Carbon Foote-Print

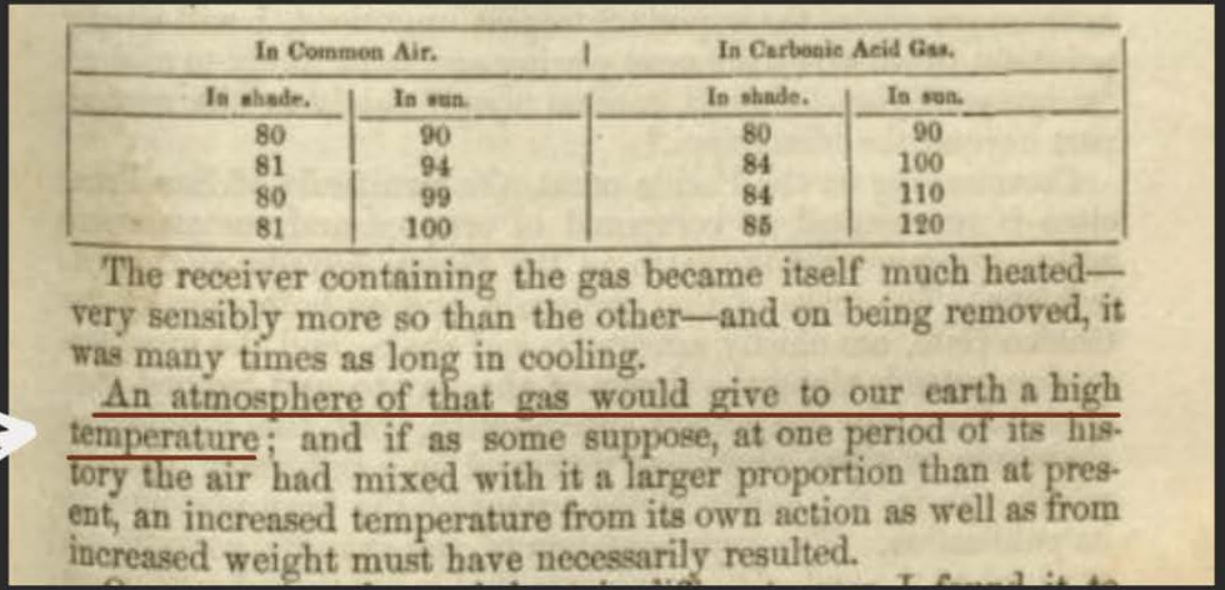
On researching Eunice Newton Foote and her forgotten discovery

Maura Shapiro, University of Pittsburgh

AIP Niels Bohr Library and Archives and Center for History of Physics

In 1856, Foote Discovered the Heat-absorbing Property of Carbon Dioxide and Water Vapor

Here, she predicts global warming



In Common Air.		In Carbonic Acid Gas.	
In shade.	In sun.	In shade.	In sun.
80	90	80	90
81	94	84	100
80	99	84	110
81	100	85	120

The receiver containing the gas became itself much heated—very sensibly more so than the other—and on being removed, it was many times as long in cooling.

An atmosphere of that gas would give to our earth a high temperature; and if as some suppose, at one period of its history the air had mixed with it a larger proportion than at present, an increased temperature from its own action as well as from increased weight must have necessarily resulted.

"On the heat in the sun's rays"
Published in the *American Journal of Science and Arts,* 1856

Despite her groundbreaking conclusions, her name and discovery were forgotten

"Possibly Eunice Newton Foote, or one of her daughters, or a friend."

-WKSU website

Eunice Newton Foote

1819-1889

Foote was born in Goshen, Connecticut to Theriza Newton and Isaac Newton Jr., a distant relative of Isaac Newton but grew up in Bloomfield, New York.

She attended Troy Female Seminary which had a science curriculum and encouraged students to attend lectures at a local men's science college

Foote dedicated much of her life to fighting for women's rights. Both she and her husband, Elisha Foote attended the 1848 Seneca Falls convention and signed the *Declaration of Sentiments*

Why didn't Foote recieve credit for her discovery?

