1 / VOL. 1, NO. 3
THE CHEMICAL EDUCATOR

ISSN 1430-4171
http://journals.springer-ny.com/chedr
10.1007/s00897960039a

Chemistry and History

Some Nineteenth Century Chemistry Teaching Aids

WILLIAM D. WILLIAMS
Harding University
Searcy, Arkansas 72149-0001
wwilliams@harding.edu

Although nineteenth century chemistry was largely descriptive in content, students struggled with some of the same abstract concepts that trouble their modern counterparts. Invisible atoms, formulas, and chemical combinations have always been difficult topics for the beginner. We would expect the modern teacher to illustrate these ideas with models and charts, but what was used in those early classrooms? This paper describes four chemistry teaching aids marketed in the United States in the mid-1800s.

Invisible atoms, formulas, and chemical combinations have always been difficult topics for the beginner.

Jacob Green's Atomic Models, 1834

The 1834 catalog of the Philadelphia firm, Carpenter's Chemical Warehouse, advertised [1]:

> A case containing fifty cubes of wood, differently coloured, and with names and other remarks upon them for explaining the Atomic Theory, and composition of all substances, as arranged by Dr. Green.

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

FIGURE 1. EDWARD L. YOUMANS (1821–1887).

Jacob Green (1790–1841) taught chemistry at Princeton and at Jefferson Medical College of Philadelphia. He wrote two textbooks, *A Text Book of Chemical Philosophy* (1829) and *Chemical Diagrams* (1837), but neither mentioned the set of models. No examples of Green's atomic models are known to have survived to the present.

Youmans' "Chart of Chemistry," 1850

In 1850 Edward L. Youmans (1821–1887, Figure 1) published a "Chart of Chemistry," which presented atoms as squares of different sizes and colors. The area of the squares were proportional to the equivalent weights of the elements, and each different element was a different color. Groupings of the colored squares illustrated the atoms present in common chemicals — essentially a two dimensional model of the formula. The "Chart"

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

was advertised as 4 × 5 feet, in sixteen colors, mounted on rollers, and costing five dollars.

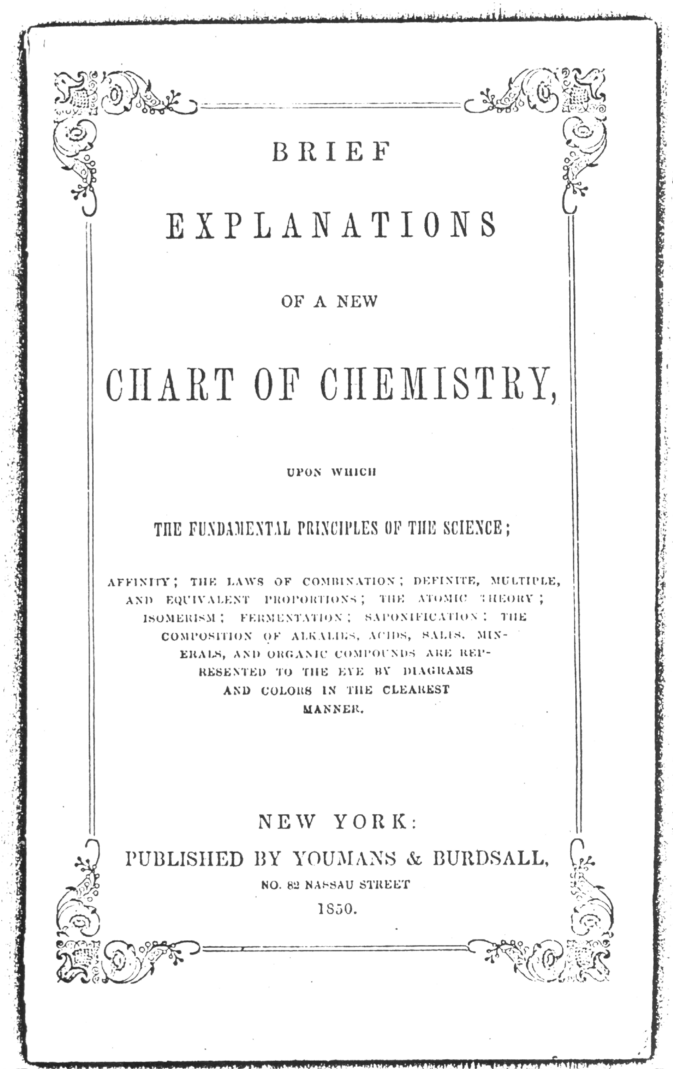
Youmans, who suffered various stages of total and partial blindness, had visualized atoms in a manner similar to his "Chart" when others read chemistry books to him. He felt that such a visual chart would help students who also could not "see" the abstract atoms. He showed his diagrams to a druggist friend, J. R. Burdsall, who became so enthusiastic that he paid Youmans five hundred dollars for a one-fifth interest in a publishing partnership [2]. Youmans wrote a 12-page pamphlet, "Brief Explanations of a New Chart of Chemistry," which accompanied the "Chart" (Figure 2). The preface argued that a chart could help students understand chemistry, just as charts of planets aided in understanding astronomy or as maps helped in understanding geography. Short paragraphs applied the chart illustrations to the law of definite proportions, binary combinations, salts, minerals, organic compounds, and other groups of compounds. He apologized for his brevity [3]:

> The following very brief and imperfect explanations of the "Chart" are offered as an apology for the non-appearance of a completer key, which would have been published with the "Chart", but for the bad health of the author. It is to be issued as soon as possible, and will contain full explanations, together with a synopsis of the most interesting and important points of the science.

Although no copy of the wall chart is known to have survived, the same diagrams were used, in reduced size, as plates in Youmans' later book, *Chemical Atlas* (Ca. 1854 Figure 3) [4]. The *Atlas* plates printed some of the squares in solid color (oxygen in red, hydrogen in purple, carbon in black), while the squares for the other atoms were printed with a thin black outline and then hand colored with what looks like water colors. (See Figure 4.) There were 14 pages of plates, each 9 × 11 inches, which, when enlarged, would have filled the 20 square feet of the wall chart. The *Atlas* also contained 80 pages of detailed discussion. The thirteen diagrams were titled:

- Metalloids and their compounds
- Metals and their compounds with oxygen
- Composition of salts
- Chemistry of geology (with earth strata)
- Examples of isomerism
- Compound radicals, types and pairing
- Homologous series of compounds

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7



BRIEF

EXPLANATIONS

OF A NEW

CHART OF CHEMISTRY,

UPON WHICH

THE FUNDAMENTAL PRINCIPLES OF THE SCIENCE;

AFFINITY; THE LAWS OF COMBINATION; DEFINITE, MULTIPLE, AND EQUIVALENT PROPORTIONS; THE ATOMIC THEORY; ISOMERISM; FERMENTATION; SAPONIFICATION; THE COMPOSITION OF ALKALIES, ACIDS, SALTS, MINERALS, AND ORGANIC COMPOUNDS ARE REPRESENTED TO THE EYE BY DIAGRAMS AND COLORS IN THE CLEAREST MANNER.

