavily burdened officer from a part of his care and yet be as distinguished as anything that he has ever presided over — a Department devoted alike to the benefit of the people, and, as it has been, to the support of the Government, in which shall be exemplified, in all its different aspects, the inventive genius of our people, and have within it such an abundance of room that those who labor to give to the patentee his title to the creation of the brain, shall not be smothered in small compartments and crowded rooms. May we not hope that the legislators of this land, who seek their support from their constituencies and the emoluments and benefactions they may bestow upon them, shall yet find them so enlightened by the intelligence conveyed by the inventor by rail and telegraph, by press and lightning, that they shall say to him: "Do you cease to look to your district, and begin to look to the Nation." [Applause.] "Do you cease to erect within the small district that does not need it a vast building costing millions, and do you expand the organization of the Constitution and government, so that its functions shall not only be easily but freely performed that the Nation may receive the full benefit of the laws and of the intelligence of the land." Let the sectional spirit die out. [Applause.] Let sublime intelligence that comes like the sunlight from heaven over all our broad land, warm the hearts of the South and of the North until they meet in one common aspiration for the good of the Nation. [Applause.] Let the genius of the land inspire the creative heart of both sections to rivalry and let arms reside in the background, and if used at all be used against our foreign foes. Let this bond of union, growing from the soil and inspired by the genius of the land find in this beautiful city at the capital of our common country, that home, that beautiful home, where all that it has created shall be exhibited, which is in the spirit of the present, because the spirit of the present has in it all the past has developed, as it has also in it all the opportunities of the future; and let that hall rise in beautiful proportions and make in the beginning of the next century that temple, in which love of country, with genius, shall preside beneath the solemn form of justice and guarantees of constitutional liberty.

The CHAIRMAN. The fifth regular toast, "American Patents from a Financial Standpoint," will be responded to by Hon. Charles Foster, Secretary of the Treasury.

RESPONSE BY HON. CHARLES FOSTER.

Mr. Chairman and Gentlemen: I, too, have my acknowledgments to make to the Chairman and the Board of Trade, for two reasons; first, because I thought the toast was one of pretty large proportions, but he relieved me of that fear by preparing the speech himself; and, secondly, for what he said here to-night, which is certainly a very great relief, that the Board of Trade will not importune me for an office.

I hardly know, gentlemen, how to undertake to respond to this toast: "American Patents from a Financial Standpoint." I think we all agree, and I do not wish to touch upon the domain of politics, I think we all agree that the protective principle was never yet applied to an American manufacturer without a reduction in price. We Republicans all claim that, and I do not think it is disputed by any one. How much the inventive genius of this people have to do with it no one can determine. I apprehend that this great reduction in prices, when American genius takes hold of a thing, is due to the patent system, to the inventions of our people. If I were to undertake to measure in dollars and cents the benefits to the people and to mankind that have resulted from inventions, I am afraid that I could not furnish the figures to sustain it. But I have been asked to-night, I suppose, to make a speech upon a single point, and that is from a Treasury standpoint, to state the receipts and disbursements of the Government from this source. Your Chairman very kindly furnished me a memorandum this morning, but being a little bit suspicious of boards of trade, I thought I would verify it myself from the Treasury figures. It is but just to say to the Chairman of the Board of Trade that his figures were substantially correct, and I find the facts to be about as follows:

The first patent law was passed in 1790. It seemed to have been unsatisfactory, and the receipts were very small, the total for forty-six years up to 1836 being only about $300,000. We have no means now of ascertaining the expenses during that period. The first favorable patent law was passed in 1836, and the receipts in 1836 were $15,000; expenses, $8,000. From 1836 each year shows a large increase of receipts and expenditures, until 1890, when the receipts were $1,347,000 and the expenses about $1,000,000, the annual profit about $350,000; the total net profits up to date about $4,000,000.

Now, gentlemen, the Secretary of the Interior has eloquently portrayed the necessity of a building in this city that shall be fit in all respects to accommodate the inventors of the country. I answer for the Treasury, and say, if you can get our intelligent Congress [laughter] to make the appropriation I will see that the Treasury foots the bill. [Laughter.]

The CHAIRMAN. The sixth regular toast, "Relations of Patents to the Law," was to have been responded to by the Hon. W. H. H. Miller, Attorney General. In his absence the Secretary of the Board of Trade will read his response.

LETTER FROM HON. W. H. H. MILLER.

The Secretary of the Board of Trade read the letter as follows:

Department of Justice,
Washington, D. C., April 10, 1891.

MR. MYRON M. PARKER, *President Washington Board of Trade.*

My Dear Sir: I regret that it is impossible for me to be with you to-night at the Patent Centennial banquet.

"The relation of patents to law" is quite the reverse of their relations to almost everything else. In the arts, manufactures, agriculture, mechanics, trade, and, in short, in almost everything, patents give benefits. From the law they ony receive benefits. The old saying that "Necessity is the mother of invention" is much less a general truth than formerly.

The law is the creator of patents. In the laboratory of the law, thought, ideas, inventions are crystalized into value and become property, and thereby invention is stimulated and the results are the amazing discoveries and stupendous progress of the nineteenth century. The Patent Office is a sort of a free coinage mint, where every man's ideas are coined into property, labeled and returned to him for use at whatever the world will give for them. Why not have the Government "fiat" a value for each patent, so that a seventy-cent idea will go for a dollar?

The effect of patents on the law is slight. Its fundamental principles as to property rights, "Thou shalt not steal," "Thou shalt not bear false witness," "So use thine own as not to injure that of another," were about as well understood by Moses and Solomon as by Mansfield and Marshall, or the jurists of Westminster and Washington to-day.

The applications of the law, resultant from inventions and progress, are infinitely multiplied, but the principles are unchanging and unchangeable. Property in patents is safeguarded upon exactly the same principles, and for the same reasons as property in potatoes, viz: Natural ownership of the results of individual labor, whether of the hand or head.

But there is no property in the law. No man can make a discovery and get a patent on any part of it. No monopoly, no corner, no trust, has any exclusive, peculiar, or superior right in or claim on the law. It is the inestimable heritage of all citizens, as equal tenants in common, the expressed conscience of the whole people, growing with their growth, developing with their development, sensitive and vigilant, or dull and inefficient, according to the condition of public morals.

In the law is the patent of the rights and liberties of all. To the law all are amenable for their conduct. And for the law all are responsible as its makers. Very truly yours,

W. H. H. Miller.

The eleventh regular toast, "American Patents in the Army," was responded to by General Lewis A. Grant, Assistant Secretary of War.

RESPONSE BY GENERAL LEWIS A. GRANT.

The War Department of the Government does not deal in patents, and, as a rule, does not use patented articles.

Many of the most important inventions within the Department are not patented, because they are not for general use. They are the implements of war and destruction, and the inventor generally has blood in his eye, and people generally do not care to speculate in these inventions. The main effort of the Department is not to secure patents and the right to use them, but to secure exclusive use, as against foreign nations; and in that, secresy is sometimes necessary. And yet the Department receives great benefit from the stimulation to American genius developed by our system of patent laws. Perhaps no part of the Government has felt their influence more potently.

In all that pertains to our Government, there has not been more striking and remarkable improvements within the last one hundred years, or even in the last quarter of a century, than in the arts and implements of war. While the navies of the world have been active in constructing armor (to resist the force of shots and projectiles), the Army has kept along in its construction of guns and projectiles capable of penetrating or shattering the heaviest and strongest armor made.

The inventive genius of General Rodman, of the Army, aided in improvement and development by Professor Tredwell, has given to American guns the quality of strength, resistance and force of propulsion heretofore unknown. General Rodman secured a patent, but the principle has been wrought upon and improved, probably far beyond his expectations. The strength of texture and the resisting power which has been attained is simply marvelous; and by improved projectiles and explosives a power of propulsion and a distance of range and accuracy of aim have been reached not generally known.

Before 1849 our most powerful gun was a 10-inch cast-iron smooth bore, which, with a charge of fourteen pounds of powder, would drop a one hundred pound ball considerably within the well-known marine league. Now the same size of bore, the 10-inch rifled gun, uses 250 pounds of powder, and hurls a projectile of 575 pounds with about fifteen times the force of the smooth bore of forty-two years ago. This, indeed, is effective, but its power is small compared to the 16-inch steel gun, which explodes one thousand pounds of powder, and hurls a projectile of a ton's weight with an initial velocity of lifting 60,000 tons one foot, and of penetrating, at five miles distance, the heaviest and strongest armor afloat.

Very important indeed, in connection with these heavy and long-range guns, is the more recent invention of one of our Army officers, of what is known as the "range-finder." By means of this invention the distance of the range, the propulsive force of the gun, the weight and shape of the projectile, the resistance and movement of the air, and the velocity of the vessel or moving target, are all taken into account and accurately adjusted, so that the destructive projectile is hurled against and into the fated target at a distance of five or more miles with almost as much precision as was formerly attained by our smooth bore muskets at a distance of five rods.

The interrupted screw breech mechanism, so largely used in this gun and generally called French, was developed and perfected in this country, and was in many essential features covered by Chamber's patent in 1849.

The steel wire wound gun, the inception of which dates from 1856, now an active competitor for public favor, is the invention of an American, Dr. W. E. Woodbridge.

The recent improvement in powder, the distinguishing feature of which is its slow burning property, has much to do with the great force of propulsion obtained in the use of modern guns. One improvement serves to increase the strength of the gun; and the other to reduce and control the strain upon it, and both are largely due to American invention. This property in the powder was fully appreciated and successfuly produced by the studious investigations of Mordecai and Rodman, both officers of the Ordnance Department.

One of the latest improvements is the so-called smokeless powder, which has already been adopted in some degree by other countries. But our inventors have not been slow in entering this field, and we already have several smokeless powders invented by Americans, among whom are Maxim and Houghton, promising great results. The revolving cannon is the result of the invention of Hotchkiss. The Gatling gun, that terrific repeater, is known by all, and the inventor whose name it takes is probably known to many of you. The Gatling gun is a revolver while the Maxim will deliver hundreds of shots per minute from a single bore.

But it is not upon the large guns alone that we rely for military operations of aggression and defense. These require heavy and intricate machinery for handling, and their use, and firing is necessarily slow; while the smaller guns can be handled with more ease and fired with greater rapidity, and the result is more destructive than that of the larger guns, although not at so great a distance. The condition and efficiency of American arms, and the machinery and skill used in handling them, may well invite an assailant to closer quarters.

Within the last few days, much has been said about the powerful navy and the heavy guns of a European nation, and fear has been expressed that such heavy armament might enter the harbor of some of our larger cities. So far as the Army is concerned, we would gladly let them come. Let them come in if they want to; they would go no more out forever.

So perfectly and effectively has the work of destruction been planned and carried out, that within a surprisingly short time there can be placed beneath the waters' surface an indefinite number of destructive explosives; and those can be so arranged that vessels passing over them will cause explosion and their own ruin. Or they may be so arranged that vessels may pass over them unharmed, and arrange themselves in line of battle ready for attack; and then by a simple touch on the shore—it may be from the hand of a small child—there will come instantaneous explosions all along the line, sufficient to destroy in an instant of time the largest fleet finding room in one of our harbors.

There is also ready and waiting for any foreign invader the pneumatic dynamite torpedo gun, wholly an American invention, largely due to Mr. Mefford, but Captain Zalinski is entitled to much credit in its development. "It is a veritable innovation, in that compressed air is used in place of gun powder to propel the projectile, charged with high explosives." It is capable of hurling a tremendous mass of dynamite through the air and against a vessel, causing its complete destruction.

Again, if the work of destruction is not already complete, we will plant on shore in safe positions groups of mortars, sixteen forming a group, from which the most destructive explosives can be at once hurled high in the air; and so nicely is the propulsive force, distance of range, and other considerations taken into calculation, that they may be made to drop with wonderful accuracy upon the offending vessel. It will do more than pierce the joints of the vessel's armor; these huge and destructive missiles will drop upon the upper deck, penetrate the ship, explode and destroy it.

These things are not mere theories in the minds of American inventors; nor do they exist simply in the models in the Patent Office, but they exist in terrible reality, and any nation beligerently inclined is respectfully invited to test them.

The improvement in small arms and all the paraphernalia of war has not been less marked, and the American inventors hold a conspicuous place. Our machinery for manufacturing is of the latest and most improved kind. "We were early in the field to substitute machinery for hand-work, and the first to perfect the machinery for making any number of parts of different arms to be assembled at will."

The superiority of our small-arms cartridge manufacturing has been equally well marked, and the machinery for this, which was devised at the Frankfort Arsenal in 1886 by J. G. Gill, the master mechanic, is a model of excellence.

The present service rifle is the Springfield single breech-loader, a weapon which has proved most valuable in our frontier service, and one which it will be difficult to replace. But the small bore magazine rifle is attracting great attention, and repeated and successful experiments are now being made with it.

But it is not in guns and arms and munitions of war alone in which we excel, or upon which we depend. Almost every invention within the range of human skill is utilized in some way for the purposes of the Army. The horse and the mule and the army wagon are used in their place for purposes of transportation, but the best and fastest steamboats, and all the constructions and appliances of railroads are used in the transportation of troops and supplies, and in the concentration of forces. The telegraph and the telephone are used in the transmission of orders and information. Signals and balloons, and all the devices of aerial navigation are utilized to obtain bird's eye views of the enemy's camp, and in watching his movements. And by means of the photographer's art the exact condition of the enemy and his defenses are caught by the rays of the shining sun, transmitted to paper, and laid before the Commander of an Army for his information and inspection.

With the best of guns and small arms, and all the equipments of war, with all the appliances and inventions for moving troops, and so concentrating armies with an effective force of more than three millions of stalwart men, ready for the field, sustained and supported by more than sixty million of loyal hearts—among whom are the mothers and daughters of the nation—our Army is invincible to any force that can be brought against it. The American standard is full high advanced, and forcibly sustained. With the increasing strength of our Navy and maritime commerce, our flag shall not only proudly wave over all our land, but it shall spread its ample folds in every commercial port of the globe.

The thirteenth regular toast, "American Patents in the Navy," was responded to by Hon. J. R. Soley, Assistant Secretary of the Navy.

RESPONSE BY HONORABLE J. R. SOLEY.

It is no small satisfaction in rising before an assemblage that represents the advance guard of technical science in America, to speak in behalf of an establishment whose highest aim and most earnest effort are to keep in the forefront of scientific and mechanical progress. Nine years ago the Navy of the United States was composed of a collection of rapidly decaying wooden ships, propelled by antiquated engines, and armed with smooth-bore guns. So far from advancing, its condition since the war had been one of steady deterioration. Its vessels and its guns were a subject of derision at home and of contempt abroad. To-day the Department is engaged in the building of twenty-five modern steel ships, three of them battle-ships of 10,000 tons displacement, and two more will shortly be added to the list. In these vessels every device has been put that the inventive ingenuity of the age could suggest. The triple-expansion engine, the dynamo, the sub-divided structure and double-bottom, the modern pneumatic and hydraulic appliances, the multitude of contrivances for propulsion, for distillation, for steering, for ventilation, for hoisting, for defense against projectiles, for excluding the dangerous inrush of water, for increasing the efficiency of the armament, have made the modern war-ship, with her machinery, and her main and secondary batteries, a structure so complex and so diversified in its innumerable details as to call for the application of inventive skill in nearly every department of mechanical science.

Back of all this lies the vast advance which recent years have shown in the materials of construction, in the steel itself by means of improved tools, improved processes of manufacture, improved combination of elements, in frames and plates, in castings, in armor, in gun forgings. When the high and exacting requirements of the Navy Department in the quality of steel which it called for were first made known, it was doubtful if the manufacturers could furnish it; but the mechanical skill of the country showed itself equal to the demand, and the result has been a product which has no superior in the world. The progress less marked in materials and in mechanical devices, stupendous as it has been during the last few years, seems to be without bounds or limits that man can fix. Truly it may be said that in the field of the inventor or working with the applications of naval science, there are no horizons.

It is in this vast field of mechanical enterprise that the bureaus of the Navy Department are now at work; and such has been their success that we have to-day a fleet, built or building, which though small numerically, is unsurpassed in the types of which it is composed, ship for ship, by any navy in the world; and it is a fleet constructed of American material, built by American labor, and embodying in its design the genius of American invention.

I cannot help quoting here, although public notice has already been taken of them, the remarks of Mr. J. H. Biles, the eminent English naval architect, in his paper read four weeks ago before the Institute of Naval Architects, where he says of our new battle-ships: "They are distinctly superior in most respects to any European vessels of the same displacement, and for the purpose of protecting the American coast-line they seem to be quite a match for any ships afloat.''

From the time when David Bushnell devised, and Robert Fulton developed the torpedo; when Fulton again applied the steam-engine to navigation; when Ericsson, a fellow-citizen by adoption, went a step further, and invented the screw propeller; when the same Ericsson, following in the footsteps of Timby, applied the movable turret to armored ship construction—down to the time of Dahlgren, Parrett, Hotchkiss, and others of equal or greater eminence who are present here to-night—naval architecture has been under a heavy debt to the inventor of this country. The patent laws give security to the property of the inventor; but it is a problem above and beyond law to give security to the wealth and prosperity, individual and national, with which the community has been endowed by the inventive skill of its citizens.

The nation that grows rich and prosperous excites the envy of its rivals. It must provide for its defense. It is for this purpose that the Navy exists, and it is this work that its officers, if we will only give them the right weapons and plenty of them, stand ready to accomplish. The country which, by the hands of its inventors, has thus cast its bread upon the waters will then find it returning after many days; and the debt which the navy is under to the mechanical skill of America, it will repay four-fold by the security and protection it affords to the fruits of American labor.

The fifteenth regular toast, ''American Patents in the Postal Service,'' was responded to by the Hon. S. A. Whitfield, First Assistant Postmaster-General.

RESPONSE BY HONORABLE S. A. WHITFIELD.

Swift once defined invention as being the talent of youth and the judgment of age. If this definition is accepted as correct it will be conceded, I think, that the talent of this country is in that particular precocious to a degree absolutely unprecedented, or else it has attained the judgment of age at a period when, according to comparative chronology, it should be barely on the threshold of early manhood. We have here, perhaps, the best illustration of the maxim that ''Those who are least governed are best governed;" and, in fact, the touch of the government is so light that in most localities the only tangible, visible evidence of its existence is found in the various ramifications of the postal service. I do not, therefore, draw invidious distinctions between departments when I claim that the one I have the honor to represent here to-night is the most notable beneficiary of American inventive genius. It is because this service has come home to every nook and corner of our land, that we are able to say that in a domain of practical human achievements we have benefited most because we have presented most opportunities and most direct association.

In one great branch of the department, the Contract Office, we occupy a position perhaps unique in the history of mechanical appliances. We not only invite competition by public advertisement, but for the protection of the Government we reject articles not actually patented. In fact, so numerous have become the patented articles in use in the postal service that a separate clause is inserted in all contracts requiring parties supplying the various equipment to furnish a bond protecting the Government from possibility of damages growing out of infringement. No better object lesson could be offered the student of mechanical invention than would be afforded by a study of the splendid rotary registry lock in use to-day in securing packages filled with valuable matter or passing between our great commercial centres, and the one in use even at a period as late as 1880. Losses under the former, though inconsiderable, reached a respectable percentage, while under the latter they have grown so small as to be almost incapable of mathematical calculation. In fact, the unfortunate thief is now reduced to the necessity of stealing the whole pouch. It is a physical impossibility for him to get into it and conceal the evidence of his crime. A short time ago the Department found that it had in its possession more than 250,000 mail locks, for which it was offered the magnificent sum of twenty cents a hundred pounds. These locks had cost the Government fifty-seven cents each. They could not be used at this time without a change of keys and combinations. As usual in this country, the occasion produced demand; and with a single blow of the die, and at a cost of about five cents each, every one of these 250,000 will be made available for service, and a most excellent lock restored to use.