Joseph Henry presented her paper at the 1856 AAAS Meeting

“Although the experiments were interesting and valuable, there were [many] [difficulties] encompassing [any] attempt to interpret their significance”

-Joseph Henry, 1856

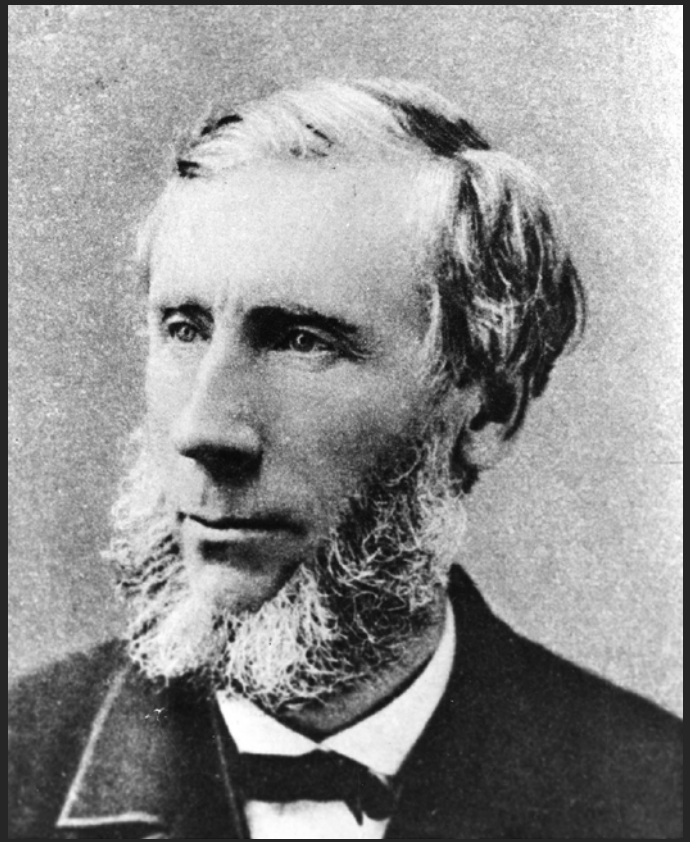
Portrait of Joseph Henry

Historical Context

America’s Identity Crisis
Industrialism, westward expansion, and slavery forced many to reckon with social disparities.

New American Scientific Establishment
In the US, there was a greater emphasis on applied sciences and the large scientific bodies that centralized and advocated for science were relatively new.

Physics Flourishing in Europe
There were advancements across the board in electromagnetism, thermodynamics, and classical mechanics.



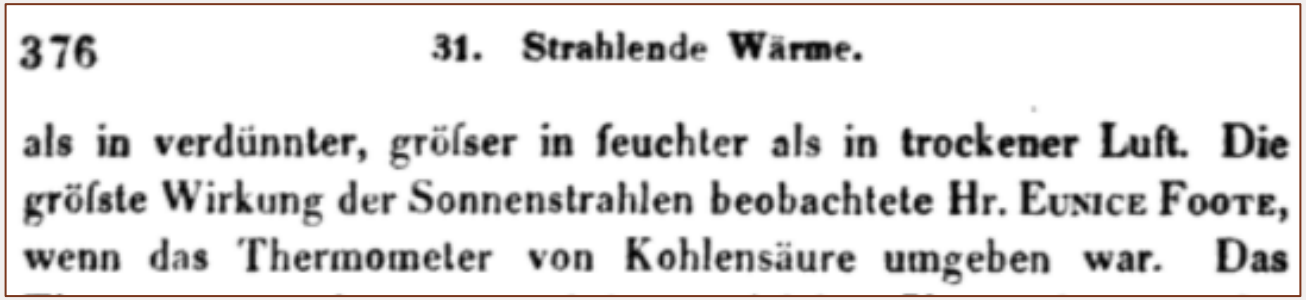
Portrait of John Tyndall

John Tyndall Received Credit

Three years after Foote published her work, in 1859, Irish physicist John Tyndall performed an experiment to measure various gases' reaction to infrared radiation.