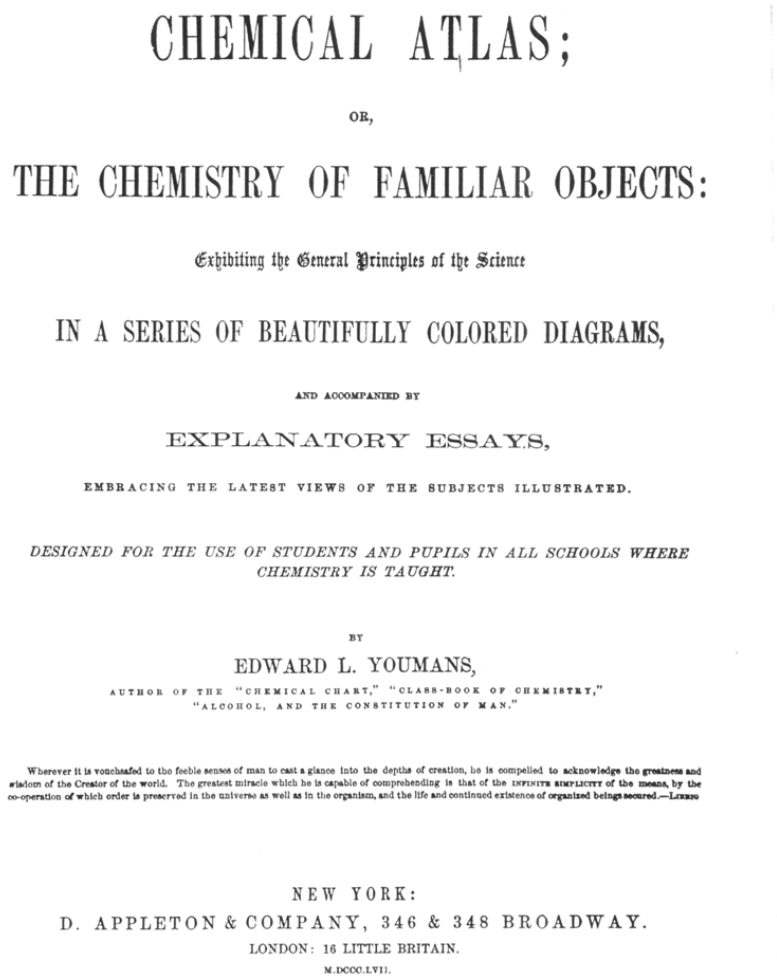
NEW YORK:
PUBLISHED BY YOUMANS & BURDSALL,
NO. 82 NASSAU STREET
1850.

FIGURE 2. COVER PAGE TO THE PAMPHLET “CHART OF CHEMISTRY” BY EDWARD L. YOUMANS.

- Non-nitrogenized principles of food
- Nitrogenized and sulphurized principles of food.
- Fermentations
- Combustion and illumination.
- Plants, animals and the air (O_2 - CO_2 cycle)
- Structure of solar rays (spectrum)

Another Youmans text, *Class-Book of Chemistry* (1851), was an immediate and long-lasting success. It went through three revisions and many reprints from 1851 to 1889,

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7



CHEMICAL ATLAS;

OR,

THE CHEMISTRY OF FAMILIAR OBJECTS:

Exhibiting the General Principles of the Science

IN A SERIES OF BEAUTIFULLY COLORED DIAGRAMS,

AND ACCOMPANIED BY

EXPLANATORY ESSAYS,

EMBRACING THE LATEST VIEWS OF THE SUBJECTS ILLUSTRATED.

DESIGNED FOR THE USE OF STUDENTS AND PUPILS IN ALL SCHOOLS WHERE CHEMISTRY IS TAUGHT.

BY

EDWARD L. YOUMANS,

AUTHOR OF THE "CHEMICAL CHART," "CLASS-BOOK OF CHEMISTRY," "ALCOHOL, AND THE CONSTITUTION OF MAN."

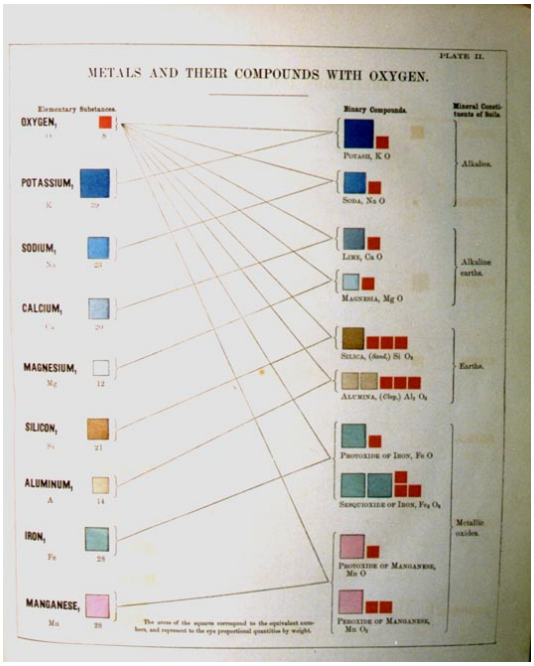
Wherever it is vouchsafed to the feeble senses of man to cast a glance into the depths of creation, he is compelled to acknowledge the greatness and wisdom of the Creator of the world. The greatest miracle which he is capable of comprehending is that of the INFINITE SIMPLICITY of the means, by the co-operation of which order is preserved in the universe as well as in the organism, and the life and continued existence of organized beings secured.—LIEBIG