I could more easily and quickly enumerate what would be left in the service were the fruit of American ingenuity withdrawn, than I could give you a list of useful patents now in use. We begin with locks of all descriptions and run the gamut through the long scale of mail pouches and fastenings of all descriptions, bag racks, mail-bag catches, stamping pads, lock boxes, and keys, and soon down to the latest and perhaps most notable invention of stamping-machines for cancellation of stamps and back stamping of letters. Three samples of these machines are now in use at the Washington office, and would well repay a visit of inspection. One of them recently cancelled, under the supervision of the board of our own officers convened in the city of New York, 14,615 pieces of unassorted miscellaneous mail matter in thirty minutes, and others have attained a speed of from seven thousand to nine thousand in the same time. Thus, while each machine relieves for other useful work from four to six men previously employed in stamping letters by hand, it performs the still more important function of shortening radically the time that elapses between the receipt of the letter at the central office and its delivery to the addressee.

The high rate of speed attained by the trains on our main trunk roads leaves little room for shortening the time actually consumed in the transportation of mails between our great cities. The latest and most troublesome problem is to overcome the difficulties attendant upon the distances between the central offices and outlying stations, consequent upon the thronged condition of the streets in all our business centers. The attention of the Postmaster-General has been especially directed to the loss of time experienced there, and at an early date we design to avail ourselves of the agency of pneumatic tubes, at least experimentally in this work. If this shall prove a success, it is believed that the difficulties imposed by time and space are as nearly overcome as it is possible for mere human agencies to accomplish. Recent advances in telegraphy and improved methods in all branches of this great system have led the Department to desire to avail itself of them to an extent not possible under the limitations of the existing contract.

As a brief and final illustration of the prolific genius of our inventors, it may be interesting to know that under a recent advertisement issued by the Postmaster-General for private letter boxes to be used by individuals and firms, 577 models and designs were presented to the Board convened in Washington City, to which may be added about 200 communications containing suggestions more or less valuable. There are to-day in the Post-Office Department, awaiting the action of a Commission soon to be appointed, more than a hundred designs for improving the mode of closing the present leather mail pouch now in use. It is no longer a question of finding something suitable for the wants of the Government, but rather one of deciding, among so many excellent designs, which is the most excellent.

The seventeenth regular toast, "American Patents at the World's Exposition," was responded to by Hon. Benjamin Butterworth, secretary of the World's Columbian Exposition.

RESPONSE BY HON. BENJAMIN BUTTERWORTH.

Mr. Chairman: It is now after two o'clock in the morning, and if I were the sworn enemy of each one of you, I do not think I could have the heart to detain you here to make a speech. Even if I were disposed to make one, you would not be disposed to listen to it. What I had contemplated saying I will use in response to another toast at another centennial on some other occasion. If I draw these papers on you, I trust you will not feel disturbed. It is only for the purpose of stating what I desire to omit, not what I propose to say.

You have swept the whole horizon in respect to patents, both those which are utilized in peace and those which are available in war. I am asked to say something with regard to American patents at the centennial. The truth is, I might as well try to give you an account of all creation, and there will not be anything there that has not some relation to our American patent system.

If you will hear me for one single moment, I desire before I refer to that to show what the opportunities there are, and what they will be for exhibiting everything that pertains to the American patent system, and all other things of interest. We may well take pride in this great enterprise. We may well take pride in that aggressive spirit of the great West which has contributed more to the enterprise than any city or State or nation has ever heretofore contributed. It is true, my own desire was that this great enterprise should be held at Washington City, and it was fit and proper that it should be so held. Other persons desired that it should be held in New York. But our people are becoming a little anxious as the course of empire takes its way westward, that those beyond the Alleghanies, those in the interior, should have a chance. The people of the country desire to turn the Federal cow around. She has had her head on the other side of the Alleghanies, but her udders have been stripped on this side. It was determined to turn the animal around, so that she can now be fed east of the Alleghanies and the lacteal food will be poured out upon the West.

It has been decided that this great exposition shall be held at Chicago. It has met with the most generous, warm-hearted support from every quarter of Europe. I desire to call your attention for but a moment to the opportunities for exhibition that will present themselves there. Chicago is a city of over eleven hundred thousand inhabitants, inhabited by the most enterprising people in the world. From the boot-black to the mayor, each one believes that Chicago was foreordained from the foundation of the world to be the metropolitan city of the continent, and in this belief they work according to their faith, and their works have justified their faith.

There can be no more conclusive fact that they intend to make the exposition the event of the nineteenth century, than that they have pledged to this enterprise $17,000,000, $12,000,000 of which they have already raised. The great State of Illinois, one of the youngest of the sisterhood of States, carved out of this great Northwestern territory, will add $1,000,000. Some twenty States of the Union have already appropriated $1,500,000 and the other twenty odd States will follow that with more than $2,000,000 ; in addition the General Government has appropriated $1,500,000 making in all

$25,000,000 appropriated to offer conveniences for the taking account of the stock of our civilization and to ascertain what we have done during the last century that shall go down through all the centuries.

I have been in Chicago a little while, long enough to take on that natural reticence and diffidence which is characteristic of that people in speaking about what they are about to accomplish. [Laughter.] Now as to the site selected. It lies fronting the waters of Lake Michigan, and embracing as handsome parks as can be found on either continent. The number of acres to be covered by the main buildings to be constructed for the purposes of the exposition will be double that of any ever held. The greatest floor space provided by any previous exposition was at Paris in 1889, which contained a trifle over seventy-five acres. The floor space that will be covered by the main buildings at Chicago will be over 150 acres. The area devoted to the exposition will contain a thousand acres, with five or six acres adjacent for overflow. Those who have examined the plans for the buildings, and who are experts, assert that they have never been surpassed in architectural beauty and in adaptability to the purposes intended. Every single foot of this space will be utilized to show what the genius of man has planned during the last few centuries and that which will be worthiest of use, and about which you will linger longest, which has done most for our civilization, most to bring us peace and make it permanent will be that which is due to the ingenious inventors of the last fifty years! [Applause.]

I am asked what will be seen there? Now the patent system is related to the fair. How is the patent system related to civilization? The civilization of my country would not have passed the Indian line up to this, 1891, but for the inventive genius of my countrymen, and the American patent system, which was the first really formulated and made practicable by a nation.

As I said to-day, nations have been carved out upon the field of battle and planned in the council chamber; but never until the founding of a free government in this country did it occur to man to encourage inventors and authors as public benefactors.

How will the American patent system show itself there, or in other words, how will invention find expression there? What is invention in its broadest and best sense? It is the application of ideas to the needs of man, no matter whether the idea find expression in a spoon or an engine or a sewing machine, in the telegraph or in the ten thousand inventions less consequential in their separate significance. The author is an inventor, although he may deal with a different class of subjects than those which find expression in material things.

So far as the material world is concerned, there is not a laboratory in the world that has produced anything worthy of use that will not be seen in Chicago. There is not a shop which has produced a contrivance or device so interesting or so useful as to attract and deserve the consideration of men that will not be seen at Chicago.

In other words, all the classes of industrial wealth will contribute. The arts will be represented there by their best productions. The applied and occult sciences will contribute their share to the exhibition. But there has been organized in connection with this great enterprise, that which in my judgment is of equal, if not higher consequence than things material. Things material may fall, but words, principles, ideas which find expression in books and records will last and go down through the centuries and outlive possibly this crumbling republic.

We have provided in the exposition for a world's congress to deal with ideas. In other words, in order that we may have the benefit of ripened thoughts gathered from the 40 centuries, there will be gathered together the wisdom and wise men of our times from all the nations of the earth to deal with all subjects; to deal with economic questions, and those principles that require an early solution. We cannot be blinded to the fact that there are great questions—social, economic and political—which must be settled in the arena of investigation and free discussion, or at an early day they may refer themselves to the dread arbitrament of battle. It is in order that the great minds of the world, the great thinkers and the great writers may meet there that we have provided for this world's congress.

My honored friend upon my right has spoken to me about the absolute failure upon this continent, if not throughout the world, of municipal government. They are a complete, abject pitiable failure, but that we are a generous people, and stand bleeding freely, we would have rebelled against them long ago. The men who have given this subject the most attention will be heard in Chicago.

There is a question as to whether the time has not come when we may put aside the munitions of war and refer the disputes between nations not to the arbitrament of battle, but to arbitration. The men who have given this subject careful consideration will also be in Chicago.

There are questions touching the coinage; questions touching our economic system of supply and demand, and the relation between the methods of getting supplies from points of production to points of consumption. All these questions will be considered in these several congresses. My honored friend upon my left, Archbishop Ireland, is entirely in charge of one of these departments. I would like to hear from him for a few moments touching the possibilities that await us there. We have already had responses from England, from France, from Belgium, from Austria, from Russia and from Brazil. The great thinkers in each one of these countries have signified their willingness and their desire to meet the thinkers and writers of this country. They realize that a time is rapidly approaching when drums will be muffled and battle-flags furled in that parliament of human confederation.

All the nations of the world will be there. There is not to-day a race of people where the agents of the World's Columbian Exposition are not visiting. England will be there, rejoicing in the great prosperity that has waited upon the children of her loins. The Fatherland will be there, delighted with the prosperity that has waited upon her children. France will be there, our old ally, and Italy will be there—yes, Italy will be there. If she comes in a belligerent spirit, we will read to her the address of Secretary Grant and let her know that it will not do for her to come within our border with such a spirit. Italy will be there, and she will find that in the integrity of our people her Sicilians will be as safe in the streets of Chicago as they are under the shadow of the dome of St. Peter's in Rome.

But above all, the possibilities of our own country will be represented there. Emerson said, "The United States" is but another name for opportunities. It will be realized there fully. In the intermingling of one nation with another the United States is nearer to Austria to-day than the State of New York was to Ohio a century ago ; so that after all we are neighbors.

I am not putting it too strongly when I say it is not at all improbable that by the time the exposition is under way, we can go from Chicago down to the exposition through the air. You say that is strong, but it is not. It is now within sight, and I will promise you that you will go the seven miles in six minutes with perfect comfort. I know our European friends imagine that when they pass 200 miles west of New York they are in danger of being scalped with tomahawks by the Indians, but we can assure our brothers that when they go to Chicago from Baltimore, Philadelphia or New York they can be carried in palaces upon wheels and be as comfortable as they would be in their own parlors, and there see a city the people of which are unsurpassed for pluck and energy, and a city which is itself worth a trip across two oceans to visit.

What there is worth seeing there will be due in a large measure to the benefits derived from the patent system, which simply says that every man who contributes to the well-being of society shall have this reward.

My honored friend, Mr. Noble, said that it was not love of gold that prompts the inventive genius. Well, "may be it aint," but my experience and observation alike are that the inventor keeps an eye partially and singly to glory, but it is largely centered on his pocket, and I would not respect him if it were not so.

As my honored friend, Mr. Mitchell, has said, a man who saves to you a dollar is entitled to a percentage for saving it. A man who reaps for you a harvest at $50 that cost $100 ten years ago, or would now cost you $100 without his invention, is entitled to a fraction for saving it. The man who blesses the community and saves it millions of dollars is entitled to dividends for his effort, and what has made the young republic the first nation in the world is the fact that every worthy noble action has its reward.

We do not patent anything that is worthless. The measure of patentability is that it shall involve the exercise of that god-like attribute of genius and invention; next, that it shall be useful; and third, that it shall be novel. Where these three elements contribute to the welfare and convenience of men, we have provided, or our fathers provided before us—and they builded better than they knew—that the men who thus contributed to the well-being of society should have his reward, and the amount of that reward should be the excellence of the invention and the amount which he contributed to the well-being of those who seek to use that which he has given them.

Now, gentlemen, I want to congratulate you upon the success of this convention. I wish our people knew how much they owe to the patent system, to the thinkers, writers and inventors of this country. A great many people think it is an easy thing and that there is no trouble in an invention. They think it is easy to think. As I said before, very few of those who talk that way ever tried to think or ever made a success of it if they did. There is nothing harder in the world than earnest thinking, and as the result of that earnest thinking the blessings to which I have referred have come to us.

I will say, in conclusion, that if you will come to Chicago, you will realize what has been accomplished during the last few decades, what is now being accomplished in all the nations of the earth, and how much is being contributed from every locality to add to the comfort and convenience of mankind. [Applause.]

Mr. PARKER. Before we adjourn I desire to call attention to the fact that we have with us to-night Hon. Richard Pope, Commissioner of Patents for the Dominion of Canada, and we would like to hear a word from him.

Mr. POPE. Mr. Chairman and gentlemen: It is too late, or, I should rather say, too early in the morning for me to make a speech, and I think it would be undesirable upon my part that I should inflict another one upon you. I doubt very much, also, whether you would allow me to do so even if I desired.

But, gentlemen, I feel that I must express to you my sincere thanks on behalf of the Canadian Patent Office, which I have the honor to represent. I feel that you have conferred upon us an honor in the invitation which has been extended to us, which has only been equalled by our participation in the magnificent celebration of the Centennial of the Patent System of the United States.

The design here has been to pay homage to human invention and progress in the arts and sciences useful to man and essential to modern material prosperity and wealth.

I feel, gentlemen, that the inventor, filled with a desire to put into practical effect the evolution of his inventive brain, little knows, or perhaps stops to think of, the benefit his invention may confer upon future generations. So I feel that you, gentlemen, who have promoted this centennial celebration cannot foretell the advantages that may accrue not only to your own country, but to every intelligent country on the face of the earth by arresting public attention and diverting it to serious thought and consideration of the wisdom of the patent law and of legislative enactments tending to encourage and promote industry and the inventive genius, and in assembling together those that have conferred upon the world in general such great benefits. I say that the benefits are inestimable, in view of the great and mighty inventions which the world has recently been put in possession of, among which may be enumerated that which has enabled the human voice to annihilate space and travel with lightning rapidity on an electric wire, which must conduce to future invention, and which will extend further benefits to the world at large and to future generations, when time and distance shall be no more.

Gentlemen, it would be undesirable to occupy your time any further upon this great question of the advantages of inventive genius to mankind. In view of the many eloquent, able, and exhaustive speeches which we have heard upon that subject in the last few days, which have been supplemented again to-day in the most extraordinary manner, it would be unwise and unnecessary for me to proceed further. But, gentlemen, I cannot sit down without again thanking you most sincerely for the honor you have conferred upon the Canadian Patent Office and those gentlemen who have accompanied me. I thank you for the respect, attention, kindness and consideration which we have received, not only from the Centennial Committee but also from every one with whom we have had the honor of coming in contact, since our advent into your city, which we will always look upon as one of the most pleasant reminiscences of our lives, and which will make us feel the approaching advent of our departure from you to be a source of sincere regret and sorrow. [Applause.]

Professor WATKINS: I want to make an announcement. I wish to state that the American Association of Inventors and Manufacturers have completed their organization. It gives me great pleasure to say to you that Dr. R. J. Gatling, of Connecticut, has been chosen president of that organization and that he is present.

Dr. GATLING: Gentlemen, it is too late to make a speech, and I will merely say that I have been greatly interested in what has been said here in the last few days. I have never listened to addresses that have pleased me more, or addresses that I think will do more in the future for promoting the happiness of mankind. It is too late to make any address. I have been of my feet without food all day, for I have worked to get the organization of inventors perfected. I never dreamed that the honor of being elected president would be conferred upon me. One or two individuals spoke to me yesterday upon the subject casually, and asked me whether I would serve in that capacity, but I told them that I did not desire it and wished they would not put my name in nomination at all. They voted by ballot, took around the hat. I voted for Mr. Hubbard, and thought he was the man, and he ought to have been the man; but it seems they voted for me and insisted that I should accept it. I can be in Washington only occasionally, but I will do all I can to further the purposes of the organization. Mr. Hubbard has been elected first vice-president and we have got a good committee and a good organization, as far as was possible in the time we had.

I have enjoyed myself very much in Washington. I have been here a great many times, and when I first came here it was all a commons. Now I think it is the most beautiful city in the world. You ought all to be proud of it as American citizens. [Applause.]

PAPERS UPON U. S. PATENT OFFICE TOPICS.

THE OLD AND THE NEW PATENT OFFICE.

BY ROBERT W. FENWICK, WASHINGTON CITY, D. C.

After the seat of Government was removed from Philadelphia to the City of Washington, which took place in 1800, the entire business of the Patent Office continued to be carried on by a single clerk in the Department of State.

In 1801, Dr. William Thornton, a very accomplished and thoroughly Americanized English gentleman, at one period one of the early Commissioners of the Federal city, was appointed by the Secretary of State to take charge of the issuing of patents for inventions. The business continuing to increase, a clerk and messenger were appointed to assist in the duties of the office, which had been removed to Cocken's two-story house on Eighth street, between E and F streets N. W. (which house was afterwards occupied by Mrs. Blanchard).

In 1811 the large three-story brick and stone building erected by Mr. Samuel Blodgett, previously, for a hotel at the southwest corner of the square on which the new general post office now stands, having been purchased by the Government and fitted up for the General Post Office and Patent Office, the business of the latter was removed from its location to the second floor of this building, where it remained under the superintendance of Dr. Thornton* till his death, which took place on the 27th of March, 1828.

In 1816 William Elliot, mathematician and astronomer, and formerly surveyor of Washington City, was appointed by the Secretary of State, Mr. Monroe, as assistant to Dr. Thornton, in which office he remained till 1829, when he resigned.

*A fine portrait of Dr. Thornton is now on exhibition at the New Patent Office.

William Parker Elliot,* the architect of the present Patent Office building, and a son of the William Elliot* above referred to, was acting as draughtsman of the old Patent Office during part of the time his father was in office.

William Elliot was born in England in 1773. Had one daughter, Emily, and three sons, Seth Alfred, John Bowman and William Parker Elliot. He died at Washington, D. C., December 31, 1838. *The National Intelligencer* of January 1, 1838, speaking of his death, said: "Suddenly on the forenoon "of Saturday last Mr. William Elliot, surveyor of the city of "Washington, aged 64. Mr. E., though a native of England, "was an old resident of this city. Was the founder of the "*Washington City Gazette* in 1813, and possessing considerable "scientific attainments, was a useful as well as a kind hearted "citizen. He was one of the earliest and most zealous mem-"bers of the Columbian Institute, and his remains were "attended to the grave by that Society."

Prior and up to the administration of General Jackson the entire business of this office was carried on by four persons, viz: Dr. William Thornton, William Elliot, William P. Elliot and Benjamin Fenwick; and in 1836–37 by seven persons, including messenger, machinist and assistant clerks. The number of persons now (1891) employed at the new Patent Office is fully six hundred.

It is an interesting fact to relate that in these early days a single pony was kept by the Government for the use of the Patent Office, and that the messenger or clerk rode this pony when he went to the State Department to have the patents signed by the Secretary of State and other officials.