He came to the same conclusion as Foote: carbon dioxide and water vapor absorb significantly more heat than other gases.

John Tyndall Should Have Known About Foote's Work…



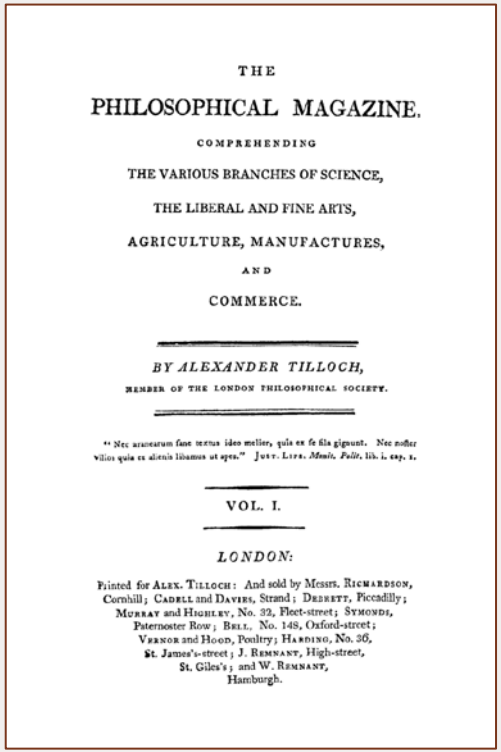
376 31. Strahlende Wärme.

als in verdünnter, gröſser in feuchter als in trockener Luft. Die gröſste Wirkung der Sonnenstrahlen beobachtete Hr. Eunice Foote, wenn das Thermometer von Kohlensäure umgeben war. Das

Shown above in *Jahresbericht*, 1856.

John Tyndall Should Have Known About Foote's Work…

As a member of *Philosophical Magazine's* editorial board, he was scouring other publications to select works to republish. Elisha Foote's, paper which was printed directly before Eunice Foote's in the *American Journal of Science and Arts,* was chosen. **It was unlikely that he would have read one without seeing the other.**



THE

PHILOSOPHICAL MAGAZINE.

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum sane textus ideo melior, quia ex se fila gignunt. Nec noster vilior quia ex alienis libamus ut apes." Just. Lips. *Monit. Polit.* lib. i. cap. 1.

VOL. I.

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...but there is no proof he (or anyone else) did.

He does not mention her in any correspondence

He fights for priority for the same discovery with his contemporary and friend, Gustav Magnus.

His results were treated as the first of its kind

Upon reading his paper, William Thompson, later known as Lord Kelvin, remarked that the results were "novel."

He generally supported overlooked scientists

He advocated for multiple scientists he felt were not getting proper recognition and from his correspondence, it is clear priority was important to him.

"It really is the most curious, the whole thing"

-Sir Roland Jackson, *Royal Society*

Understanding Eunice Foote's 1856 experiments: heat absorption by atmospheric gases

Joseph D. Ortiz and Roland Jackson

Overlooked No More: Eunice Foote, Climate Scientist Lost to History

Happy 200th birthday to Eunice Foote, hidden climate science pioneer

Author: Amara Huddleston

July 17, 2019

EUNICE FOOTE, JOHN TYNDALL AND A QUESTION OF PRIORITY

This Suffrage-Supporting Scientist De-fined the Greenhouse Effect But Did Get the Credit, Because Sexism

Eunice Foote's career highlights the subtle forms of discrim that have kept women on the sidelines of science

Scientists understood physics of climate change in the 1800s – thanks to a woman named Eunice Foote

8.09am EDT

How I spent my summer

On my visit to NBLA with a confused-looking Niels Bohr

Researching Foote

Sorting through archival documents, reading historical publications, and interviewing the experts.