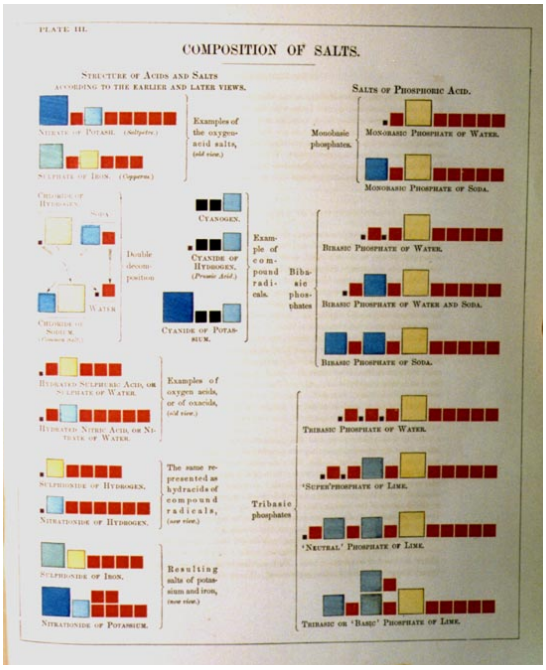
NEW YORK:
D. APPLETON & COMPANY, 346 & 348 BROADWAY.
LONDON: 16 LITTLE BRITAIN.
M.DCCC.LVII.

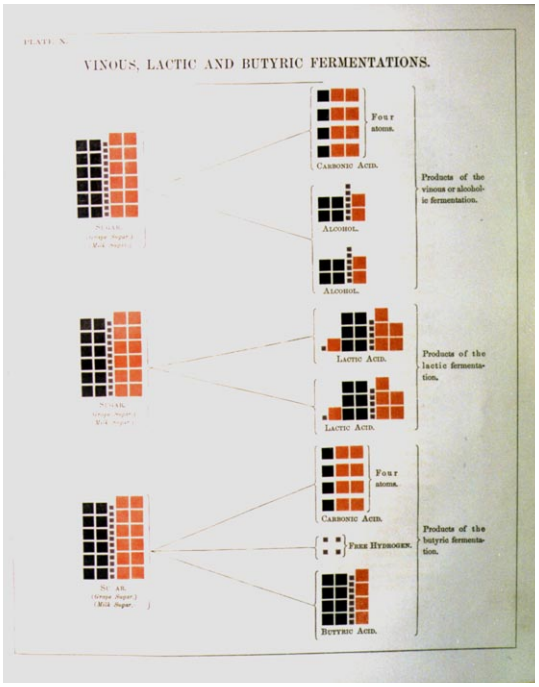
FIGURE 3. COVER PAGE OF "EDWARD L. YOUMANS' *CHEMICAL ATLAS*.

selling 150,000 copies. Such a popular textbook also increased the circulation of the "Chart of Chemistry." Appleton, publishers of the *Class-Book*, took over distribution of the wall chart and published a revised edition in 1858. The new edition was 5 × 6 feet, sold for six dollars, and continued to be advertised as late as 1873. The "Brief Explanations" pamphlet was apparently discontinued after publication of the *Chemical Atlas*. Since the *Atlas* sold for only two dollars and contained the same diagrams plus 80 large pages of explanation, it is difficult to understand why the "Chart" cost six dollars. We assume that it was always printed on heavy paper, but only one reference was found mentioning the material — calling it "beautiful paper" [5].