In 1832 the General Post Office building on E street was extended eastward to Seventh street, and the following year the Patent Office was removed to the new portion of the building, where it remained till the 15th of December, 1836, when the whole structure with its contents (excepting some of the books of the General Post Office) was destroyed by fire.

During the construction of the main central portion of the present Patent Office building in accordance with the architec-

*Portraits of both of the Elliots are on exhibition at the new Patent Office.

tural plans designed by William P. Elliot, which was adopted on July 4th, 1836, by Congress and approved by the President, General Jackson (an interval of four years), the business of the Patent Office, which was resumed on July 7, 1837, was carried on in the "City Hall," from whence in 1840 it was transferred to the new Patent Office building.

In connection with the history of the old Patent Office, it should never be forgotten that by the patriotism and scientific devotion of Dr. William Thornton the germ of our grand patent system was saved from destruction by the British soldiery. It was related to the writer by Mr. Seth A. Elliot, another son of William Elliot, that as the British commanding officer was about to have the torch applied to the Patent Office building, Dr. Thornton appeared on the portico and earnestly cried out, "This is the emporium of the Arts and Sciences of America ; don't burn it." To the credit of this officer, be it remembered, he listened to the appeal, and gave orders to his soldiers to pass on without burning the building.

THE NEW PATENT OFFICE BUILDING.

This magnificent building, occupying two whole squares, bounded by Seventh and Ninth and F and G streets northwest, is of quadrangular shape, 413 by 280 feet with an open court of 270 by 112 feet, giving light and air, and with slight expense might be made to present to the eye of the overtasked wearied officials beautiful grass plats, growing plants, flowers and flowing fountains. This building as originally designed was to contain a large room for patented models, 270 by 65 feet ; and two smaller ones for the same purpose, each 85 by 65 feet, communicating with the larger room, thus making a room of 400 by 65 feet on the principal floor ; with thirty six commodius rooms for office purposes ; and the same number of rooms on the basement floor, not for clerks, but for useful storing purposes. There was also to be a continuous gallery above the principal floor of 1100 by 65 feet, intended as a receptacle for patented models, and the manufacturers' national exhibition gallery. The business part of the structure was to be divided by wide passages of 16 feet, running longitudinally through the center of the same with openings at each end for light and air, by which arrangement, and the open court and the streets on all of its sides, the rooms were to be well ventilated and lighted.

ARCHITECTURE OF THE BUILDING.

The building was to be two stories high, resting upon an elevated basement. The order of architecture adopted for the exterior was the Grecian Doric of the age of Pericles, when the fine arts in Greece, particularly architecture and sculpture, had reached the highest points of excellence. The details are modeled after the celebrated Parthenon, erected on the Acropolis at Athens, one of the finest specimens of Athenian architecture, and which was in 1827-'28, in part still standing, although more than 2,000 years had passed since its erection; and before it, in his early manhood, the architect of the Patent Office stood, and by it had his genius so kindled into a living flame, that he was enabled, on his return to his native land, to reproduce some of its most striking parts in his design for our noble Patent Office structure. At that date the marble of the ancient building had indurated to such a degree from its long exposure to atmospheric influences, as to resist the action of a chisel. The principal front of the Patent Office on F street is graced with a portico of sixteen columns, octastyle arrangement, the columns, and entablature, and pediment being of the size and proportion of the Parthenon, each column being 18 feet in circumference at the base. The tympanum and metopes are left blank. In the Parthenon these parts were enriched with very fine sculptures in *basso relievo* and *alto relievo* of such extraordinary excellence that modern artists may well despair of equalling them. The monotony of this extended front is still farther broken up and the boldness of the outline increased by projections of 13 feet next to west and east sides. The whole building is surrounded with bold *antæ* or pilasters let into the external walls, which produce nearly as rich an effect as the isolated frustrum of cone columns, and are much stronger and serve also as buttresses to resist the thrust of the arches. The entablature is continuous and surrounded by a blocking course, which finishes the superstructure. The windows are arranged between pilasters. The north front on G street is the same as the south front on F street, except that the inner columns of the portico are omitted. The east front on Seventh street is graced with a portico of six columns which tends to break the too great monotony of the extended facade. The west front is relieved by a similar portico. This portico, owing to the position of the ground on the west, rests upon a vaulted terrace from which it is approached. The cellar story under this side of the building has, owing to the low grade of Ninth street, a greater height. A horizontal terrace or pavement surrounds the whole structure from the curb line. A handsome ornamental railing with gates encloses almost the entire building. The aforegoing is a description of the building as given by the architect himself, and it is in accordance with the original design adopted by Congress, July 4, 1836.

ERECTION OF THE BUILDING.

In the erection of the building the original architectural design was substantially adhered to, except in a few minor points, which departure, in the opinion of the designer or architect, were not beneficial nor an improvement. These changes were made by the constructing and superintending architect, Mr. Mills, who had nothing to do with the production of the original plan adopted by Congress.

ITS ORIGINAL PURPOSE.

The original intention of this building was that it should be exclusively used for the interests of inventors and manufacturers of patented inventions, and it was to supply the want caused by the destruction of the Patent Office by fire December 15, 1836, at which time there was a total loss of the models, drawings, records, and indeed papers of every kind, and the officials of the Patent Office were obliged to obtain accommodations in the City Hall, Henry L. Ellsworth, Esq., being then the Commissioner of Patents, and having only five or six other employes as his assistants. In the mind of this Commissioner the rights of inventors were sacred ; his burning words to Congress on this subject are as follows : " Interest, sympathy and " patriotism will unite in the effort to repair the loss. Justice " demands all the reparation that can be made. Government " has received from industry and ingenuity their choicest trib-

"ute. She confided the valuable repository to a place of little "security. I have mourned in common with others at the ruin, "but candor compels me to say that without much help I can "do nothing to repair the loss. I leave, therefore, with the "National Legislature the importunities of those I am com-"pelled to hear, but which I have not the power to relieve." A like zeal and interest for inventors actuated Hon. John Ruggles, chairman of the Senate committee, to whom the matter of providing for the erection of the new Patent Office was confided; and to him, and the members of the House committee, the inventors of the country owe a deep and lasting debt of gratitude. In his report submitted January 9, 1837, to the 24th Congress, second session, is found the following: "In ex-"amining the subject referred to them, the committee have "been deeply impressed with the loss the country has sustained "in the destruction by fire, on the fifteenth of December, 1836, "of the records, original drawings, models, etc., belonging to "the Patent office. They not only embrace the whole his-"tory of American invention for nearly half a century, but "were the muniments of property of vast amounts, secured by "law to a great number of individuals, both citizens and for-"eigners, the protection and security of which must now be-"come seriously difficult and precarious. Everything belong-"ing to the office was destroyed, nothing was saved. There "were 168 large folio volumes of records and twenty-six large "portfolios containing nine thousand drawings, many of which "were beautifully executed and very valuable; there were "also all the original descriptions and specifications of inven-"tions, in all about ten thousand, besides caveats, and many "other valuable documents and papers. The Patent Office "also contained the largest and most interesting collection of "models in the world, there being about seven thousand. The "American inventions pertaining to the spinning of cotton and "wool, and the manufacture of fabrics, in many respects ex-"ceed those of any other nation, and reduce so much the ex-"pense of manufacture, that the British manufacturers were "reluctantly obliged, at the expense of a little national pride, "to lay aside their own machinery and adopt our improve-"ments, to prevent our underselling them even in their home "market.

"In this department were the inventions of Brown, Thorpe, "Danforth, Couillaird, and Calvert. The beautiful operative "model of Wilkinson's machine for manufacturing weavers' "reeds by one operation, was considered one of the most in-"genious mechanical combinations ever invented. Of this "character was also Whittemore's celebrated machine for mak-"ing wool cards. There were several models of valuable im-"provements in shearing and napping cloth, patented to Swift, "Stowell, Dewey, Parsons, Daniels and others." Continuing "his report, he referred to the patents of "Griggs, Perkins, "Reed, Odiorne, and specially to the patent of Fulton for the "application of steam power for propelling boats," and says, "the name of Fulton is associated with one of the noblest "efforts of genius and science."

He further says in his report: "The sentiment is not an un-"common one, that the tax upon patents is both unwise in "policy and unjust in principle. * * * Inventors are "public benefactors, contributing to the promotion and im-"provement of all branches of national industry, and in most "instances without any adequate remuneration." And he en-"quired: "Who has done more to enrich the South, nay, in-"directly, the whole country, than Whitney, and what was his "reward? Let the South answer. Evans and Fulton, with "genius and talents, never while they lived appreciated to "their worth, died overwhelmed by embarrassments."

And he also remarked, having reference to the destruction by fire, that "It, the Patent Office, was an object of just pride "to every American able to appreciate its value as an item in "the estimate of American character or the advantages and "benefits derivable from high improvements in the useful arts."

THE ARCHITECT OF THE PATENT OFFICE BUILDING.

To William Parker Elliot, Esq., of Washington, D. C., son of Mr. William Elliot, mechanical draughtsman in the first Patent Office during the superintendency of the celebrated William Thornton, or up to the year 1829, when he resigned, belongs this high honor. The young architect is introduced to us in the following letter, found among his private papers:

"MAYOR'S OFFICE,
" *Washington, April 16, 1827.*

"Having just learned that Mr. William P. Elliot, a young "gentleman of this city, is about to leave Washington for "London to pursue his studies as an *architect*, it affords me "pleasure to state that I have known him for several years, "and that he is a young gentleman of exemplary habits and "promising talents.

"R. C. WEIGHTMAN."

Mr. Roger C. Weightman was Mayor of Washington at the date he wrote the letter.

He is next introduced by the following report of the Congressional Committee on Public Buildings:

"The Committee on Public Buildings having approved of "the plan submitted, amongst others, to their consideration by "William P. Elliot for a fire-proof building for the Treasury "Department, etc., and having framed the bill making the "appropriation toward erecting the same upon the estimates "and details furnished by Mr. Elliot, do therefore recom-"mend his plan for adoption by the President of the United "States.

"LEVI LINCOLN,
"MICHAEL W. ASH,
"ANDREW T. JUDSON,
"E. PETTIGREW,
"A. WARD.

" *Washington, July 4, 1836.*"

"The Committee on the Patent Office having approved of "the plans submitted, amongst others, by William P. Elliot "and Ithiel Town, for a fire-proof building for the Patent "Office, and having framed the bill making the appropriation "for the erection of the same upon the estimates and details "furnished by them, do therefore recommend their plan for "adoption by the President of the United States.

"GORHAM PARKS,
"JAMES HARPER,
"SAMUEL F. VINTON,
" *Committee of H. R.*

" *Washington, July 4, 1836.*"

"The Committee of the Senate on the Patent Office accorded "in opinion with the Committee of the House, as above. The "undersigned being the only member of that Committee now "in Washington, adds his individual recommendation of the "plan of Messrs. Elliot and Town.

"JNO. RUGGLES.

"*July 4, 1836.*"

PRESIDENT JACKSON'S APPROVAL OF THE PLAN.

"Under the act of Congress authorizing the President of the "United states to cause a Treasury Building and Patent Office "to be erected, I hereby designate the Commissioner of Public "Buildings to superintend generally the detailed modifications "of plans for them: The advertising and forming of con- "tracts and the whole disbursements thereon; and to enable "him to keep the accounts, make the payments, etc., prepare "vouchers for settlements and conduct the other correspond- "ence relating thereto, I authorize him to employ a clerk at "not over nine hundred dollars a year, to be paid equally out "of the appropriations for said objects. I further appoint "Robert Mills as architect to aid in forming the plans, making "proper changes therein from time to time, and seeing to the "erection of said buildings in *substantial conformity to the plans* "*hereby adopted, which are, in their general outlines, to be, as to* "*the Treasury building, that plan annexed by said Mills; and,* "*as to the Patent Office, that annexed by Mr. Elliot:* The "former building to be erected on the old site, and the latter "one on the square north of the Post Office.

"ANDREW JACKSON.

"*Washington City, 6th of July, 1836.*"

The aforegoing reports of the Committees, and order of the President of the United States would appear to be conclusive proof as to the authorship of the design of the Patent Office by William P. Elliot, associated with his partner, Ithiel Town.

From an examination of all the private (original) papers of Mr. Elliot, and letters from Mr. Town, the proof is conclusive that while Mr. Town was associated with Mr. Elliot as a partner in the profession on account of his *practical* mechanical and scientific experience in the construction of public buildings, William P. Elliot's classical culture, genius and taste were relied upon as to the original conceptions of the designs and styles of architecture introduced into our present Patent Office. If Mr. Elliot was now living he would place every credit upon Mr. Town that belongs to him for the part he took in connection with his great achievement.

At different periods subsequent to the adoption of Mr. Elliot's plan, misunderstandings have arisen as to the authorship of the Patent Office building, growing out of the fact that Mr. Robert Mills was employed as the constructing architect to carry out Mr. Elliot's plans, and to settle this question the following letter was written by Senator Ruggles :

"*Washington, February 27, 1841.*

"*Dear Sir:*

"Your note is before me, desiring me to state my recollec- "tion of the authorship of the plan of the new Patent Office "building now nearly completed.

"I was chairman of the select committee of the Senate in "1836 that reported the bill for reorganizing the Patent Office, "and a bill providing for the erection of a new edifice for its "accommodation. The plan furnished by you, on being called "on for that purpose, was laid before the committee and met "their full approbation. The estimates on which an appro- "priation was made, were based upon it; and your plan was "thus adopted by the committee, and by the Senate in ratify- "ing the doings of the committee, and, indeed, by both Houses "of Congress. That plan has been followed substantially in "the construction of the building. There has been a slight "departure from it in two or three instances, the most material "of which is, the segment of a circle under the north pedi- "ment. Whether any liberty taken with the original plan, be "an improvement in the archithcture, may be very question- "able.

"I remember to have signed a recommendation to the Presi- "dent, Gen. Jackson, in favor of your being appointed the "architect to superintend the erection of the building, as well "on account of your competency and skill in such matters, as "because you were the author of the plan, and it was but just "that you should have the superintendence of its construction. "But for some cause, supposed then to be party or personal "favor, another person was selected. The plan was spoken of "by the most competent judges as displaying a high degree of "architectural science and taste, and since the erection of the "edifice, incomplete as it is, it has attracted much attention "and admiration as doing great credit to the cultivated taste "of its projector. When the residue of the building as de- "signed and projected on the original plan shall have been "erected it will, as is believed, surpass in grandeur and beau- "ty any public edifice in this country.

"I am, dear sir, very respectfully,

"Your Ob't Svt.,

"JOHN RUGGLES.

"WILLIAM P. ELLIOT, Esq., Washington, D. C."

[The original of this letter is among the papers of Mr. William P. Elliot.]

In connection with the aforegoing letter of Mr. Ruggles, the following letter from Commissioner of Patents, Hon. H. L. Ellsworth, found among the papers of Mr. Elliot, is important:

Patent Office, December 14, 1840.

Sir:

Yours of the 14th inst. is received—I hasten to say that I am surprised that any one should presume to rob you of the merit of the beautiful and very convenient design of the new Patent Office. Some few alterations may have been suggested in carrying out the plans, but in all essential particulars the credit of the architecture belongs to yourself. Should any doubts arise I refer you to the gentlemen who composed the joint committee of Congress who met at the old Patent Office previous to the fire, and then selected and approved your plan as the best. The wants of the office I freely communicated to you, and I am happy to assure you that I find the arrangement you proposed not only adequate to our present wants, but susceptible of such addition as will accommodate this bureau for half a century to come.

I cannot believe that others will seriously claim what is justly your due.

Yours respectfully,

H. L. ELLSWORTH.

MR. WILLIAM P. ELLIOT, Washington City.

In conclusion of the subject as to who was the true architect of the Patent Office, the following extracts found among Mr. Elliot's papers, and endorsed "from the private journal of William P. Elliot," are very interesting:

NOTES FROM W. P. ELLIOT'S DIARY.

"*1836, March 1.* Submitted my plan for a new Patent Office "to the Committee on Patents, who met at the room of the "Superintendent of the Patent Office, in the old General Post-"Office building—John Ruggles of the Senate, chairman.

"Understood from Mr. Ellsworth that several plans were "before the committee, and that mine was preferred as being "the best adapted for the wants of the office. Committee ad-"journed to meet at the Capitol this day week in order to have "a more full meeting for final action on the subject of a plan."

"*March 8.* Again submitted my plan for New Patent Office "to Committee on Patents at the room in the Capitol. Under-"stood that Mr. Mills submitted another plan. My plan re-"ceived unanimous approval of the committee, and was finally "adopted at this meeting, and I was requested to furnish an "estimate of the cost of erecting about two hundred and seventy "feet of the south side or front of the block."

"*March 10.* Called on Mr. Ellsworth with estimates for "new Patent Office—then on Mr. Ruggles, who thought it "too high, and requested me to reduce it if possible."

"*March 11.* Called to see Mr. Ruggles—left estimate for "Patent Office."

"*July 2.* Heard that the bill appropriating one hundred "and eight thousand dollars toward erecting a new Patent "Office on my plan had been passed by the two Houses of "Congress. And one hundred thousand dollars toward erect-"ing a new Treasury building, also on my plan as submitted "and adopted by the Committee on Public Buildings, of which "Leonard Jarvis is chairman."

"*July 3.* Waited on Senator Ruggles, Levi Lincoln, G. "Parks, Gen. A. Ward, Samuel F. Vinton, and other members "of the Committee on the Patent Office and the Public Build-"ings, and Mr. Ellsworth, Superintendent of the Patent Office, "to advise with them on the course to be pursued in order to

" obtain the superintendence of the execution of my plans for " the Patent Office and Treasury building.

"*July 4.* The Committee on the Patent Office gave me cer- " tificates in writing that they had adopted my plan for a new " Patent Office, and recommended the same to the President " for his adoption.

" Signed by—

"GORHAM PARKS, M. C.
"SAMUEL F. VINTON, M. C.
"JAMES HARPER, M. C.
"JOHN RUGGLES, S. U. S."

" The Committee on the Public Buildings gave a similar cer- " tificate respecting the Treasury building, signed by—

" LEVI LINCOLN,
" MICHAEL W. ASH,
" ANDREW T. JUDSON,
" E. PETTIGREW,
" A. WARD."

"*July 5.* Wrote to the President soliciting the office of arch- " itect and enclosing the above mentioned certificates of the " committees of Congress and other testimonials. The plans " of the public buildings submitted by the several architects " were brought from the Capitol to the President's house. The " subject of the adoption of a plan for a Patent Office and " Treasury building was brought before the Cabinet by the " President. Major Noland, the Commissioner of Public " Buildings had invited Mr. Robert Mills, architect (who had " been recently employed by General Jackson to make draw- " ings for the Hermitage), to be in readiness in the room of Mr. " Earl, opposite the President's office. No plan was adopted " this day. I understood it was the supposition that my plan " for the Treasury building would be rejected because I had " made no provision for the accommodation of the General " Post Office under the same roof with the Treasury, as desired " by Amos Kendall, a member of the Cabinet, and that Mr. " Mills had been invited to draw a plan according to the view " of Mr. Kendall, which would bring the two departments " *under the same roof and on the President's square.* Although "my plans had been pronounced the best by the Committees of "Congress, by the Superintendent of the Patent Office and by "the public, yet I was not even invited by General Jackson or "his Cabinet to modify them to meet their views; or to have "anything to do in the business."