Developing Teaching Guides

Created three teaching guides for middle school and high schoolers to teach Foote's story, the physics of global warming, and the women's suffrage movement.

Writing an Article for Physics Today

More research, more writing, even more editing.

Other projects

Laura Bassi teaching guide, "Which Physicist Are You" Ex Libris Universum, and Wikipedia editing.

Special Thanks

The Experts

Dr. Joseph Ortiz
Kent State University

Sir Roland Jackson
Royal Society

Dr. Scott Smith
University of Pittsburgh

Liz Foote
Environmental Scientists and Activist

The Mentors

Joanna Behrman
Center for History of Physics

Audrey Lengel
Niels Bohr Library & Archives

Corinne Mona
Niels Bohr Library & Archives

The SPS Staff

Brad Conrad

Kayla Stephens

Mikayla Cleaver

The other interns ☺

Scientific American

"Scientific Ladies.-Experiments with Condensed Gases"

Understood the implications

—it rose to 126°. It is believed and taught by geologists that during the period preceding the carboniferous era,—when the coal bed materials were forming—that the atmosphere of the earth contained immense quantities of carbonic acid, and that there was a very elevated temperature of atmosphere in existence, in comparison with that of the present day.

Importance of women in science

The columns of the SCIENTIFIC AMERICAN have been oftentimes graced with articles on scientific subjects, by ladies, which would do honor to men of the highest scientific reputation; and the experiments of Mrs. Foot afford abundant evidence of the ability of woman to investigate any subject with originality and precision.

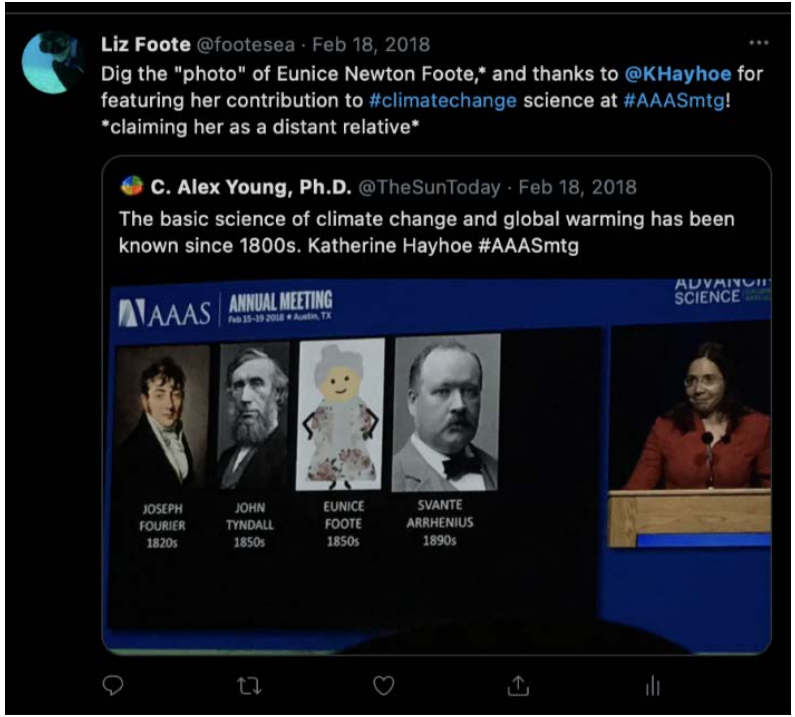
On Foote’s Rediscovery

“Eunice Foote’s Pioneering Research on CO_2 and Climate Warming”