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7







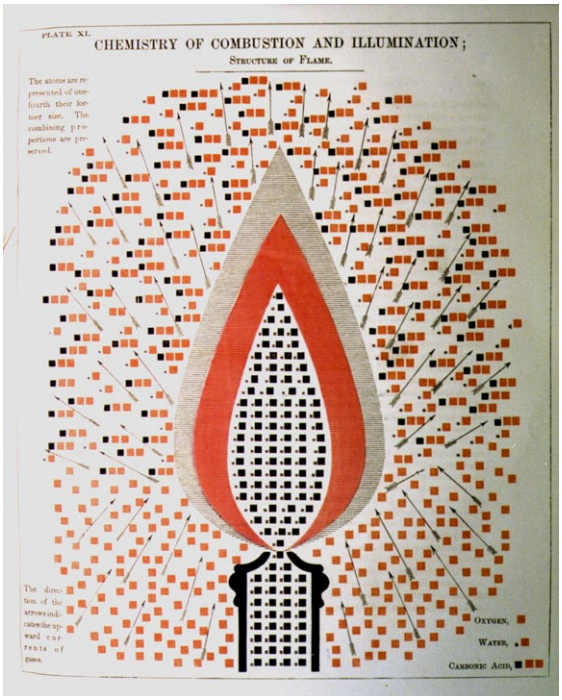


FIGURE 4. FOUR OF THE THIRTEEN DIAGRAMS SHOWN IN YOUMANS' BOOK, *CHEMICAL ATLAS.*

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

The 1850 "Chart of Chemistry" was the first chemistry publication in the United States to use color. The first chemistry book using color appears to have been *General Notions of Chemistry* (1854) by Pelouze and Fremy, which contains thirteen full page colored lithograph illustrations. Even though Youmans' *Chemical Atlas* was copyrighted in 1854, his 1856 *Class-Book* still advertised the *Atlas* as "nearly ready" [6].

Although he was largely self educated and suffered poor eyesight all his life, Edward L. Youmans exerted a significant influence upon the diffusion of science in 19th century America. In addition to his chemistry publications, he wrote *Alcohol and the Constitution of Man* (1854) and *Hand-Book of Household Science* (1857). He edited *The Correlation and Conservation of Forces* (1863), *The Culture Demanded by Modern Life: A Series of Addresses and Arguments on the Claims of Scientific Education* (1867), and Appleton's *International Scientific Series*, which contained more than fifty popular science works by leading American and European scientists. For two decades he was an active lecturer on science topics, traveling widely throughout the United States and Canada. He established and edited *Popular Science Monthly*, where he promoted the need for science education and persuaded eminent scientists to present their work in popular form.

Foster's "Chart of Organic Elements," 1856

W. Foster's "Chart of Organic Elements" was published by Harper and Brothers from 1856 until at least 1872. It was described as "69 by 70 inches with cloth back, beautifully colored and mounted on rollers." It sold for four dollars in 1856 and five dollars in 1864 [7]. Since no copy of the "Chart" is known to still exist, its content is unknown. One would assume that it presented two-dimensional models of organic compounds. Foster wrote a textbook, Foster's *First Principles of Chemistry*, which had two editions, 1855 and 1872. Although the "Chart" was advertised in Foster's books, it was not mentioned in the text.

A biography of Foster has not been located. He was apparently a secondary chemistry teacher in his earlier career. The 1856 printing of his book identified him as "Professor of Chemistry and Geology in Dixon College, Illinois" and the 1872 edition listed him as "A.M., Professor of Natural Science at Levenworth College, Kansas."

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

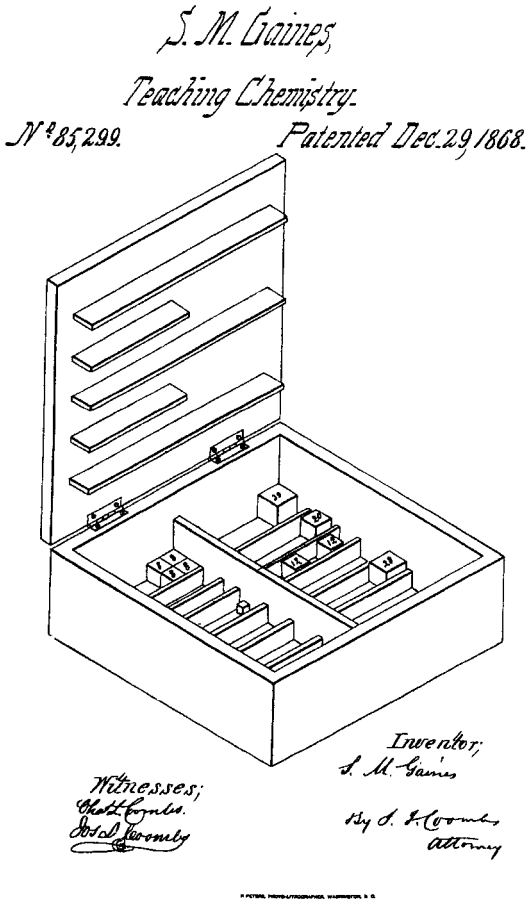


FIGURE 5. A COPY OF THE PATENT GRANTED TO SAMUEL M. GAINES FOR "METHOD OF TEACHING THE RUDIMENTS OF CHEMISTRY."