"*July 6.* Saw Mr. Noland, who informed me that the Cab-"inet had again met on the subject of the Public Buildings—"that he was present at their deliberations—that Mills had "submitted another plan, drawn in conformity to Mr. Kendall's "wishes, embracing the General Post Office in the same range "with the Treasury, and which was adopted; that my plan "for the Patent Office was preferred over all the others as the "best, and adopted; that Robert Mills was appointed architect "to attend to the *execution* of them."

"*July 7.* Called on the President to learn what action had "been taken on the subject of the public buildings. He "informed me that my plan for the Patent Office had been "adopted, and that Mr. Mills' plan for the Treasury building "had been selected. That he had appointed Mr. M. architect "because he had come well recommended as an experienced "builder of fire-proof buildings—that he considered me too "young and inexperienced, but that I should be well paid for "my design. I observed that I thought it strange that the "selection of the Committee on Public Buildings, after two "sessions of mature deliberation, should be set aside and "another plan made at so short a notice, without competition, "should be adopted. The President replied that the law left "the selection of these plans to him and that my plan made "no provision for the Post Office. I observed that the General "Post Office should not be in the same block with the Treasury "Department, and that none of these public buildings ought "to be on the President's square. He replied, 'that is a "'matter of opinion.' I then remarked, as to my youth "and inexperience disqualifying me for the superintendency of "these works, that if I was competent to design them, I cer-"tainly could execute them, and that at least I ought to be "allowed to superintend the execution of my own plan—and "that if his rule always prevailed, I should never have that "experience which he had required, but that I had had experi-

"ence; I could refer him to works I had completed with "satisfaction to my employer."

"*July 8.* Was surprised to learn from Major Noland that "the President had ordered the Patent Office to be built on the "southeast corner of reservation No. 8, instead of the centre "of the south side, because he did not wish to disturb the "log cabin of an old squatter on the public land. I "observed that the plan covered the whole square, and that if "his order was carried into effect it would destroy the plan. "That rather than this should take place, I would give the "old woman a residence as long as she lived. He said his "order must be obeyed. The conversation as to the conse-"quences of his order became rather angry. I left him in that "mood, and myself disappointed. I then waited on his par-"ticular friends, Governor Dickerson, Governor Cass, William "B. Lewis, Colonel Bomford, Mr. Ellsworth, and explained "to them the nature of the difficulty, and begged them "to see the President and persuade him to leave the placing of "the building to the Commissioners of Public Buildings and "Patents."

"*July 9.* Saw the Commissioner of Public Buildings and "Commissioner of Patents respecting plan of Patent Office."

"*July 10.* Learned that the President had left Washington "for the Hermitage."

"*July 11.* Received an order from the Commissioner of "Public Buildings to lay down upon the ground the lines of "the Patent Office according to my plan, as the whole subject of "the proper placing of it had been left by the President to his "judgment and the Commissioner of Patents."

"*July 12.* Laid down and marked with pegs the lines of "the Patent Office. Present Messrs. Brown, Wood and several "citizens.

"*July 13.* Called on the Commissioner of Patents and "found Mills with him endeavoring to persuade him to have "the proportions of the plan of the Patent Office considerably "reduced in order to cheapen it, and be able to erect it for "the sum appropriated—portico to be reduced from 100 to 75 "feet in width. I remonstrated against it and finally pre-"vailed."

"*July 14.* Called at the new Patent Office and found Mr. "Brown laying out the trenches for the foundation walls only "four feet wide and two feet deep which I considered quite "insufficient, and so stated at the time."

"*July 21.* Found Major Noland with Mr. Ellsworth per- "suading him to alter plan of the Patent Office. He, however, "did not succeed."

The following letter from Mr. Noland, the gentleman referred to in Mr. Elliot's private journal, is of importance in this connection:

"*Office of Commissioner of Public Buildings,*
"*Dec'm. 29th, 1840.*

"WILLIAM P. ELLIOT, Esq.

"*Dear Sir:* In compliance with your request, I with pleas- "ure state that I was present at the President's mansion in July, "1836, when ex-President Jackson adopted the plan presented "by you for the new Patent Office building and gave written "orders to that effect. I am respectfully,

"Your obt. servant,
"W. NOLAND,
"*C. P. B.*"

THE CONSTRUCTION COMMENCED.

The rebuilding of the Patent Office in accordance with the plan of William Parker Elliot's design adopted by Congress on July 4, 1836, was begun July 12, 1836, and four years were occupied in the completion of the main or south front portion, which did not in 1840 have the wings east and west completed, nor were they commenced at that date. In 1840 the business of the Patent Office was transferred from the City Hall to this new structure. Robert Mills was the superintending or construction architect to carry out the plan of Mr. Elliot, and the well-known late John P. Pepper was superintendent under him. The new building was designed especially for the use of the Patent Office in conformity to the new code of patent laws. Among the private papers of Mr. William P. Elliot is found the very first drawing for the foundation, made in pencil lines, doubtless by the hand of the architect, and also other sketches of earlier date than the sketch for the foundation, as well as estimates of costs, etc., all of which point to him as the originating architect of the entire structure in its general design as it now stands in its grandeur and beauty, and excellent adaptation for the purposes it was designed to subserve.

William Parker Elliot, the architect of the Patent Office, was born at Washington, D. C., January 19, 1807—died in the same city November 3, 1854. Had seven children, of whom Miss Mary E. Elliot, Annie S. Lancaster and Charles A. Elliot survive him. His widow, now critically ill, was Mary Ann Maher, of Philadelphia, Pa.*

Mr. William P. Elliot was paid a small sum—about $500—for his design of the Patent Office, as the public records show. If you would know him, look around you and behold him in his works.

A description of the finished building, with its wings, was given in one of the papers of this city in 1867, as follows:

"The entire completion of the Patent Office building is now "near at hand. Yesterday the portico on the North front was "finished, and now there remains but the granite steps on the "North front and the pavement on G street to be done, and this "building, claimed to be the most handsome in the world, so "far as architectural proportions are concerned, will be, when "completed, a standing monument to the architectural talent "and mechanical ability of the country. In 1849 Thomas "Berry and Frank Mohun entered into contract with the "Government for the building of the East and West fronts, "including the granite and marble. Subsequently Messrs. "Berry & Higgins contracted for the building of the North "front on G street, and this is the portion that is now nearly "completed. All the marble used for the extension of the "building was obtained in Baltimore county, Maryland. The "granite came from Rockland, Maine, Cape Ann, Mass., Con- "necticut and Maryland. The columns used in the porticos "are from a quarry in Baltimore county, Maryland, and are "pronounced very handsome."

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*Mrs. Elliot died shortly after this paper was prepared, and the writer served as one of the honorary pall-bearers at her funeral.

WRONGFUL USE BY OTHER BUREAUS.

At this date the Patent Office building was used by the Secretary of the Interior for the various bureaus that came under the charge of his department; these included the Agricultural, Indian, Land, Pension, Patent and other bureaus.

In order to thus wrongfully use this building, necessitated the cutting up of its interior arrangement to such an extent that, instead of having seventy-two large and well ventilated rooms, there are at the present time two hundred and fifty-two rooms in the Patent Office building, *ninety-nine* of which are occupied by the Patent Office proper and the remainder (*one hundred and fifty-three*) by the Secretary of the Interior, the assistant Attorney General, and the General Land Office. The result of this misuse of the Patent Office has crowded the officials of the Patent Office into an insufficient space for performing their duties, and besides this, many of the rooms occupied by them are so unhealthy and illy ventilated that after a few years of service many of these valuable and useful men die off rapidly. This should not be so, as the Patent Office was designed to be a benefit to inventors and not a detriment to their interests, nor a death-trap to the faithful servants of the Government. It should be set apart as a *monument* to the men of genius who have paid more, above the expenses for carrying it on, than enough for its erection, as the surplus Patent fund in the Treasury of the United States shows. Justice also demands that it should be devoted to the interest of inventors and the comfort of those in charge of the administration of the rights of inventors; and that well lighted and ventilated and healthy accommodations should be provided for the six hundred or more officers employed in the administration of the present business relating to patents for new inventions and discoveries; and to this end every other branch of the Government should be removed from the Patent Office building, and, if the Government is too poor to pay the cost of a new building, let one be erected with the surplus Patent fund now in the United States Treasury, amounting to about four million dollars.

INCREASED CORPS OF EXAMINERS NEEDED.

Furthermore, the force of the Patent Office corps should be increased to at least fifty principal examiners, and as many assistants and clerks as such increased force will require. This done and the government fees somewhat reduced, a step in the right direction in regard to the rights of inventors, will have been taken, and applications for patents could be examined and passed upon more speedily, and inventors thus no longer be kept, by long and vexatious delays, out of their rights, by being deprived of the speedy grant of letters-patent therefor.

THE ORIGIN, NATURE AND EFFECT OF PATENTS.

BY W. C. DODGE, OF WASHINGTON CITY, D. C.

It is not an uncommon thing for even intelligent persons to think and speak of patents as *monopolies*, and to class them with the "odious monopolies" of former times.

A brief statement of their origin and nature will show that such is not the fact.

True, our modern system of patents grew out of the ancient system of monopolies, but they are entirely different in their nature and effect.

A monopoly, which formerly meant "the exclusive right to sell," is a franchise created by the Government, vesting in an individual or corporation the exclusive privilege of practising a certain art, or making, using or selling a certain article, which, but for such monopoly, the public at large would have the right to exercise.

This idea of granting these exclusive privileges originated in the infancy of European commerce, when commercial ventures were attended with great risks both to life and capital, the seas in those days swarming with pirates and the land with robbers.

In those days these exclusive grants were conferred by monarchs upon individuals, companies or particular cities, to induce them to embark in these hazardous undertakings.

As trade increased other monopolies were granted to these same companies or cities for service rendered or money furnished to the State, and in that way they acquired a monopoly of nearly all branches of trade.

The most famous of these was the "Hanseatic League," composed of eighty-five cities of North Germany, and organized about the middle of the thirteenth century, their object being the protection of their commerce from the depredations of pirates and the petty princes, whose theory was that "might makes right."

This league, commencing with a few of the leading cities, soon became very powerful, and by its efforts suppressed piracy and opened new channels of trade in various parts of Europe.

From 1250 to 1278 it established factories and depots in England, Belgium, Norway and Russia, and also had treaties with the commercial cities of Holland, France, Spain and Italy. It established a system of finance and administration that was of great benefit to commerce and trade, in consideration of which it obtained special grants from the leading monarchs of Europe, so that it soon became the dominant commercial power of the world, and monopolized nearly all the trade of Europe. It became so powerful that in 1348 it fought and defeated the Kings of Sweden, Norway and Denmark. It deposed Magnus, King of Sweden, and gave his crown to his nephew, Albert, Duke of Mecklenburg. In 1428 it declared war against Denmark and equipped a fleet of 248 ships with 12,000 soldiers.

Its growing power and wealth excited the jealousy of the monarchs who had conferred upon it the exclusive privileges by which it had grown so great, and as the naval power of Holland and England had greatly increased, in 1597 its special privileges were withdrawn by England, and gradually by other powers; so that it lost its power and control of trade, and was disbanded about 1630—the monopolies which it had enjoyed being conferred upon subjects of these various countries, especially in England.

At a very early day England manifested her solicitude for trade, and early in the tenth century a law was passed conferring upon every merchant who had made three voyages beyond the sea the dignity of "Thane"; and from the time of William Rufus special privileges were granted for the development of *domestic* trade; and it was under these grants that the powerful trade and merchant "guilds" grew up and flourished until they monopolized and controlled nearly every branch of business.

Up to the middle of the sixteenth century the foreign commerce of England was almost entirely in the hands of foreigners. From that time their privileges were withdrawn and conferred on British subjects.

In the days of the Saxon and Norman kings it was a maxim of the common law, that the King had the right to grant any part of the common property of the nation to one or more individuals of the nation, provided such grant would inure to the public benefit; and under that law grants were frequently made to individuals of the commons or waste lands, on the theory that it was for the public good that such lands should be improved—some of the rights continuing to the present day. The idea was similar to that of our "homestead law," under which a quarter section of the public lands was given to any person who would settle upon and improve the same.

Acting upon this idea of promoting the public interests, and more especially to build up the manufacturing and commercial interests of England, the British monarchs began granting monopolies for limited periods to individuals for any trade or manufacture, *not before known or worked in the realm*, it being thought that that was the best means for securing the introduction of new branches of manufacture and commerce, experience having demonstrated that without some such inducement parties would not be at the trouble, expense and risk of introducing new and untried branches of manufacture.

In the course of time this, like all arbitrary power, overstepped its proper bounds, and these monarchs began to grant for money, to their favorites, exclusive monopolies of business already established in the kingdom—business in which people generally had a right to engage—thus taking from the public at large rights which belonged to it, and conferring them upon particular individuals at the pleasure of the monarch, and that, too, without any reference to the public good.

This was especially true of the Norman kings, and it was this arbitrary exercise of kingly power in many directions, which in 1215 eventuated in wresting from King John that great charter of English liberties—*Magna Charta.*

In *Magna Charta* it was provided among other things as follows:

> "All merchants, *if they were not openly prohibited before*, shall have their safe conduct to depart out of England, to come into England, to tarry in and go in and through England, as well by land as by water, to buy and sell without any manner of evil tolls by the old and rightful customs, except in time of war."

The words, "If they were not openly prohibited before," were always understood and held to mean, "if the trade were not prohibited by a monopoly or grant before it was commenced in England," and up to the time of King John this had been held to be the only legal ground on which such monopolies could be granted.

Five statutes in the reign of Edward III, and one of Richard II, reiterate the substance of this clause of *Magna Charta.*

Notwithstanding these repeated enactments, the monarchs of England continued to grant monopolies *in violation of the law.* Queen Elizabeth was a notorious offender in this respect. She granted to one of her favorites the exclusive right to sell salt in the kingdom, to another the sole right to sell steel, and so on with many articles in common use, and by which the cost of these articles to the public was increased many fold, salt alone being increased in price from sixteen pence to fifteen shillings—*over eleven hundred per cent!*

So intolerable did these abuses become that upon the accession of James I, in 1602, Parliament made a declaration that the King had no right to grant a monopoly for any trade or business already established in the kingdom, to which the King gave his assent. But like his predecessors, he continued to violate the law by granting monopolies to his favorites for money, until finally, in 1623, Parliament passed the famous Statute of Monopolies.

This statute provided that all licenses or privileges for the sole buying, selling or working of anything, etc., should be void, with the exception only that patents not exceeding fourteen years might be granted to the authors of *new inventions.*

By the decision of the English courts *anything not already known in the kingdom* was held to be a new invention, and therefore patentable. In the celebrated case of monopolies, *Darcy vs. Allen*, decided in the time of Elizabeth, it was held that:

> "Where any man, by his own charge or industry, or by his own wit or invention, doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that was never used before, and that for the good of the realm, in such cases the King may grant to him a monopoly patent for some reasonable time, until the subjects may learn the same, in consideration of the good that he doth bring the commonwealth ; otherwise not."

The word "invention" was then held to have a meaning in accordance with its primary derivation from *in venire* "to come in", and hence an inventor was one by whom a new trade or discovery came into the kingdom, whether it was by importation, intuition, or by his own careful working out.

By this statute of Monopolies, the grant of a patent was limited to *new inventions;* and the exception in their favor, it will be observed, was based solely upon the ground of the *benefits conferred thereby upon the nation.*

This exception in the Statute of Monopolies is the foundation of the modern system of patents, which has since been adapted in various forms by nearly every civilized nation of the globe, and which it is safe to say, has been the prime mover in the marvelous progress and development of the past century.

Our patent system is based upon the same idea of *benefit to the public*, and that idea is clearly expressed in the clause of the constitution which confers upon Congress the power,

> "To promote the progress of science and useful arts, by securing for limited times, to authors and inventors, the exclusive right of their respective writings and discoveries."

It was not primarily to benefit the individual, but to *promote the progress of science and useful arts* that this power was conferred, in order that the whole nation might have the benefit of this progress—the benefit to the individual being merely an inducement to him to devote his time, labor, thought and means to aid in the accomplishment of this desired result or progress, by making new inventions.

There is, however, a marked difference between our patent system as embodied in our statutes and that of England; for whereas, the English system gave a patent to the *importer* as well as to the *inventor*, our law gives it to the "first and original inventor" alone.

In order for a person to secure a patent here, the invention must not have been "patented or described in any printed publication in this or any foreign country before his invention or discovery thereof", and must not have been in public use for more than two years. In other words, it must be something that is *actually new as against all the world—something added to the world's knowledge and possessions.* And even then, the grant is made only upon the condition that the inventor shall give such a descriptlon and illustration of his invention as will enable a person skilled in the art to which it belongs, to make and use the same, so that when his patent expires the public shall be put in full possession of the invention.

A patent is therefore simply a contract between the Government and the inventor, by which the Government agrees that if a party will make an invention, and so describe it that the public can make and use it, it will protect him for a limited time (now 17 years) in the exclusive right to make, use and sell the same, a right which I am sorry to say, has not of late years been protected as it ought to be.

From this brief statement it will readily be seen that there is no similarity between a U. S. patent and the "odious monopolies" of former times. Under the old system of monopolies, *rights of which the public were already in full possession, were arbitrarily taken from the public and conferred upon an individual, to the great injury of the public at large.* On the contrary, under our patent system, *the inventor gives to the public something which it never had*, something which it wants, and which but for his efforts and genius it might never have had, or if ever, not for a long time to come, not until some other inventor following on the same line, and spurred on by the same incentive, perchance might produce.

It is difficult to understand why a person who creates or produces a new thing or art, is not naturally entitled to the possession of it, as much as he who builds a house or raises a crop; and many able writers have so contended. An invention however, differs from other property, in that it is more intangible, and far more difficult to protect. As was well said by Commissioner Holt:

> "The citizen can take his stand on the threshold of his home, and with his own right arm beat back those who would invade it; but the rights of the inventor are co-extensive with the limits of the Republic, and may be assailed at a thousand points at the same instant of time. The eyes of Argus would not suffice to discover, nor the arms of Briareus suffice to

resist the assaults of so omnipresent a foe as it is his lot to encounter. The insolence and unscrupulousness of capital, subsidizing and leading on its mercenary minions in the work of pirating some valuable invention held by powerless hands, can scarcely be conceived of by those not familiar with the subject."

For these among other reasons, all civilized nations have adopted the present system of giving to the inventor who complies with the statutory conditions, a patent for a brief period only.

Said Lord Bacon :

> "The introduction of new inventions seemeth to be *the very chief of all human actions.* The benefits of new inventions may extend to all mankind universally; while the good of political achievements can respect but some particular cantons of men ; these latter do not endure above a few ages, the former forever. Inventions make all men happy, without injury to any one single person. Futhermore, they are, as it were, new creations and imitations of God's own works."

As was well said by Hon. W. H. Seward :

> "The exercise of the inventive faculty is the nearest akin to that of the Creator of any faculty possessed by the human mind ; for, while it does not create in the sense that the Creator did, yet it is the nearest approach to it of anything known to man."

"Invention," says Mr. Ray, "is the only power on earth that can be said to *create.* It enters as an essential element into the process of the increase of national wealth, because that process is *a creation* and not a mere acquisition. Hence the most frequent cause of the increase of the national wealth is the increase of the skill, dexterity and judgment, and the mechanical inventions by which national labor is applied."