Raymond P. Sorenson, 2011

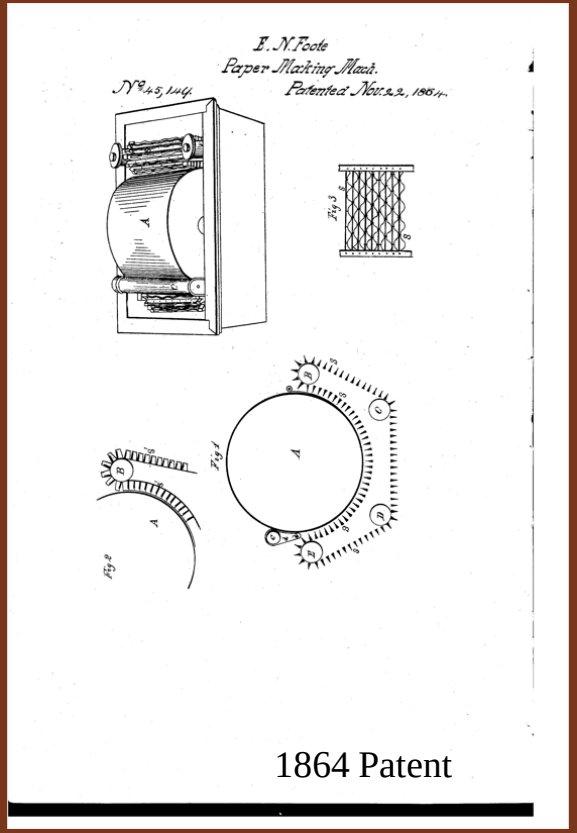
Raymond Sorenson

On What's Happening Now

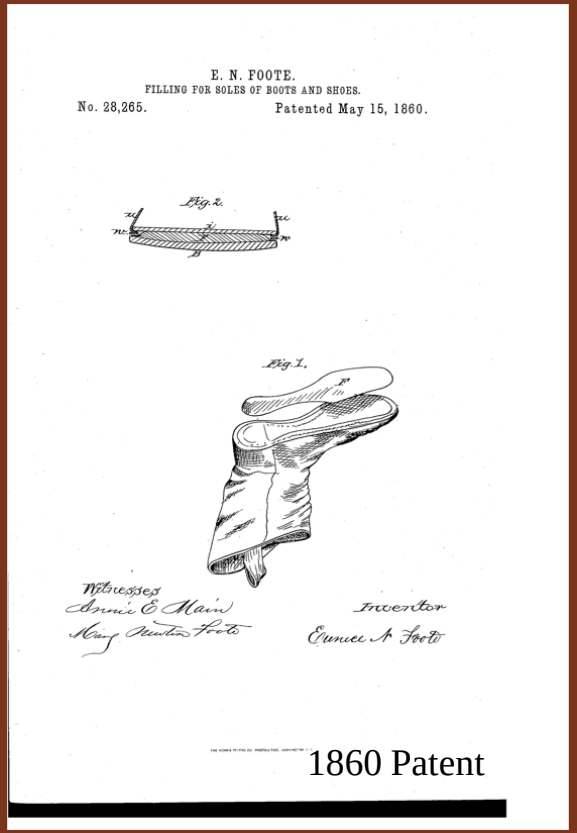


Twitter is connecting scientists, historians, relatives, and everyone else.