Gaines' Atomic Models, 1868

In 1868, Samuel M. Gaines of Glasgow, Kentucky was granted U.S. Patent 85299 for a "Method of Teaching the Rudiments of Chemistry." It described a box of models quite similar to those of Jacob Green as shown in Figure 5. Fifteen different elements were represented by cubes of different size and color. Hydrogen was an one-fourth inch cube, colored pink and marked with a 1; oxygen was eight times larger, colored red and marked with an 8; etc. Chemical combinations could be illustrated by grouping the proper cubes. Gaines did not mention Green's models, but he called Youmans' chemical chart "sadly deficient," since the pictures were already prepared and thus demanded no decision by the student. He described the teaching method with his cubes [8]:

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

> If a class be at the recitation bench, and one of them is requested to form carbonic acid, he will walk quickly to the table in front, where the box is open, and place on one of the shelves a cube marked 6 and two marked 8 — carbon, one, and oxygen, two. If requested to form lime, he will place on the shelf a cube marked 20 (calcium) and another marked 8 (oxygen) these being the elements of lime. These cubes being all placed in contact, and the pupil being asked, "What have we now?" answers, "Carbonate of lime."

Gaines was listed in the 1870 census as a school teacher, age 55, at Glasgow, Kentucky. Nothing is known about the production and marketing of his models, but a surviving set is preserved in the National Museums of Scotland [9].

NOTICE: If any readers know of existing copies of any of the charts or models described in this paper, please notify the author or the editor.

REFERENCES

1. Carpenter, G. *Essays on Some of the Most Important Articles of the Materia Medica*; Geo. W. Carpenter's Chemical Warehouse: Philadelphia, 1834; p. 287. The models were not in the 1831 edition of this work.

2. Fiske, J. *Edward Livingston Youmans, Interpreter of Science for the People*; D. Appleton: New York, 1894; pp 62–3.

3. Youmans, E. *Brief Explanations of a New Chart of Chemistry*; Youmans & Burdsall: New York, 1850; p. iv. The only known copy of this work is in the Harvard University Library. The author is grateful for a photocopy.

4. Youmans, E. *A Class-Book of Chemistry*; D. Appleton: New York, 1860; opposite title page states: "The Atlas employs the same mode of illustration in book form as is employed in the 'Chemical Chart'...It is a chart in a portable and convenient form.…" A page from the Atlas is reproduced in Oesper, R. *J. Chem. Educ*. **1957**, *34*, 408.

5. Youmans, E. *A Class-Book of Chemistry*; D. Appleton: New York, 1858; opposite title page.

6. Pelouze, J.; Fremy, E. *General Notions of Chemistry*; J. B. Lippincott: Philadelphia, 1854. Some copies of Pelouze and Fremy contained colored illustrations, while others had almost identical illustrations using uncolored woodcuts. The National Union Catalog lists some copies of Youmans' *Chemical Atlas* as "1854" and others as "1856." It is possible that the "1854" entries were later editions with no date on the title page and merely recorded with the copyright date.

ISSN 1430-4171
http://journals.springer-ny.com/chedr
S 1430-4171 (96) 03039-7

7. See Harper advertisements in: Foster, W. *Foster's First Principles of Chemistry*; Harper and Brothers: New York, 1856 and 1872; p. [xi]; Hooker, W. *Science for the School and Family. Part II. Chemistry*; Harper and Brothers: New York, 1864; ads in back. The 1855 printing of Foster's text did not mention the chart.

8. Gaines, S. "Method of Teaching the Rudiments of Chemistry" U. S. Patent 85299, December 29, 1868.

9. Bryden, D. "George Washington Carpenter: A Philadelphia Supplier of Chemical and Philosophical Apparatus" Rittenhouse, **1994**, *8*(*4*), 97.

10. The portrait of Youmans is from reference 2, frontis.