No better evidence of the truth of this statement can be required than the growth and prosperity of the United States as compared with that of other nations during the past century.

Under the stimulus of our patent system, American inventors have given to the world the cotton gin, the planing machine and wood and metal-working machines of all kinds, the sewing machine, the lathe for turning irregular forms, the perfected steam engine and locomotive, the air brake and automatic couplers, the palace and sleeping car, the street car, the steamboat, the modern plow, the harvester and automatic binder, the elevator, the typewriter, the friction match, the perfected printing press, vulcanized rubber in its myriad applications, boot and shoe machinery, the revolver, the machine gun, the Monitor with its revolving turret, the telegraph, the telephone, the electric light, the electric motor, the insulation of electric conductors, without which the ocean cable were an impossibility, and innumerable other inventions by which machinery is made to do the work of human hands, and contribute to the comfort and happiness of humanity.

In the words of Commissioner Holt:

> "The class of men who have given to their native land and to the world these grand inventions whose beneficent influences tell with measureless power upon every pulsation of our domestic, social, and commercial life, are indeed public benefactors, and may well be pardoned for believing that their wants should not be treated with entire indifference by that body which represents alike the intellect and heart, as it does the material interests of the great country of which they are citizens."

Well did Commissioner Fisher say:

> "No class of our citizens have done more for the glory and prosperity of the nation than the inventors and mechanics of the United States, and they have never been favored children."

What is now needed is the perfection of the system, better and more complete means for carrying it on, and more effectual means for protecting the inventor.

Surely, no person who has studied the subject, and has any just conception of what the system has done and is doing for the growth and prosperity of the country and the world, can for a moment question its beneficence, or ever again class it with the "odious monopolies" of former times.

THE MINOR INVENTIONS OF THE CENTURY.

BY JAMES L. EWIN, WASHINGTON, D. C.

It is well understood that the recent centennial celebration was intended to celebrate our Patent System and its fruits in general, rather than specific inventions. Many individual inventions were, however, necessarily referred to as types and by way of illustration. Some of those which I did not hear mentioned appear to me sufficiently striking and characteristic of the century to render some recognition of them essential to a just and complete review.

Those which have suggested themselves as of this class include the following, viz :

1. The Phonograph and the Graphophone, as among the most amazing inventions of the past century, rendering it possible to transmit sounds of every description, including human speech and song, farther than the telephone is yet able to transmit them, and to preserve them from generation to generation, indefinitely, so as to be reproduced at will.

2. The myriad Coin-Actuated Machines, or "Nickel-in-the-slot" Machines, as they are familiarly termed, illustrating the boundless fertility of that class of inventors who need a seed-thought from some one else to begin with, but given this produce wonders.

3. The Fare-Register, in its various forms, which Colonel F. A. Seely has termed "A mechanical conscience for street-car conductors." Of the numerous types of these machines, two are marvels of perfect construction and adaptation. I refer (a) to the "bell-punch," which, in connection with the noted "trip-slips" of the newspaper paragraphs, provides for registering any variety of fares, transfers and passes, by one and the same simple device carried on the conductor's person, and (b) to what is distinctively known as the "permanent" fare-register or passenger-register, which in one make at least is so guarded against fraudulent manipulation that the conductor is provided with means for wiping out the record against him on

the face of the machine, by resetting the trip-register or primary counting device to zero at will, without any danger that he can thus prevent the machine from keeping a correct and unmistakable tally of every fare he has "rung up." Very ingenious recorders have also been patented and reduced to practical use, whereby the record of each trip of a street-car or like vehicle is obtained on paper in a permanent form.

4. The cheap time-pieces which the century has produced, enabling the poorest boy, if so disposed, to carry a real watch that will keep fairly good time, a good office clock, with alarm and calendar attachments, to be obtained for two or three dollars, and a split-second "stop-watch" suitable for timing horses or machinery, to be obtained for as little as six dollars.

5. The wonderful improvements in weighing scales, dynamometers, testing machines, and the like, which have distinguished the century. One of the members of the recent Congress was Mr. Albert H. Emery, whose inventions in this line deserve recognition, if no others. (See Plate XLIX in *Knight's New Mechanical Dictionary*, and the accompanying letter-press.)

6. Cycles—the various forms of "The Wheel," now ridden by ladies as well as gentlemen, and by old men and children as well as the young and athletic.

7. Cash registers and cash-railways or store-service apparatus, as conspicuous contributions to mercantile "machinery."

8. Some of the wonderful achievements in textile machinery, other than the sewing-machine and the power-loom, whose inventors received due recognition. A member of the Congress communicated to me the very interesting history of the introduction of the manufacture of a French fabric into this country, and the multiplication of the population of a New England neighborhood by fifty within a few years, as the results of an almost microscopic invention, developed for another purpose.

9. Photolithography, and the various other arts whereby the unerring sun is made to do the work of countless artistic fingers with a degree of perfection which could not possibly be reached by human skill.

I was not able to attend all the public sessions, nor to remain throughout all I did attend; and omissions were made to save time in reading some of the papers. It is, therefore, quite possible that some of the above inventions may have been included by some of the able essayists. It is not probable, however, that all the countless "minor inventions of the century," as they may be termed, were even suggested to the average inventor or manufacturer, and some, if not all, of those here mentioned may have been omitted. Others will doubtless suggest themselves to every intelligent reader who knows anything of what has been accomplished in his individual sphere by that wonderful human endowment known as Inventive Genius.

DIED AT PORTLAND, MAINE,

JULY 21ST, 1892,

HONORABLE JOHN LYNCH,

Chairman of the Executive Committee,

PATENT CENTENNIAL CELEBRATION.

Intelligence of the death of Mr. Lynch having been received by the Committee while it was in session, the following resolution was placed on its records and ordered printed in the Memorial Volume:

Resolved, That the members of the Executive Committee of the Patent Centennial Celebration deplore the loss of their associate, whose sagacious counsel and efficient co-operation has proven of the greatest value, not only to the Committee, but to all interests related to the American Patent System.

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Eversman, Ernst A., Toledo.
Fisher, Wm. Hubbell, Cincinnati.
Fleetwood, C. V., Cincinnati.
Gould, Aaron P., Canton.
Kaufman, C. H., Bridgeport.
Marsh, James A., Cleveland.
McClellan, Felix G., Carrothers.
Olney, Chas. F., Cleveland.
Palmer, C. H., Akron.
Palmer, C. O., Cleveland.
Roberts, Edward P., Cleveland.
See, J. W., Hamilton.
Simons, Howard T., Cambridge.
Toulmin, H. A., Springfield.
White, W. J., Cleveland.
Whitely, W. N., Springfield.
Whitter, E. E., Milford Centre.

Pennsylvania.

Allen, Geo., Franklin.
Alsen Finius, Philadelphia.
Automatic French Spring Company, Pittsburg.
Babendlier, A. I., Philadelphia.
Barnaby, Chas. W., Meadville.
Berg, Walter S., Philadelphia.
Bethlehem Iron Company, South Bethlehem.
Boies, H. M., Scranton.
Bonwill, W. G. A., Philadelphia.
Boyd, John T., Erie.
Burnham, Geo., Philadelphia.
Carkhuff, R., Lewisburgh.
Carty, Jerome, Philadelphia.
Cox, Eckley B., Drifton.
Douglass, J. Walter, Philadelphia.
Dudley, Chas. B., Altoona.
Elder, J. T., Philadelphia.
Ely, Theo. N., Altoona.
Emerson, J. E., Beaver Falls.
Emmens, Stephen H., Youngwood.
Eschner, Louis, Philadelphia.
Fraley, Frederick, Philadelphia.
Goodwin, John M., Sharpsville.
Hall, Augustus R., Philadelphia.
Hickman, Louis C., Philadelphia.
Hill, B. B., Philadelphia.
How, W. Storer, Philadelphia.
Howson, Henry, Philadelphia.
Jaques, W. H., South Bethlehem.
Kingsley, John F., Athens.
Kneass, Strickland L., Philadelphia.
Koskul, Frederick, Philadelphia.
Lewis, Wilfred, Philadelphia.
Longsbieth, Edw., Philadelphia.
Lorimer, John H., Philadelphia.
Macbeth, Geo. A., Pittsburg.
Mann, Harry F., Allegheny.
Marquis, C. F., Beaver Falls.
Midgley, Thos., Beaver Falls.
Millhauser, B., Scranton.
Moxham, A. J., Johnstown.
Myers, H. M., Beaver Falls.
Newell, A. W., Bradford.
Pettit, Horace, Philadelphia.
Phillips, C. C., Philadelphia.
Price, J. A., Scranton.
Price, James M., Philadelphia.
Ripple, Ezra H., Scranton.
Schoen, Chas. T., Allegheny City.
Sellers, Coleman, Philadelphia.
Sellers, Wm., Philadelphia.
Shaw, Thos., Philadelphia.
Smith, E. D., Pittsburg.
Smith, John Y., Doylestown.
Stanley, Edward, Bridgeport.
Stewart, W. G., Reading.
Sulzberger, D., Philadelphia.
Travis, W. H., Philadelphia.
Vogt, A. S., Altoona.
Westinghouse, Geo., Jr., Pittsburg.
Wiedersheim, John A., Philadelphia.
S. S. White Dental Mfg. Co., Philadelphia.
Wood, W. D., McKeesport.

Rhode Island.

Corliss, Wm., Providence.
Cottrell, C. B., Westerly.
Gammell, A. M., Providence.
Howard, Henry, Providence.
Miller, Joseph R., Providence.
Reynolds, Edwin, Providence.
Smith, Chas. R., Providence.

South Carolina.

Alanken, C. H., Charleston.
Brotherhood, F., Beaufort.
Duc, Henry A., Jr., Charleston.
Emanuel, Philip Albert, Aiken.
Martin, James N., Newberry.

Tennessee.

Green, M. M., Lynchburg.

UTAH.

Silver, Wm. J., Salt Lake City.

VERMONT.

Butterfield, F. G., Derby Line.
Cooper, Geo., Bennington.
Williams, N. G., Billings Falls.

VIRGINIA.

Barlow, W. H., Charlottesville.
Bartlett, John H., Roanoke.
Sears, W. G., Lynchburgh.

WASHINGTON.

Duryee, Schuyler, Everett.

WEST VIRGINIA.

Creigh, Alfred E., Ronceverte.

WISCONSIN.

Oliver, Garritt H., Kaukauna.

BRAZIL.

Chermont, A. L., Para.

ADDRESSES INCOMPLETE.

John S. Boneville.
John A. Brill.
J. W. Hyatt.
W. H. Miller.
Shoemaker Co.
John Truesdale.
M. A. White.
E. O. Young.

NEWSPAPER COMMENT UPON THE CELEBRATION.

[From the SCIENTIFIC AMERICAN March 12, 1887.]

CELEBRATION OF THE CENTENNIAL OF THE ENACTMENT OF THE PATENT LAWS.

To the Editor of the Scientific American:

The first patent law was enacted in the United States of America on the 10th of April, 1790. I would suggest that inventors meet in 1890 at some place for centennial celebration for the purpose of showing the great progress made by the American genius under the protection of the law. I would like to hear from others.

F. M. SHIELDS.

Coopwood, Miss.

[As the locality for such a convention we would suggest this city. The patent law was passed by the first United States Congress, whose first two sessions met in New York, the first session lasting from March 4 to September 29, 1789, and the second from January 4 to August 12, 1790. An exhibition of inventions of early productions of the pioneers of the arts might be organized in connection therewith, and a really memorable centennial might be celebrated. We echo the sentiment of the last sentence of our correspondent's letter. Others should be heard from.]

[From the SCIENTIFIC AMERICAN, January 24, 1891.]

CELEBRATION OF THE BEGINNING OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM.

The first century of existence of the American patent system has now been completed. In the history of the country there are to be found few more important epochs or more worthy of being adequately signalized. The inauguration of the patent laws marks the beginning of a career of unprecedented prosperity among nations. It indicates the fostering by the federal power of the most distinctive feature of the national character. The many inventions, now nearly half a million in number, set forth in the records of the United States Patent Office are a history of mechanical genius and progress of which our country and the world at large should be proud.

It is hard to believe that those who composed and accepted the constitution of the United States, and those who subsequently amended it, could have foreseen the influence which each paragraph would have on the fortunes of so many millions of people. It is definitely certain that the clauses relating to the patents could never have been supposed to embody the foundations of the edifice that has been based upon them. In the first days of the republic there was but little interest in the subject of invention. The people were largely agricultural in their pursuits, and carried on their work with primitive appliances. Gradually a few patents were taken out, but up to the year 1825, including the first thirty-five years of operation, only 4,183 patents had been issued. The annual number of patents granted gradually increased from ten or twenty per annum to 299 in the year 1825. In 1854 the first great increase is observed, when the number rose from 846 for 1853 to 1,759 for 1854. Since that period they have increased until now over 20,000 are issued annually.

It is not in the mere granting of letters patent that the fostering arm of the government appears most prominent. Entitled by statute to federal protection by the judiciary the rights of patentees have formed one of the great subjects of defense by the highest courts of the land. The district and circuit judges are the first appealed to, but from them case is brought before the United States Supreme Court at Washington. No subject of personal or even international right can find a higher tribunal for adjudication of its claims than is afforded to the right of the inventor.

The highest judges in the land, and those who have obtained the highest reputation as expounders of the law and as interpreters of the intentions of the legislative bodies, have pronounced strongly and unhesitatingly in favor of the inventor. No class of citizens has been the subject of higher encomium from the bench. Those judges who have been most outspoken in their appreciation of the poorly rewarded efforts of mechanical genius have been those who have attained the highest reputation. Numerous attacks have been made upon the system in Congress, but all have met with the same fate, and have failed at an early stage. To-day the nation at large may be thankful in seeing the statutes undisturbed and intact. It is a guarantee of the future progress of the country. The maintenance of laws so fruitful in good in the past promises well for the future, and is the best insurance of the continuance of inventors' efforts. The more enlightened of our legislators have uniformly opposed on the floor of the houses of Congress any impairing of the force and scope of these statutes.

Fortunately we can be said to be entering on this second century under good auspices. The rights of inventors are sustained in the courts and by the houses of Congress. A century of unprecedented work by the inventor now begins. To fittingly celebrate the present epoch, the beginning of the second century of the American patent system, a central executive and advisory committees have been organized at Washington. The *personnel* of the committees includes a long list of names prominent in business and official circles. The Patent Office, United States Senate and House of Representatives, the Smithsonian Institution, the National Museum, United States Geological Survey, the United States Coast and Geodetic Survey, and many other federal bureaus and institutions are represented by their chiefs or other officials.

The centennial of the patent system has passed, because the first patent was granted in 1790. The idea of holding the proposed convention has come a year beyond the proper date for a centennial. It is therefore termed a celebration of the beginning of the second century of the American patent system. The inventor and manufacturer of inventions are appealed to by the committee to hold a fitting celebration in the national capital, to commemorate the entry into the second century of mechanical and scientific progress. They are invited to assist in putting on record the nation's appreciation of the labors of those whose work in the realm of invention has done so much to elevate their country.

It is also suggested that the occasion is a fitting one for organizing a National Association of Inventors, a society for mutual benefit, which it is obvious might accrue in many ways to the members. The committee invite all interested to communicate with their secretary, Mr. J. Elfreth Watkins, U. S. National Museum, Washington, D. C.

[From THE FORUM, March, 1891.]

OUR BARGAIN WITH THE INVENTOR.

A United States patent is a contract. The parties to it are the inventor on the one hand and the people of the United States on the other. The inventor, by a public record, informs the people concerning a useful discovery which he has made, which must be original with him and new in the United States. In return the people, by their letters-patent, secure to him the exclusive right to make, to use, and to sell his invention for a limited number of years. At the end of that period the contract terminates, and the discovery belongs to all the people forever. A patent, therefore, does not flow from the bounty of the community, as might a pension or a subsidy, or a medal. It belongs to the inventor by right. It comes into existence in consequence of the legal establishment of a certain state of facts, namely, that the invention is new, useful, and original with claimant. This disclosure is the consideration on the part of the inventor, who, therefore, gives to the community something of value which it did not before possess. The community gives to the inventor, not something of value which it already had, as where a part of the public domain is patented to a settler, but simply protection. If the invention is valuable so is the protection ; if the invention is worthless the protection is without benefit; thus the contract is reciprocal and evenly balanced. The validity of a patent depends upon the maintenance of the facts established. To determine issues of validity is a function of the United States courts. To determine whether the consideration probably exists, and to make the contract itself is the function of the United States Patent Office. "He who receives an idea from me," wrote Thomas Jefferson, "receives instruction himself without lessening mine; as he who lights his taper at mine receives light without darkening mine." An idea once made known is subject to human control only when incorporate, and therefore it can become the subject of patent only when it is tangible and existent. In the beginning it may be regarded as a marvel; in time it becomes a necessity of life, a manufacture, perhaps the basis of a great industry. In a certain sense the invention then detaches itself from the inventor, for the patent no longer protects only one man in his right, but through him many men in their rights. The patent system of the United States has now completed its one hundredth year. The experience of the century shows that the advantages incident to the patent contract constitute a sufficient incentive, not merely to lead people to publish their inventions, but to make them invent. The number of patents granted yearly has steadily augmented; it is now more than 26,000, and is increasing. Under the fostering protection of patents we have developed, and are developing, inventors as a distinctive national product.

[From the WASHINGTON POST, March 22, 1891.]

THE COMING PATENT CENTENNIAL.

The coming Patent Centennial, the celebration of which will be held in Washington, beginning the 8th of April next, will be one of the most notable and most interesting of such gatherings that has yet been witnessed in America; of its own kind, it will be the most important ever held.

It is the intent of this centennial to celebrate a century of patents in America, a century of progress in mechanical and industrial arts—a century of the most marvelous advancement the world has ever known.

It will be in a peculiar and marked degree a gathering characteristically and representatively American. It will testify, as perhaps no other gathering could testify, to the positive progress, the actual and eminent contributions which America has made to the stock of the mechanical possessions of man.

"To promote the progress of useful arts" was the suggestive title of the act over which Washington, as President, wrote his signature on the 8th of April, 1791. It is difficult at this time to measure or compute the wonderful development which has been made in the hundred years following this enactment, in this most important field of human effort.

When the Congress of the United States decreed to the inventor absolute rights to the products of his ingenuity and skill, the discovery of Benjamin Franklin was not understood, the invention of Watts was all but unused, the innovations of Hargrave and Arkwright were met by angry mobs; the field of centuries was laid bare by the primitive scythe and its wealth won from the chaff by the flail.

Such was the mechanical advancement of mankind in 6,000 years of recorded life.

As in the flash of a single century, such has been the wonderful activity of the age. Scarce is there a known occupation which has not undergone revolutions startling and complete. The means and manner of locomotion and communication, alike on land and sea; of heating and lighting, of production and distribution, the processes of agriculture, manufactures, printing—all have undergone within this narrow span a change so swift, so sweeping that the material world of to-day bears as little resemblance to the material world of Franklin and Washington as the conceptions of Copernicus to the conceptions of the ancient Ptolemy.

To compress history into a sentence, the achievements of the nineteenth century in the field of mechanics compose those of all the centuries of civilization preceding. The history of the century is an Arabian tale, whose most gorgeous fancy and most vivid imagination are surpassed by simple fact.