Eunice Foote Inventor

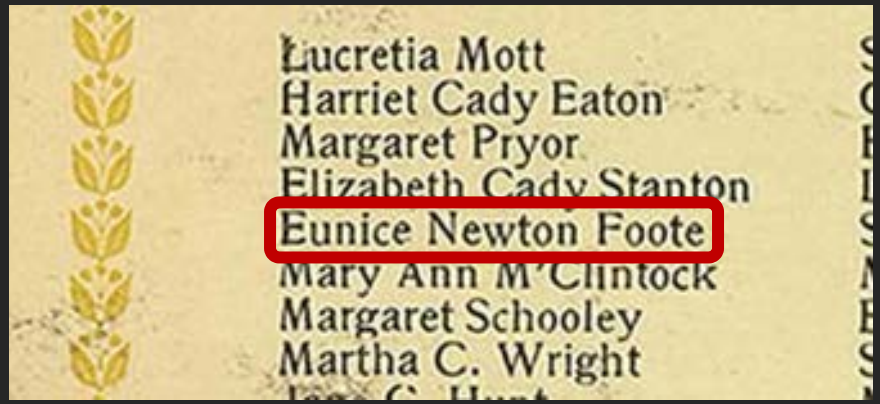


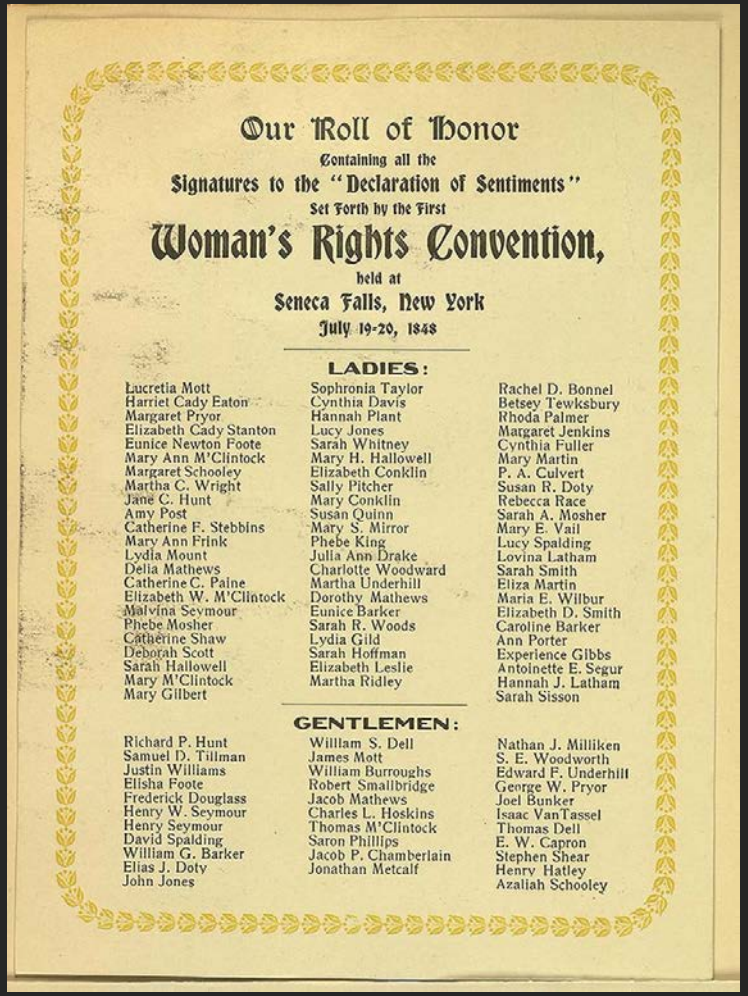
1864 Patent



1860 Patent

Eunice Foote Suffragette





Our Roll of Honor

Containing all the
Signatures to the "Declaration of Sentiments"
Set Forth by the First

Woman's Rights Convention,

held at
Seneca Falls, New York
July 19-20, 1848

LADIES:

Lucretia Mott
Harriet Cady Eaton
Margaret Pryor
Elizabeth Cady Stanton
Eunice Newton Foote
Mary Ann M'Clintock
Margaret Schooley
Martha C. Wright
Jane C. Hunt
Amy Post
Catherine F. Stebbins
Mary Ann Frink
Lydia Mount
Delia Mathews
Catherine C. Paine
Elizabeth W. M'Clintock
Malvina Seymour
Phebe Mosher
Catherine Shaw
Deborah Scott
Sarah Hallowell
Mary M'Clintock
Mary Gilbert