In this unparalleled activity the achievements of the United States represent the most important, if not the major, part. From this country have come all the greater inventions for which the century will in future times be famous. No other nationality has contributed either in like measure or like value. It is indeed questionable if the inventions of the United States alone, numbering now over 300,000, do not surpass in importance and worth the inventions of all other nations combined.

To review this marvelous work, to consider its value, to note its effect, to look somewhat to the future—this is the province of the coming centennial. It will bring together many brilliant minds. It will mark a great era.

[From the SCIENTIFIC AMERICAN, April 4, 1891.]

THE PATENT CENTENNIAL.

The Congress of Inventors and Manufacturers of Inventions, to be held in Washington on the 8th, 9th and 10th of this month, is certain to be a most enthusiastic and numerously attended assemblage, in every way worthy of such an occasion as the celebration of the beginning of the second century of the American patent system. We have been living in a period which has been distinguished by many noble centennial celebrations, from the great world's exposition in 1876, to celebrate the one hundredth anniversary of the Declaration of Independence, down to the great assembling in New York to mark the corresponding anniversary of the adoption of the Constitution, but it is believed that none of these events have been more memorable, or have been more clearly significant of American progress than will be the celebration to be held in Washington next week. There will be no disinterested onlookers, but in the large attendance, drawn from the remotest quarters of the country as well as from near-by places, and from workers in every industry and every department of science, there will be a keen appreciation of the dignity and the importance of the occasion.

Besides engaging the largest public hall in Washington for the regular meetings, provision has been made for overflow meetings, and it is expected that a far greater variety of subjects will be presented illustrative of the progress of American invention than the projectors had at first anticipated. The programme arranged by the literature committee has been most favorably regarded by all friends of the movement, and the responses from inventors, specialists and prominent men in different sections indicate that the literary entertainment provided will be a most attractive one.

In the accompanying illustrations we present portraits of a limited number of the imposing array of lawyers, judges, administrators, legislators and patent specialists taking part in this centennial celebration, our space being all too small to attempt anything like so full a record as we should like to give.

In such a list we necessarily include the Hon. Samuel Blatchford, a Justice of the United States Supreme Court, who is to deliver an address on "A Century of Patent Law." His decisions in memorable patent cases in the United States Circuit Court, and in other important causes, having during many years always commanded the close attention of all members of the bar, and his promotion to the Supreme Court was generally looked upon as a thoroughly well-earned advancement.

The Hon. John W. Noble, Secretary of the Interior in President Harrison's Cabinet, and thus the direct official head of all our patent business at present, has taken an active part in assisting to make the celebration a thoroughly imposing and representative one. He will personally preside at some of the meetings, and, with other prominent officials, hold receptions especially for inventors and manufacturers and their representatives.

The Commissioner of Patents, Hon. Charles E. Mitchell, of Connecticut, around whose office is centered the great interest of the occasion, is a man of the highest ability, wide influence and exalted character. He is distinguished by his clear judgment, and has previously been a most successful patent lawyer. He has proved himself well qualified for the arduous duties of his office. He is a graduate of Brown University, about fifty-five years of age.

The Hon. Benjamin Butterworth, of Ohio, who is to deliver an address on "The Effect of Our Patent System on the Material Development of the United States," has been so prominently before the public for many years, Commissioner of Patents and as a member of Congress, and a public speaker of great power and influence, that his participation in the celebration will be an important factor. He has been the chairman of the House Committee on Patents, and through many years has worked with energy and discrimination for the protection of the interests of inventors.

Dr. R. H. Thurston, director of Sibley College, Cornell University, who is to speak on "The Inventors of the Steam Engine," has a subject to the elucidation of which he brings a great store of knowledge. His treatment of the matter will be sure to be most instructive and interesting.

The Hon. Carroll D. Wright, Commissioner of Labor, who is to speak on the "Relation of Labor to Invention," has made a practical study of all phases of the labor question from an economic standpoint, and speaks on such questions with an authority everywhere acknowledged. He first made a science of this department of investigation as the organizer of the Massachusetts Bureau of Labor Statistics, and has brought to his present wider field a method and system heretofore unknown.

Dr. John S. Billings, who is to speak on inventions and discoveries in medicine, surgery and practical sanitation, is a United States army surgeon, in charge of the Army Medical Museum. He has an international reputation as a sanitarian, and his recent work on medical bibliography is to-day the leading authority on the subject.

Hon. John W. Daniel, U. S. Senator from Virginia, very appropriately speaks on the New South as an outgrowth of invention and the American patent law. He was born in Lynchburg, Va., in 1842, served in the Confederate service during the war, rising from the ranks to a colonelcy, and since the war has become distinguished as a lawyer and orator.

Dr. Cyrus F. Brackett, Henry Professor of Physics in Princeton College, who is to speak on invention as related to the progress of electrical science, is a widely known authority in this field, and, in conjunction with Professor Anthony, has published a recent book on physics with which many of our readers are probably familiar.

Thomas Gray, of Indiana, who is to speak on telegraph and telephone inventions, is a civil engineer and professor of dynamic engineering in an institute at Terre Haute.

Mr. Ainsworth R. Spofford, of the advisory committee, is the efficient and accomplished Librarian of Congress, and is from New Hampshire, where he was born in 1825. He became the principal Librarian in 1865, having previously served a term as assistant. Mr. Spofford has seen the library grow from about seventy-five thousand to more than half a million volumes, and he has had great influence with successive Congresses in securing legislative action for a proper building for the rapidly accumulating store of books, adequate provision for which has only recently been made, while the plans are but tardily being carried out. He is recognized as a bibliographer of great attainments, and peculiarly fitted for his responsible position.

Mr. J. W. Babson, of the Patent Office, is from Maine, and entered the Interior Department in 1866 as Chief of the Finance Division and Deputy Commissioner of Pensions. He was assigned to the charge of the *Official Gazette* in 1878, and in 1880 was appointed chief of the Issue and Gazette Division, which position he now holds. Of the 54 volumes of the *Official Gazette*, 41 have been published under his direction, and of the 448,000 patents granted by the Patent Office, more than half have been prepared and issued under his charge.

Llewellyn Deane, of Washington, D. C., a member of the Literature Committee, is a native of Maine, and descended from Pilgrim stock. He is a graduate of Bowdoin College, and a lawyer by profession, and makes the patent business a specialty. He was a principal examiner in the United States Patent Office for several years. In earlier years he had considerable legislative experience in Maine. He is actively connected with local scientific societies.

John Lynch, the chairman of the Executive Committee, is a native of Portland, Me., and is engaged in commercial business and interested in manufacturing and railroad enterprises. He was elected in 1864 from the first Maine district (now represented by Speaker Reed) to the Thirty-ninth Congress, and re-elected to the four succeeding Congresses, retiring in 1873. As chairman of committee on "The Causes of the Decline of American Shipping," he submitted a report with bills for the revival of American navigation interests which attracted attention not only in this country but in Europe. He was also the author of bills passed January 27, 1873, extending the life-saving service (then confined to the coasts of Massachusetts and New Jersey) along the whole Atlantic, Pacific, and lake coasts of the United States, and connecting same by telegraph with signal service and light-houses. This is the foundation of the present life-saving service of the United States. Owning a large tract of land near Washington, upon which are beds of terra cotta clay, he established the Potomac Terra Cotta Works, and in connection with this manufacture has made several inventions which have been patented in this country and Europe.

Marvin C. Stone, of the Central Committee, was graduated from Oberlin College, Ohio, in 1872, and began life as a Washington correspondent, representing the New Orleans *Picayune*, the Cleveland *Leader*, and various other journals. Mr. Stone drifted into the manufacturing business, and today employs over four hundred operatives, and paying out considerably over one hundred thousand dollars annually in wages alone. He confines himself to the manufacture of novelties of his own invention. He has taken out a large number of patents on the various articles which he manufactures, but he bases his claim as an inventor especially upon the fountain pen with capillary feed.

Robert W. Fenwick, a patent attorney and a member of the Central Committee, was born in Washington in 1832. His uncle, Benjamin Fenwick, was one of the three who composed the Patent Office corps in 1812–16. Mr. Fenwick studied architecture, civil engineering, and mechanical drawing, and was for seven years employed in the patent department of the *Scientific American* at New York, being afterward similarly employed in charge of our branch office in Washington. Since 1861 Mr. Fenwick has followed business as a patent attorney in Washington. He was called to preside as chairman of the meeting at which it was determined that a celebration of the second century of our patent system should be celebrated in 1891. He was authorized by this meeting to appoint a committee to arrange the programme for the celebration.

George Brown Goode, of the Advisory Committee, was born in New Albany, Ind., 13th February, 1851. He was graduated at Wesleyan University, in 1870, pursued a short post-graduate course at Cambridge, and in 1871 took charge of the organization of the college museum at Middletown. In 1873 received an appointment on the staff of the Smithsonian Institution, and on the organization of the National Museum became its assistant director, and in 1887 assistant secretary of the Smithsonian Institution. The natural history division of the United States Government at the Philadelphia exhibition in 1876 was under his supervision. He was United States commissioner in charge of the American sections at International Fisheries exhibitions in Berlin in 1880 and in London in 1883, and was also member of the Government executive board for the New Orleans, Cincinnati, and Louisville expositions in 1884, and of the board of management and control of the World's Columbian Exposition of 1893. From 1872 until 1887 he was intimately associated, as a volunteer, with the work of the United States Fish Commission. In 1887 he was employed by the Department of State as statistical expert in connection with the Halifax fisheries commission, and in 1879–80 was in charge of the fisheries division of the Tenth Census, and in 1887 was appointed United States Commissioner of Fisheries, resigning the position early in 1888. He has traveled through Europe for the purpose of studying the methods of administration of the public museums, and has made extensive natural history explorations in the Bermudas and Florida. His published papers are numerous, and include, besides several books, about 200 minor titles on topics in ichthyology, museum administration, and fishery economy and American history.

Franklin A. Seely, of Pennsylvania, of the Advisory Committee, was born in 1834, graduated at Yale College in 1855, served in the Federal army during war of the rebellion as assistant quartermaster of volunteers, and was discharged in 1867 with the brevet rank of lieutenant colonel. He was appointed assistant examiner in the Patent Office in November, 1875, and chief clerk of that office in April, 1877. He held the latter office until June, 1880, when he was appointed principal examiner, and put in charge of the classes of invention which had heretofore formed the philosophical division, except electricity, which was made to constitute a separate division. To the new division was added trade marks, which had heretofore constituted a division by itself. Colonel Seely's division has remained substantially the same ever since. When the United States became a member of the International Union for the Protection of Industrial Property, the work of reviewing the Convention of Paris of 1883 was assigned to Examiner Seely, and his interpretations of that instrument have been accepted here and abroad as correct. Since then he has had charge in the Patent Office of all questions arising under the convention, and growing out of international relations, and a year ago was a delegate from the United States to the International Conference at Madrid. Colonel Seely was for many years secretary of the Anthropological Society of Washington, and is at present one of the editing committee of its quarterly publication, the *American Anthropologist*. He has given much time to the study of the philosophy of invention, on which he has published several papers.

George C. Maynard, of the Advisory Committee, is a native of Ann Arbor, Michigan. He was educated in the public schools of that State and studied physics with the late Professor James C. Watson, director of the Michigan Observatory. Commenced telegraphing at the age of fifteen and has been engaged in electrical work ever since. During the war he entered the Military Telegraph Corps, and after the close of the war was chief operator in the Western Union Telegraph office for several years. He organized the telegraph system of the Weather Bureau, and, after two years' service in the signal office, resigned to engage in private business as an electrical engineer, in which he has continued until this time. He has been an extensive builder of telegraph lines, organized, and, for five years, managed the telephone business in Washington, and has been connected with many electrical enterprises. He is a member of the American and English Institutes of Electrical Engineers, president of the "Old Timers'" telegraph society and the Washington editor of the *Electrical Review*.

Hon. Joseph K. McCammon, chairman of the Finance Committee, was born in Philadelphia, October 13, 1845. He graduated in 1865 from the College of New Jersey, at Princeton. In 1868 he was admitted to the bar in Philadelphia; in 1870 appointed register in bankruptcy, and in 1871 special counsel for the United States before the Court of Claims, having special charge of suits in which the Pacific and other railroads were engaged in litigation with the Government. In 1880 he was appointed Assistant Attorney General, and assigned to the Interior Department. In 1881 he was appointed, by President Arthur, Commissioner of Railroads, holding this position with the Assistant Attorney-Generalship. In May, 1885, he resigned from public service, since which time he has been practicing his profession in the city of Washington. He has been president of the Cosmos Club of Washington, and is a member of several learned societies and social organizations.

Alexander T. Britton, of the Advisory Committee, was born in New York City in 1835. He studied law in the office of James T. Brady, and subsequently went to college and graduated at Brown University. He has built up a large law business in Washington under the firm name of Britton & Gray, and in the department of railroad and corporation law has acquired an extended reputation. He was appointed by President Hayes a member of the Public Land Commission, and in that capacity revised and codified the public land laws. Mr. Britton is president of the American Security and Trust Company, and vice-president of the Columbian National Bank.

James T. Du Bois was born at Hallstead, Pennsylvania, in 1851. He graduated at the Ithaca Academy in 1871. President Hayes appointed him consul to Aix-la-Chapelle, Germany, in 1877. He was transferred to the consulate at Callao, Peru, in 1883, and to the consulate at Leipsic during the same year. In 1889 Mr. Du Bois established the *Inventive Age* at Washington, D. C. He has been an earnest promoter of the patent centennial celebration.

J. Elfreth Watkins, of the United States National Museum, Washington, has been the efficient secretary of the organization committee, and taken upon himself a large amount of the necessary detail work.

Dr. J. M. Toner, of Washington, a member of the advisory committee, has also been an active and efficient promoter of the movement for this celebration.

[From THE INVENTIVE AGE, Washington, April 7, 1891.]

WORDS OF WELCOME.

With pardonable pride, and in per fect accordance with "the eternal fitness of things," *The Inventive Age* extends most cordial greeting to the inventors and all others who have come to Washington to attend the centennial of invention—the inauguration of the second century of invention under the stimulating protection of the American Patent System. This journal is both proud and glad that the success of the celebration is assured. The fitness of a welcoming address in these columns resides in the fact that, but for this journal, for its original suggestion of this centennial and its incessant efforts to promote it, no such gathering would have occurred. Of all the centennials that have been celebrated in the United States since 1876 none have been worthier of the world's notice, none more replete with great suggestions, none has noted more remarkable achievements than this will celebrate. The dawn of our national prosperity began with the inauguration of the patent system. Until the laws recognized property in ideas, in new discoveries, in all genuine products of inventive toil, there was no other inducement than philanthropy for men to devote their time or means to invention. Philanthropy does not support families. The consciousness of doing good will not take the place of food, raiment or shelter. It was necessary to guarantee opportunities for acquiring wealth in order to develop the inventive talent of the nation. The patent system gave that guaranty, and then the nation started on such a career as has no parallel in all the ages. The recorded facts of our national life show that our increase in wealth and progress in the arts and sciences has been in exact ratio with the progress of invention.

It was never the privilege of any assemblage of citizens in this or any other land to contemplate such results of their own labors as are now before the inventors of the United States. "Their fame is gone out into all the earth and their words to the end of the world." There is not a being in any civilized land on the globe who is not the beneficiary of the American inventors. There is not a life lived that is not happier, not a home that is not brighter, not a day or an hour or a place where the beneficent influence of the American inventors is not felt. Toil has been stripped of its brutality, the gap between the brutal and the human has been widened, the good things of this world have been cheapened so that the poor can enjoy them; life has been exalted and refined; all arts, all industries, in the field of agriculture, commerce, manufactures, mining and other occupations have been beneficently revolutionized by our inventions. Education, religion, the press—art, science, literature—all human interests worth preserving, are the debtors of the inventor. Why should not he and his friends rejoice and be exceeding glad on such an occasion as this centennial?

THE EXECUTIVE COMMITTEE.

HON. JOHN LYNCH, *Chairman.*

Hon. John Lynch, chairman of the Executive Committee, was born at Portland, Maine. He was for many years successfully engaged in foreign commerce with the West Indies and South American States, and was also largely interested in manufacturing and in railroads. In 1861 he was elected a member of the State legislature and represented the first Maine district at Washington in the 39th, 40th and 41st Congresses. This is the district now represented by ex-Speaker Reed. During his congressional career he served on many important committees, such as Banking and Currency, Commerce, Pacific Railroads, Post-Offices and Post Roads, Bankrupt Law. He was chairman of the Committee on Expenditures in the Treasury Department, and chairman of a special Committee on Decline of American Navigation Interests. This committee made a famous report with bills for the revival of shipping interests, and President Grant sent a special message to Congress strongly endorsing the same and urged a favorable action on the bills of the committee. Mr. Lynch was instrumental in securing an extension of our life-saving service, making it the most efficient in the world. Mr. Lynch is a successful inventor and manufacturer. He is president of the well-known Potomac Terra Cotta Company, and his work as chairman of the Executive Committee of the Patent Centennial Celebration has been very valuable.

COL. J. W. BABSON.

Colonel Babson was one of the early active promoters of the Celebration and was unanimously elected chairman of the Central Committee and was also chosen member of the Executive Committee. In the work of both of these committees he has been untiring in his efforts to make the celebration worthy of the important event it commemorates. He was born at Brooksville, Maine, became a student and subsequently a tutor at the Maine Wesleyan Seminary and Female College, and was for a time postmaster at Brooksville. He came to Washington with Vice-President Hamlin in 1861 and was an official of the United States Senate until 1866 when he resigned to enter the Interior Department, where he became chief of the Finance Division, Deputy Commissioner of Pensions. He was assigned to the charge of the *Official Gazette*, the most important patent journal in the world, and upon the absorption of the Issue Division by the Gazette Division he was appointed Chief of the Issue and Gazette Division, which responsible position he still holds with great credit to himself and the Patent Office. Of the 448,000 patents granted by the United States Patent Office more than half have been prepared and issued under his charge.

Colonel Babson has been active in promoting the interests of Washington, as a member of the Citizens' Committee of One Hundred, and was Chairman of its Committee on the World's Fair celebration, making an elaborate report in favor of the National Capital as the site.

SECRETARY J. E. WATKINS.

During the past three months Professor Watkins has been by far the busiest man at the National Capital. The work he has accomplished as general secretary of the Patent Centennial Celebration has been astonishing. His capacity to organize and execute have been tested and proven equal to the task. But very few people know of the difficulties which he and his faithful colleagues on the Executive Committee encountered and conquered in their gallant battle to make the most important event of this century a remarkable success. To Professor Watkins the inventors, manufacturers and all interested in the magnificent industrial development of the country owe a large measure of gratitude for the public spirit and devotion which he has shown in organizing and perfecting the details of the celebration.

J. Elfreth Watkins, C. E., was born in Goochland County, Virginia, in 1852. He graduated at La Fayette College in 1871. In the year 1872 he became mining engineer for the Delaware and Hudson Canal, and in 1873 was appointed assistant engineer of construction for the Pennsylvania Railroad, and was for a time examiner and chief clerk of the Amboy Division. For a number of years he was actively and successfully engaged in journalism, and in 1886 he was appointed Engineer and Curator of Transportation and Engineering in the United States National Museum, Smithsonian Institution, which position he now occupies, having made that department one of the most successful and interesting connected with that great institution. Professor Watkins is the author of a number of valuable works, among which are: "Semi-Centennial History of the Pennsylvania Railroad," "Electrical Train Lighting in England," "Evolution of the American Passenger Car." Aside from these works he has written a number of valuable papers on scientific and historical subjects. Professor Watkins is a member of the Philosophical Society of Washington, also of the Franklin Institute, and the American Society of Civil Engineers.

George C. Maynard.

George C. Maynard, an active and energetic member of the Executive Committee, has been a resident of this city for nearly thirty years. He came from his native place, Ann Arbor, Michigan, during the war, and joined the Military Telegraph Corps, in which he served until it was disbanded at the close of the war. He was chief operator in the Western Union Telegraph Office until 1872, when he was selected by Gen. Albert J. Myer to organize the telegraph system of the Weather Bureau. After two years service in the Signal Office he resigned to engage in private business as an electrical engineer. He assisted Professor Bell in some of his early experiments, was one of the pioneers in the telephone business, and organized and, for five years, managed the telephone exchange in this city. He has been connected with various telegraph, electric light and kindred enterprises. He was a practical telegraph operator before he was fifteen years old, and is now the president of the "Old-Timers" Telegraph Society, also a member of the National Electric Light Association, the American and English Institutes of Electrical Engineers and other scientific societies, and is the Washington editor of the *Electrical Review.*

Marvin C. Stone.

Marvin C. Stone was graduated from Oberlin College, Ohio, in 1872, and began life as a Washington correspondent, representing the New Orleans *Picayune*, the Cleveland *Leader*, and various other journals. He finally drifted into the manufacturing business, and is to-day the largest manufacturer at the National Capital, employing over four hundred operatives, and paying out considerably over one hundred thousand dollars annually in wages alone.

Mr. Stone has taken out a good many patents, all of which have become financially successful; but he bases his claim as an inventor, especially upon the fact that he has given to the world an approved writing instrument, viz: the fountain pen as it is found in the market to-day. In a recent judicial decision in New York in which the court sustained Mr. Stone's patent and granted an injunction and an accounting with costs, Judge Hoyt H. Wheeler, who presided, said: "Stone invented and patented the capillary feed. He invented 'not merely an improvement on the part but the part itself.'"

Mr. Stone invented a pencil sharpener, which is now manufactured in London, England, and has a phenominal sale, not only on the continent but at home. He also invented the steel spring for coat collars, and manufactures millions of straws for lemonade drinking. But perhaps the most successful of all Mr. Stone's inventions is his mouth piece for cigarettes, of which he turns out the enormous quantity of two and one-half millions daily.

THE COMMITTEE ON LITERATURE.

When it was known that Professor George Brown Goode, the Hon. A. R. Spofford and Llewellen Deane, Esq., had consented to take charge of the literary program, all were convinced that the literary side of the celebration would be a grand success. It would have been difficult for the Central Committee to have found three other gentlemen better qualified for the difficult and important task.

The chairman, Professor George Brown Goode, was born in New Albany, Ind., 13th of February, 1851.

He was graduated at Wesleyan University in 1870, pursued a postgraduate course at Cambridge, and in 1871 took charge of the organization of the College museum at Middletown. In 1873 he received an appointment on the staff of the Smithsonian Institution, and on the organization of the National Museum became its assistant director, and in 1887 assistant secretary of the Smithsonian Institution. The natural history division of the United States Government at the Philadelphia exhibition in 1876 was under his supervision. He was United States Commissioner in charge of the American sections at the International Fisheries Exhibitions in Berlin in 1880, and in London in 1883, and was also a member of the executive board for the New Orleans, Cincinnati, and Louisville Expositions in 1884, and is of the Board of Management and Control of the World's Columbian Exposition of 1893. From 1872 until 1887 he was intimately associated as a volunteer with the work of the United States Fish Commission. In 1877 he was employed by the Department of State as statistical expert in connection with the Halifax Fisheries Commission, and in 1879–'80 was in charge of the fisheries division of the Tenth Census, and in 1887 was appointed United States Commissioner of Fisheries, resigning the position early in 1888. He has traveled through Europe for the purpose of studying the methods of administration of public museums, and has made extensive natural history explorations in the Bermudas, and Florida. His published papers are numerous, and include beside several books about 200 minor titles on topics in ichthyology, museum administration, the fishery economy and American History.

THE COMMITTEE ON FINANCE.

HON. JOSEPH K. McCAMMON.

Judge McCammon became chairman of the Finance Committee early in February, and selecting an able committee of public-spirited men, he secured for the guarantee fund in less than six days a sum amounting to nearly ten thousand dollars, and cheerfully asked the committee if they desired any more.

Hon. Joseph K. McCammon was born in Philadelphia, October 13, 1845. He graduated in 1865 from the College of New Jersey, at Princeton. In 1868 he was admitted to the bar in Philadelphia; was a candidate for the Pennsylvania Legislature in 1869. In 1877 he presided over a board to investigate the condition of the Bureau of Indian Affairs. In April, 1880, he was appointed by President Hayes Assistant Attorney General, and assigned to the Interior Department. In 1881 he was designated by President Garfield to negotiate with the Indians on the Fort Hall Reservation, Idaho—the Shoshones and Bannocks—and in 1882 with the Flatheads and other Indians in northwestern Montana. In October, 1881, he was appointed by President Arthur Commissioner of Railroads, holding this position with the Assistant Attorney-Generalship. In May, 1885, he resigned from public service, since which time he has been practicing his profession in the city of Washington. He was chairman of the Reception Committee of President Harrison's Inauguration. He has been President of the Cosmos Club; of Washington, and is a member of several learned societies and social organizations.

COL. A. T. BRITTON.

Col. Britton, the President of the American Security and Trust Company, is the Treasurer of the Patent Centennial Celebration fund, and he has lent valuable assistance in securing the guarantee fund. The excellent work done by Messrs. John C. Poor, Jas. H. Gridley, Reginald Fendall, George C. Maynard and J. W. Whelpley of the Finance Committee, soon placed in the hands of Treasurer Britton the handsome sum of $10,000, and he then asked Judge McCammon, chairman of the committee, if he desired any more funds. When the enterprising men of the National Capital say a thing must go, it glides along to its destination without any interruption of travel worth mentioning.

ROBERT W. FENWICK

Mr. Robert W. Fenwick was the fortunate man who had the public spirit to accept the chairmanship of the Arlington meeting after a number of prominent men had declined. All beginnings are difficult, but now that the difficult beginning has developed into a magnificently proportioned national movement and a splendid success, there is not a man in Washington but what would have felt honored had he been selected to preside over that Arlington meeting from which the organization for the celebration actually sprang. Mr. Fenwick was born in Washington in 1832. His uncle, Benjamin Fenwick, was one of the three persons who composed the entire corps in charge of the United States Patent Office in 1816, and his father, Mr. Robert W. Fenwick, was one of the six persons who constituted the entire force of the office in 1835–'36. Mr. Fenwick was educated in tne public schools of this city, and in 1848 entered the office of Mr. William P. Elliot, the architect of the Patent Office. Subsequently he was engaged by Munn and Company, and for a time had charge of their branch office in this city. Mr. Fenwick was at one time one of the aldermen of Washington, and has been president of the Washington Free Kindergarten.

Brainard H. Warner.

Mr. Brainard H. Warner, who from the first agitation of the subject of the celebration took a deep interest in the movement, is a member of the Central Committee. For twenty years Mr. Warner has identified himself with the progress and best interests of the National Capital. He is at the head of one of the most important real-estate firms in the city of Washington, President of the Columbia National Bank, President of the Washington Loan and Trust Company, a director in a number of other well-known commercial and philanthropic institutions and is one of the busiest and most successful men at the Capital of the Nation.

Myron M. Parker.

Mr. Parker, during many years, has been prominently identified with the business interests of Washington, and was the first president elected to preside over the Board of Trade of this city. He is recognized as one of the eading spirits in the progressive Naional Capital, and has been influential in promoting its welfare. Mr. Parker is a member of the Central Committee.

W. C. McIntire.

Mr. W. C. McIntire, the chairman of the Reception Committee, offered the resolution at the Arlington meeting which suggested the appointment of a Central Committee of seven, whose duty should be to look after the details of the arrangements of the celebration. It was very natural therefore that he should have been chosen as chairman of one of the most important committees, and that the selection was wise is evidenced by the fact that all through the preliminary arrangements for the celebration he has shown much tact and energy, and has secured a committee composed of some of the most prominent and public-spirited gentlemen at the National Capital. The invited guests will find in the members of the Reception Committee a courteous, polite and attentive body of men, who will make their sojourn in our beautiful city an event in their lives that will long be remembered.

Alexander D. Anderson.

The National Capital has many good friends. A few of them are pre-eminently useful friends, and Alexander D. Anderson ranks among the very first of these. For years Mr. Anderson has been devoting much of his very active life to the progress and development of Washington City, which he calls the "Gem city of the world." He it was who long before any other person gave it thought, brought to the attention of the country the propriety of celebrating the quadrennial anniversary of the discovery of the New World, and he named and fought gallantly and long for the National Capital as the most fitting place for the great celebration, and although he lost the battle after a heroic struggle, the Directors of the World's Fair have had the eminently good sense to put him in charge of their Eastern Department, and thus secure the services of the best man in the country for the place. In the earliest efforts of the *Inventive Age* to get the public to favor a celebration of the Beginning of the Second Century of the American Patent System, Mr. Anderson came forward and took an active and influential part, and to him the citizens of Washington, and the inventors and manufacturers of the country owe a debt of gratitude for the early and valuable assistance which he promptly gave to the cause.

W. C. Dodge.

W. C. Dodge is a native of New England. He went West in 1849 and engaged in journalism. In 1851 he was admitted to the bar, and taking an interest in Minnesota politics was sent as delegate to a number of State conventions and was nominated State senator. In the winter of 1860 he was appointed Assistant Doorkeeper of the House of Representatives, and in 1861 the Secretary of the Interior, the Hon. Caleb B. Smith, appointed him Examiner in the United States Patent Office, which position he filled with ability until 1864, when he resigned it and established himself in business at the National Capital. He is an inventor, and has taken out twenty United States patents and several foreign patents. He was presented with a medal by the King of Italy and the King of Spain with a decoration for his inventions in fire-arms and cartridge-loading machine. He was active in trying to secure the adoption by the Government of breech-loading guns, and published an able pamphlet on "Breech-Loaders *vs.* Muzzle-Loaders," in recognition of which the breech-loading gun manufacturers of the country presented him with numerous mementoes. Mr. Dodge has been a persistent and active champion of the patent system, and has often appeared before Congressional committees to protest against obnoxious bills which if passed would have been very injurious to the patent system.

Schuyler Duryee,

Chairman of Committee on Medals and Badges, chief clerk United States Patent Office, born at Pamrapo, N. J., January 13, 1847. Educated in the public schools in New York City, and then followed mercantile pursuits until 1871, when he was appointed in the Adjutant-General's Office of the War Department. In August, 1872, was transferred to the office of the Chief of Engineers, and on November 1, 1872, was placed in charge of the General Record Division in said office. Remained in that position until January 5, 1887, when he was appointed by Hon. E. M. Marble, Commissioner of Patents, as Chief of the Assignment and Copying Division in the United States Patent Office, where he served until he was appointed Chief Clerk of the Office on May 5, 1883. He served as Chief Clerk to Commissioners Marble, Butterworth, Montgomery and Hall, and resigned July 20, 1887, to enter the patent practice. He was reappointed Chief Clerk by Hon. C. E. Mitchell May 2, 1889.

Joseph B. Marvin.

Joseph B. Marvin, of Massachusetts, was appointed Chief of the Draughtsman's Division of the Patent Office to succeed Marcellus Gardner, who died in October, 1888. Mr. Marvin had previously been in charge, for a few months, of the Issue and *Gazette* Division, but, upon Mr. Gardner's death, Commissioner Benton J. Hall selected Mr. Marvin as his successor.

The duties of the position are varied, and require chiefly executive ability.

It was especially in view of Mr. Marvin's experience in the Issue and *Gazette* Division that he was selected for his present position.

The Draughtsman's Division has the custody of all printed copies of patents, of which some 600,000 are sold annually, and nearly as many more are selected for use by Examiners, and for foreign exchange and the Executive Departments.

This Division has the custody of original drawings; accepts or rejects the drawings filed with applications for patents; and, when desired, makes and corrects drawings for applicants. Among the other manifold duties of the Division are the examination of all photo-lithographs of drawings, and the keeping of the record of all such photo-lithography.

Any one visiting this important division and noticing the cramped and crowded condition of the rooms, and the meagre facilities afforded the chief and his large corps of intelligent assistants for the proper discharge of their duties, must wonder how it is possible that the work of this great division of the Patent Office is done so well under the manifold difficulties in which they are performed. Mr. Marvin is a member of the Advisory Committee.

[From the Washington EVENING STAR, April 8, 1891.]

Only the civic framers and the military saviors of a great free state deserve more of the commonwealth than do the inventors as a class. Down at the bottom of things is the original inventor, the man who, by the friction of two pieces of wood, first ascertained that there was fire elsewhere than in the heart of man and the physical center of the universe. Then came the early agriculturists with their plowthongs made of hardened timber tickling the hard surface of the earth in such wise as to cause the laughing soil to give forth of its resources an abundance of provision for primeval man. It was not until cities were formed as nuclei for embryo states that inventive art in its true sense was developed, as other things are developed, out of the necessities and wants of man. Consider the stride from the primitive plow of the akkadians to the McCormick reaper, from the burnt-brick libraries of Babylon and Nineveh to the superb treasures in movable types and sumptuous bindings that stand, piled tier on tier, in the British Museum and the Library of Congress. Looking at civilization in this way and reflecting how impressive even commonplace facts are when lifted into a philosophic system as indices of progress, the primacy of the framers of constitutions that set patterns of civic grandeur for ages and of patriot soldiers may even seem dubious. Hence, when the chief promoters of American inventive art—the inventors and designers and those who put their inventions and designs into every-day use—come to Washington to celebrate the centennary of the patent system of the United States, it is everywhere regarded as a most signal event. This is a practical people—this an age of grand material results. Here, at the political center of the hemisphere, at the capital of the great republic, distinguished for its industrial advancement as well as its intellectual power and the freedom of its institutions, is the true seat of American art, science and learning,

Lafayette in 1824 was the distinguished guest of the republic in the hour of its morning enthusiasm. Patriotism, now as then, mingles with gratitude in our tender of hospitality. The noble Frenchman aided Washington in freeing America from political thralls. These native Lafayettes of industry have aided our later leaders and statesmen in breaking America's bonds of commercial dependence.

[From the Washington EVENING STAR, April 10, 1891.]

The United States have, as an industrial people, considering their youth, eclipsed all history. But the whole Union has not advanced at equal pace and the friction of the delay has retarded the general movement. The great evil of slavery was the fault of the world—the curse chiefly of the States practicing it. The inventive genius of the old slave States has, however, produced three thousand patents during the last twelve months. The mines and manufactures of these communities are no longer toys or experiments. Invention, business wisdom and pluck are planting the banners of progress in the western arid plains as well as on the wasted fields of the south. The present assemblage here of the inventors and manufacturers of patented articles marks the highest point of advantage yet gained in the whole nation's material progress; but this eminence merely permits us a glimpse of the brilliant prospects of future America in this line of development.

[From the WASHINGTON POST, April 10, 1891.]

A NOTABLE CENTENNIAL.

To-day is the hundreth anniversary of the signing by the first President of the Republic of the law which, according to its title, was designed to promote the sciences and useful arts by securing to authors and inventors, for a certain period, the exclusive right of property in their works and inventions, and the occasion is being appropriately celebrated by the convention of prominent inventors from all parts of the country now in session in this city.

The wisdom of the patent law has been amply justified by the results which have followed its enactment through a century of industrial development. From a small beginning the patent system has grown to immense proportions, until to-day it embraces very many of the most important interests of the civilized world. At first its progress was slow, in 1791 but thirty-three patents being issued, and in the subsequent year only eleven. Even in 1836, when the new law was passed which organized the Patent Office substantially in its present form, the number of patents issued was only 109. But as science progressed and as the needs and imperfections of industrial processes came to be understood, their issue greatly increased, keeping pace steadily with the prosperity and marvelous development of the country, until last year the issue amounted to 26,292. The greatness of this growth may be estimated from the fact that the Patent Office, which, from 1802 to 1828, consisted of a superintendent and two clerks, to-day has thirty-six divisions and 600 employes.

The effect of our patent system, as established by law, and administered as an agency of the Government, has been to make our country the natural home of the inventor, and it is more than probable that many of the achievements which mark the progress of the century would not have been made but for the stimulation afforded by it to inventive genius, in the prospect of large and secure pecuniary rewards. That such rewards have frequently followed as the result of inventions is shown in many conspicuous instances, but the excellence of the system is made apparent by the fact that, where immense fortunes have been made in supplying some ingenious contrivance in universal demand, an incalculable benefit has been at the same time conferred upon the great body of the people.

It were needless to observe that all the great mechanical discoveries and the most valuable applications of scientific principles to the useful arts in modern times have had the closest relationship to the operation of the patent laws. To them may be directly attributed the application of steam to navigation, the world-girdling telegraph, the various methods by which electricity is made to produce light and motion and to store and convey sound, the multitudes of inventions which in the home, the workshop, the field, the mine, and the furnace have revolutionzed so many branches of industry and have proved so generally beneficial to mankind—in a word, all those means of material achievement which make our time richer and fuller, more prosperous and more hopeful of progress than all preceding ages.

[From the Washington EVENING STAR, April 11, 1891.]

The banquet given last night by the Board of Trade, commemorative of the centenary of the American patent system and of the laying of the corner-stone of the District, was a notable success. The board of trade takes the place of the common councils of the ordinary city in tendering municipal hospitality to distinguished guests, and Washington has reason to be proud of the hospitable welcome which was last night given in her name to her guests, the inventors of the country.

[From the WASHINGTON POST, April 11, 1891.]

A BRILLIANT BANQUET.

The patent celebration which has been in progress in this city during the week came to a brilliant close at the Arlington Hotel last night with a banquet given by the Board of Trade in commemoration of the Patent Centennial and of the centennial of the founding of the District of Columbia. The occasion was notable not only for the elaborate plan on which it had been projected, but also because every Department of the Government was represeuted by a Cabinet officer or his chief assistant, and the Supreme Court was present in the person of Associate Justice Harlan. At the head of the table sat as distinguished a gathering of men as are to be met with in many a day's travel, while around the handsomely decorated board were the representative merchants of the Capital City. In the menu, decorations, and general appointments the dinner was a memorable one, even in the city where the art of giving dinners has grown to be a science. The responses to the toasts, which concluded the entertainment, were in keeping with the high character of the event. Mr. Myron M. Parker, as the President of the Board of Trade, presided. By his side was the commanding form of Justice Harlan, and near him were Secretaries Foster and Noble, Assistant Secretary of War Grant, Assistant Secretary of the Navy Soley, and Assistant Postmaster General Whitfield.

When the guests had been escorted into the dining-hall they found the tables set for over 200, and the sparkling glass and decorated china, with generous bunches of rare roses in terra-cotta jars, made up a picture worthy of an artist's brush. At each plate was an extremely artistic menu card, bearing a representation of the genius of invention, while the seal of the Patent Office, fastened with blue ribbon in true legal style, formed a unique and striking feature of its ornamentation. It took two hours to discuss the enjoyable feast which had been provided.