Sophronia Taylor
Cynthia Davis
Hannah Plant
Lucy Jones
Sarah Whitney
Mary H. Hallowell
Elizabeth Conklin
Sally Pitcher
Mary Conklin
Susan Quinn
Mary S. Mirror
Phebe King
Julia Ann Drake
Charlotte Woodward
Martha Underhill
Dorothy Mathews
Eunice Barker
Sarah R. Woods
Lydia Gild
Sarah Hoffman
Elizabeth Leslie
Martha Ridley

Rachel D. Bonnel
Betsey Tewksbury
Rhoda Palmer
Margaret Jenkins
Cynthia Fuller
Mary Martin
P. A. Culvert
Susan R. Doty
Rebecca Race
Sarah A. Mosher
Mary E. Vail
Lucy Spalding
Lovina Latham
Sarah Smith
Eliza Martin
Maria E. Wilbur
Elizabeth D. Smith
Caroline Barker
Ann Porter
Experience Gibbs
Antoinette E. Segur
Hannah J. Latham
Sarah Sisson

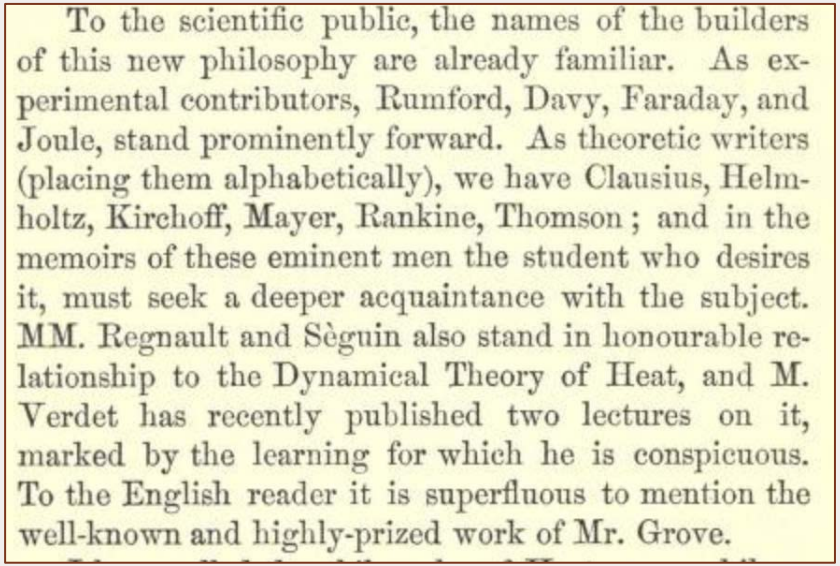
GENTLEMEN:

Richard P. Hunt
Samuel D. Tillman
Justin Williams
Elisha Foote
Frederick Douglass
Henry W. Seymour
Henry Seymour
David Spalding
William G. Barker
Elias J. Doty
John Jones

William S. Dell
James Mott
William Burroughs
Robert Smallbridge
Jacob Mathews
Charles L. Hoskins
Thomas M'Clintock
Saron Phillips
Jacob P. Chamberlain
Jonathan Metcalf

Nathan J. Milliken
S. E. Woodworth
Edward F. Underhill
George W. Pryor
Joel Bunker
Isaac VanTassel
Thomas Dell
E. W. Capron
Stephen Shear
Henry Hatley
Azaliah Schooley

John Tyndall Should Have Known…



To the scientific public, the names of the builders of this new philosophy are already familiar. As experimental contributors, Rumford, Davy, Faraday, and Joule, stand prominently forward. As theoretic writers (placing them alphabetically), we have Clausius, Helmholtz, Kirchoff, Mayer, Rankine, Thomson; and in the memoirs of these eminent men the student who desires it, must seek a deeper acquaintance with the subject. MM. Regnault and Sèguin also stand in honourable relationship to the Dynamical Theory of Heat, and M. Verdet has recently published two lectures on it, marked by the learning for which he is conspicuous. To the English reader it is superfluous to mention the well-known and highly-prized work of Mr. Grove.

Heat Considered as a Mode of Motion, 1865

He kept up to date on current literature and cited other physicists in his own work