[From the WASHINGTON POST, April 11, 1891.]

THE MILITARY PARADE.

Excellent Display Causes Applause All Along the Line of March.

The Avenue was lined during the afternoon with the usual crowd of admirers of the boys in blue, who made a most creditable showing on parade. All the District militia, the troops from Fort Myer and the Arsenal, and the High School Cadets were in line. The soldiers marched in excellent order, and their various evolutions were accomplished with a precision that brought forth applause all along the line. The orders were obeyed with accuracy and skill.

The companies assembled in the White Lot, where they were reviewed by the President, and continued their march along Pennsylvania Avenue. The Third Artillery band, the National Guard band and drum corps, and the band from the Naval Academy, which preceded the High School Cadets, furnished the music.

The battalion of six companies of High School Cadets was one of the most interesting parts of the parade, and it was greeted all along the line of march by well-merited applause from the spectators. Marching in double rank formation, with good broad fronts to the companies, the dress being perfect in both ranks, the boys looked soldierly in every particular. Their discipline and the perfection of their drill reflect credit alike upon themselves and their able instructor, Capt. Burton R. Ross, who has been tireless in his efforts to bring this organization up to the highest standard.

[From THE ELECTRICAL WORLD, April 18, 1891.]

CENTENNIAL CELEBRATION OF THE ESTABLISHMENT OF THE AMERICAN PATENT SYSTEM.

The Congress of Inventors and Manufacturers of Patented Inventions, convened to celebrate the beginning of the second century of the American patent system, met in Washington on Wednesday, Thursday and Friday of last week, as already announced in these columns, and was in every respect a most brilliant success. The gentlemen who worked so energetically and so conscientiously to perfect the numerous arrangements for the celebration may well feel proud of the result.

The weather during the meeting was spring-like and delightful, the papers read and the addresses delivered were by some of our most prominent thinkers and public speakers, and were in keeping with the importance of the occasion. The President of the United States, members of the Cabinet, Justices of the Supreme Court, members of both Houses of Congress, officers of the different engineering societies—electrical, mechanical, civil and mining—distinguished educators and many other staunch friends of the patent system, testified by their presence their interest in its preservation and development. Many of the best known inventors of the country were in attendance, including several whose names have become household words among electricians.

In addition to the interest shown in the proceedings of the congress, an important outgrowth of the celebration was the establishment of a permanent organization of inventors and manufacturers of patented inventions, mentioned more at length in another article in this issue, and from which there is every reason to expect results of a most beneficial character in the years to come.

The first public meeting of the inventors took place on Wednesday afternoon, at 2:30, at the Lincoln Music Hall. President Harrison presided. Beside him on the platform were Secretary of the Interior Noble, Postmaster-General Wanamaker, Chief Justice Fuller and Justices Blatchford and Harlan of the Supreme Court of the United States; Hon. John Lynch, chairman; Prof. J. Elfreth Watkins, secretary; Marvin C. Stone and George C. Maynard, of the Executive Committee of the Centennial Celebration; Hon. Charles Elliott Mitchell, Commissioner of Patents; Senator O. H. Platt, of Connecticut, Chairman of the Senate Committee on Patents, and Hon. Carroll D. Wright, Commissioner of Labor. Among the ladies on the platform was Mrs. Alfred Vail, whose husband (uncle of Mr. Theodore N. Vail of the American Bell Telephone Company) was associated with Professor Morse in the practical development of the telegraph. Prof. A. Graham Bell, inventor of the telephone, with his father, A. Melville Bell, and his father-in-law, Gardiner G. Hubbard, occupied a private box.

Chairman Lynch announced the organization of the congress as completed. The President of the United States had been chosen president of the celebration; Professor Bell represented the electrical industry in the list of vice-presidents, and among the honorary vice-presidents were the following electricians: Prof. William A. Anthony, Charles F. Brush, Thomas A. Edison, Dr. Norvin Green, Gardiner G. Hubbard, Prof. T. C. Mendenhall and Prof. Elihu Thomson.

Professor Watkins, Hon. John Lynch and the other members of the executive committee deserve the highest praise for their unremitting efforts in organizing and carrying out the great work. The residents of Washington, as a whole, particularly the President, the members of the Cabinet, the Board of Trade, whose banquet on Friday night to the members of the principal committees was one of the most noteworthy Washington has ever seen, the various patent officials and patent attorneys, as well as the business men generally, have earned the warmest gratitude of the inventors of the country for the princely manner in which they treated those who attended the congress. The delightful visit tŏ Mount Vernon, the reception by the President and the review of the troops from the White Lot, the reception by Secretary Noble and Commissioner of Patents Mitchell at the Patent Office, and the many other honors showered upon the inventors, make the occasion one that none of those present will ever be likely to forget.

[From THE INVENTIVE AGE, Washington, April 21, 1891.]

IT WAS A GREAT SUCCESS.

Since the one hundredth anniversary of our national independence was fittingly commemorated in Philadelphia fifteen years ago, many centennial celebrations have occurred in various parts of the country. The Federal Government, the governments of States and cities and numerous venerable organizations of citizens have united in celebrating centennial anniversaries of great events. The wealth, the learning, the patriotism and enterprise of grateful millions have cheerfully contributed to make these obervances so memorable that they will stand as historic monuments. But no centennial in all the long and splendid list was more successful than that which occurred in this city on the 8th, 9th and 10th insts. True, it did not bring together great masses of people from all parts of the country, nor was such a gathering hoped for, but it did assemble hundreds of great thinkers, hundreds of men whose achievements are immortal, whose discoveries have been essential factors in the progress of our age.

All things considered, it is safe to say that so distinguished a gathering as that which met in Lincoln Hall to inaugurate the second century of the American Patent System was never before seen in this country. We have had great conventions of scholars, of politicians, of jurists, of professional men, of benevolent associations and of various industrial and social interests. Such meetings have occupied larger space in the daily papers than was accorded this convention, and they have often been wonderfully suc cessful in advancing worthy aims. But that gathering of less than one thousand persons was such an assemblage that the President of the United States might well have felt honored in being called to address it. He and other prominent officials showed a just appreciation of the importance of the event. Statesmen who are worthy of the name recognize the part applied science bears in the development of material resources and in the social, intellectual and moral progress of a people. It is only the narrow-gauge politician—a creature whom not even death can transform into a statesman—that sneers at invention.

The one great feature of the success of this centennial, a feature in which it was incomparably superior to any other celebration in this country or Europe, was its literature. The addresses delivered covered a broader field than was ever before entered upon by any single organization, and there was no shallow plowing. There is no man or woman so high or so low that his or her interests are not embraced in some or all of the papers presented. Taken together these papers constitute not merely a monument to the fame of the inventors of the United States, but a great magazine of facts, clothed in elegant verbal drapery and calculated to exert a lasting influence. When the report of the meetings, including all the addresses, is published, it will be one of the great books of the century, and there is no citizen so wise that he will not be able to draw instruction from it, no worker in any field of honorable effort but will find encouragement and help in its pages. The speakers included men who have long been recognized for profundity of thought and felicity of expression, and they brought the best of their mental stores to this centennial.

Invention—protected invention—invention stimulated and protected by au admirable patent system—has entered upon its second century on a higher plane than it has ever before occupied. As a direct result of this celebration thousands now understand the relations of invention to society, for every ten who, a few weeks ago, knew, or cared to know, anything about the subject. Good seed has been sown over a vast area of fertile soil, and there will be a rapid growth of just appreciation. Hereafter Congressmen will have a popular sentiment behind them pressing for justice to the inventors, and the old, old story of neglect will cease to be repeated. The millions collected from inventors will be expended in promoting the objects for which the patent system was created. Every year of the new century will witness fresh triumphs. The men who celebrate the next centennial in 1991 will look back upon another century as wonderful as that which we review. The good results of the convention of this year will be a theme of discourse for many a decade. As for the *Inventive Age*, which originated this celebration and worked indefatigably to insure its success, it is enjoying that satisfaction which comes of well doing.

AT WASHINGTON'S TOMB.

The large steamer Excelsior moved away from the Seventh street dock at 11 o'clock Friday morning, April 10th, with about one thousand of the happiest, brightest, and brainiest persons that ever sailed over the placid bosom of the broad Potomac. The great saloon running the whole length of the vessel was well filled with cheerful, happy mortals, among whom were Dr. Gatling, the inventor of the Gatling gun ; L. E. Waterman, the inventor of the Ideal fountain pen ; Mr. Plimpton, the inventor of the roller-skate; George Westinghouse, the inventor of the air-brake; the Canadian Commissioner of Patents ; the U. S. Commissioner of Patents ; Congressman Butterworth, J. Thomas Jones, of Utica, N.Y. ; W. J. Johnston, of the *Electrical World;* F. E. Sickles ; Col. J. A. Price ; John A. Milliken, of New York ; E. D. Smith, of Pittsburg ; J. F. Harris, of Fort Edward ; C. C. Linindoll, of Fort

Edward, N. Y., and a large number of well-known inventors and manufacturers.

On the bow of the vessel was the famous naval band of Annapolis, while in the stern was Mr. Pistori's band, and both were kept busy all day long.

On arriving at Mount Vernon the Annapolis band headed the procession and a solemn march was made to the sacred resting-place of Washington, where, with uncovered heads, the visitors viewed the crypt containing the marble sarcophagus of Washington and his wife. The procession then moved on to the beautiful lawn in front of the mansion, where a large photograph was taken. After this the mansion was visited and the relics described. A half hour was given to this part of the program, during which the band played "The Star Spangled Banner" and "My Country, 'tis of Thee." Dr. Toner then delivered an able and very original address from the west piazza of the mansion, to which all of the excursionists paid the closest attention. This address will appear in the Memorial volumes. At the close of Dr. Toner's address a very interesting incident occurred. Col. J.W. Babson, the Chairman of the Central Committee of the Patent Centennial Celebration, presented two bouquets of white and red roses respectively to the Canadian Commissioner of Patents and the United States Commissioner of Patents, who were sitting together upon the piazza overlooking the beautiful lawn to the west of the mansion. These roses had been cut from the greenhouse built by the Father of his Country, and the Canadian Commissioner so appreciated the compliment that when he arrived in Washington he had the flowers carefully preserved and expressed to his Canadian home as a souvenir of his visit to the Centennial Celebration, which he pronounced as the most agreeable and interesting affair that he had ever attended. After the speech of Dr. Toner the Excelsior gave a deep bass warning that it was time to depart in order to reach Washington in time for the reception at the White House and the military review by the President in the White Lot.

On the return Congressman Butterworth distinguished himself and delighted the visitors by delivering one of the wittiest and most charming speeches of his life. He spoke in the bow portion of the broad saloon of the vessel, and the excursionists gathered and packed themselves about him so closely that he had hardly room for his gestures. He was in the best of humor, and in two minutes everybody caught the genial spirit that characterized the speaker, and Mr. Butterworth soon found himself in the midst of an audience that was in close touch with every word he uttered. He spoke as by inspiration. Every sentence fairly reveled in wit. Benjamin Butterworth was at his best. A roar went up when he said that "Ben Franklin, if alive to-day, could not pass a civil-service examination for fourth-class examiner in the electrical division of the Patent Office." They laughed more heartily when he said he used to believe that every inventor was a sort of long-haired genius and the Patent Office a clearing-house for cranks, and he did not know that he was very far from wrong. Then they fairly roared when he added, naively, that there were, of course, no cranks present.

Mr. Butterworth grew more serious as he said that last session he had several wrestles with members of Congress who thought that inventors had no rights which the public were bound to respect, and he hinted that there might be a struggle in the future if the products of a man's brains were to be preserved against communistic theories. He grew eloquent as he insisted that that which a man used he could afford to pay for, and that if a manufacturer saved so many dollars a day by the use of an invention he ought to be made to share with the inventor some portion of his gains. At this sentiment there was, of course, loud applause.

Then Mr. Butterworth took quite an original view of the progress of invention. He said when a boy he had often pondered with awe on the wonders which the mythological gods were said to have performed. "And yet," he said, "everything which had been attributed by fable to these gods was now an every-day affair. The thunderbolts of Jupiter were play-things compared to the mighty missiles thrown by a twenty-inch gun; Neptune never rode the sea with such an armament as that commanded by Farragut; not a blacksmith of to-day would use the tools which Vulcan had; there is not a contractor who would not undertake to accomplish the twelve labors of Hercules and give bond to complete them in half the time the son of Jupiter occupied; and the winged god Mercury could not pack his satchel and start on his errand before Morse would have the message delivered. The fickle Helen, standing on the walls of Troy, could, with a few modern guns, have by the touch of her dainty fingers destroyed all the armies and the fleets of the mighty Greeks."

At the close of Mr. Butterworth's stirring address the Canadian Commissioner of Patents spoke briefly, congratulating the Government and the committees on the success of the celebration, and the inventors of the United States on their splendid patent system, and also upon their individual achievements. When he said that Canada was trying to model her patent system after our own, the enthusiasm of the auditors was unbounded.

The boat reached the wharf at 4 o'clock, and the excursionists hurriedly took the cable-car for the White House, to attend the reception tendered them by the President.

The success of the Mount Vernon trip was largely due to Col. W. B. Thompson, the chairman of the committee on transportation, who personally superintended the arrangements.

RARE COLLECTIONS OF ANCIENT DEVICES AT THE NATIONAL MUSEUM.

The two first talking machines ever made are on exhibition in the lecture hall of the National Museum. There were a great many other curious things gathered in that apartment, put there for the edification and instruction of those who were interested in the Patent Centennial. There was a case full of talking machines, and subscribers who are continually tangling themselves with "central" might have discovered in the interior of one of the instruments the causes of their trouble.

The first talking machine is a small walnut cone divided. The apex is the receiver; the truncated portion the transmitter. Those who ought to know say it talks well, but no company could collect a rental of $90 per annum upon any such looking thing as it is. Bell's liquid transmitter is in the case, and so is the first form of hand telephone. This must have made even the inventor tired, for it is enormously large, and affords a striking contrast to the ear trumpet of the instruments now so common. The first experimental forms of the Blake transmitter were shown, and alongside of them are the component parts of a long-distance telephone. How far this latter will work no one knows. This valuable collection belongs mostly to Professor Bell.

Mr. H. V. Hayes, who arranged the exhibit, talked with his family in their home in Cambridge, Mass., a mere matter of 500 miles. Edison's motorphone was shown in the telephone case.

An antique electrical railway, dating back to 1837, was also one of the interesting curios of the collection, attracting as much general attention, perhaps, as the original telegraph instrument used at the Baltimore end of the line which made S. F. B. Morse and Stephen Vail famous.

A good many people clustered around a big case in the center of the room. The growth of photographic mechanism was there shown. The first camera ever made in the United States—a plain, clumsy, wooden box bearing the date 1839—stood alongside two portable tripod cameras of 1890, and looked much more awkward. In the corner was the contract of partnership between Niepce and Daguerre.

On the upper shelf in the same case a brass cylinder fully two feet in height stood alongside a little scrap of mechanism that could be put in a little boy's vest and unwieldy by contrast. Just below the camera was the gem of the collection—an original daguerreotype of Daguerre. It is in first-class condition and is a better picture than many so-called photographers can produce even now. The big cylinder, which is six inches in diameter, is a "rapid" lens, made in 1846; the other is also a rapid lens, but it was made this year and is only an inch long and an inch in diameter. Both lenses are for the same size plate, viz., 10 by 12 inches.

A hand camera of 1884, for a 5 by 7-inch plate, was big as a full grown valise. Near the specimen in the case is a hand camera of 1890, and it is comparatively a baby in point of size.

The instantaneous "Shutter" that was regarded as perfect in 1858, is nothing but a brass slide with two holes in it for exposures. It is a crude looking affair when compared with the beautiful piece of mechanism alongside it—the instantaneous shutter of to-day, in which the movement of the iris of the eye is precisely imitated and by which as short an exposure as the 150th part of a second is possible.

The development of the signal service weather maps was made plain on a large board, but there is no evidence to show that the weather has improved with the maps. A row of mutilated poker chips was immediately beneath the specimens of ancient and modern meteorological prophecy.

Side by side were the original Joseph Francis life-car and an improved version of the same great invention.

The Ben Franklin hand-press was under glass in the center of the room, and so is a collection of time indicators — sun-dials, clepsydra, hour-glasses and watches. With these latter is a chronoscope, an instrument that can cut a second into 500 parts.

The Steinert collection of musical instruments was another center of attraction, from the earliest key instrument—the clavichord of Mozart and Beethoven's time—through the intermediary harpsichords and pianos down to the modern upright.

A collection of typewriters assembled—not female operators, but the writing machine. Some of them were very clumsy and have an extremely antique appearanee, although none of them are very old.

Guns, revolvers and knives were there in choice variety. The history of electric lighting was made plain, and a good many other lines of endeavor are clearly traced. The collection was one of the most valuable and interesting ever gotten up by the museum authorities. New features were hourly being added, Chief Clerk Cox and Prof. Otis T. Mason being busily engaged in the work of direction.

The collection prepared and arranged by Professor Wilson, curator of the Smithsonian Institution, of ancient devices of various kinds was extremely interesting.

[From the OFFICIAL PROGRAMME, published during the celebration by Mr. Edward H. Allen of Washington.]

In 1790 only three patents were issued by the United States Government. During 18902 7,000 were issued. The conditions of life in 1890 are no more like those of 1790 than the hand loom is like the great cotton factory. What the world owes to the inventor can not be estimated. The credit of much that the world possesses of literature, science and art is due to him. To his credit also stands the greater part of what has been achieved in agriculture, mining and commerce. To him the world owes the difference between what it is and what it would have been if invention had not supplemented the work of nature. It was only fifty years ago that many of the people in this country were clothed from the products of the domestic spinning wheel and hand loom. The itinerant shoemaker went from house to house, setting up his bench and plying his vocation in the farmer's kitchen. There were no planing mills, no shops for the manufacture of doors, sash and blinds. All the work of the builder, including the carpenter's and joiner's work, was done by hand. The railroad and telegraph had not added their powers to the forces of civilization. Books were scarce, newspapers few and of little value, and the home was destitute of a thousand things that now seem indispensable to a comfortable existence. In fifty years the inventive genius of our land has made a change in all this, more wonderful than some of the stories which are told in the Arabian Nights. The best friend of labor is the inventor. He has given to the hands of the toiling millions thousands of avenues to comfort, luxury and wealth. He has opened a continent for the laborer to enter and occupy. He is still taxing his mind and body to devise new ways of benefiting universal humanity. There are hundreds of thousands of well-to-do families in the United States to-day who owe their good fortune to invention, and there are none under our flag who have been compelled to sacrifice anything for invention unless the good of the community in general demanded such a sacrifice. These are all under profound obligations to the inventor. * *

With this able and enthusiastic organization the Executive Committee entered upon its work. Earnest approval and support was met with on every hand. The newspapers of the country and technical journals gave the undertaking their indorsement from the beginning, and by intelligent discussion of the subject rendered invaluable aid in its advancement.

Since the adoption of the Federal Constitution and the organization of the new system of Government therein provided for, no event in time of peace has occurred in the history of the Republic of greater importance than the establishment of the Patent Office one hundred years ago. The most important of the many good results to be brought about by the celebration will be the quickening of thought that must be produced by contact of bright minds engaged in a common effort to make new discoveries.

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