

An Outline of the History of Chemistry Symbolically Represented in a Rookwood Fountain

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THERE are certain symbols and figures that are typically characteristic of the foremost periods in the History of Chemistry. The reproduction of some of these symbols and figures and their artistic embodiment in a fountain¹ of Rookwood faience has been accomplished in a remarkably unique and harmonious style by the master artists and ceramic craftsmen of the Rookwood Pottery of Cincinnati.

An appreciation of the symbolism of this fountain from the twofold point of view of the *history* and the *motive* of chemistry calls for a brief outline of the motives of the foremost periods in the history of chemistry accompanied by a description of the principal symbols and figures that have marked these periods. The five generally recognized overlapping periods, the predominant ideas in any one being accepted far into another, are approximately as follows:

- 1—*The Prehistoric Period*, from prehistoric times till 1500 B. C.
- 2—*The Alchemical Period*, from 1500 B. C. till 1650 A. D.
- 3—*The Iatrochemical Period*, from 1500 A. D. till 1700 A. D.
- 4—*The Phlogiston Period*, from 1650 A. D. till 1775 A. D.
- 5—*The Quantitative Period*, from 1775 A. D. till 1900 A. D.

The science of chemistry is defined by J. B. Mellor² as "man's attempt to classify his knowledge of all the different kinds of matter in the universe; of the ultimate constitution of matter; and of phenomena which occur when the different kinds of matter react one with another." Since all material transformations, physical or chemical, are accompanied by energy transformations, it follows that the extent of our knowledge of these changes and the ultimate constitution of matter determines the subserviency to mankind of both matter and energy. Accordingly, the motive of the science of chemistry as well as that of other natural sciences has been expressed in a broad and comprehensive sense by a maxim of Galileo Galilei (1564–1642) which is the motto of the fountain: "Let us remember, please, that the search for the constitution of the world is one of the greatest and noblest problems presented by nature." This applies not only to man's search for the ultimate constitution of the atom from the time of the Hindu philosopher, Kanada, 1200 B. C., to the researches of J. J. Thomson, Bohr, Rutherford, and Langmuir, but also to the past and present quests for the limits of the universe which according to the metaphysics of relativity and Einstein may be finite.

Berthelot, in his work, "*Les Origines de l'Alchimie*,"³ writes:

Chemistry is not a primitive science, like geometry and astronomy; it is constructed from the debris of a previous scientific foundation half chimerical and half positive, itself founded on the treasure slowly amassed by the practical discoveries of metallurgy, medicine, industry, and domestic economy. It has had to do with alchemy, which pretended to enrich its adepts by teaching them to manufacture gold and silver, to shield them from diseases by the preparation of the panacea, and finally to obtain for them perfect felicity by identifying them with the soul of the world and the universal spirit.

Egyptian hieroglyphics and picture writings show that many of these practical discoveries were the fruits of Egyptian Alchemy, but the Chaldeans were in fact the pioneers of alchemical science. Although no written record of Chaldean Alchemy has been discovered, we are aware that the number "7" was greatly respected in their philosophy and religion. They recognized seven visible planets, seven gods of heaven, seven gods of earth, and seven devils. The Chaldean philosophy also connected the properties of the seven metals with the influence of the seven planets and both in turn with the functions of the organs of the human body and the destinies of men. Now since these ideas originated in the Prehistoric Period and were maintained throughout the subsequent periods (and are even given credence by some to-day), it is appropriate that the seven Chaldean symbols, which represent simultaneously the seven planets and the seven metals, be embodied in the crowning arch of the fountain. Thus from left to right (Fig. 1) across the top are noted the symbols for the Sun or gold, Venus or copper, Mars or iron, Jupiter or tin, Saturn or lead, the Moon or silver, and Mercury or mercury.

The second and longest period in the history of chemistry, that of Alchemy, extends through thirty centuries—from 1500 B. C. to 1650 A. D. A series of books attributed to Hermes Trismegistus, a native of Babylonia, whom the Egyptians regarded as a god of wisdom, and other ancient records clearly indicate the existence of purely empirical technical arts such as glass-making, pottery, dyeing, painting, tanning, brewing, baking, the preparation of poisons and their antidotes, antiseptics and oils, expressed and distilled. While these are branches of alchemical knowledge, the word "alchemy" is more especially used to designate the manufacture, or better said, the sophistication of silver and gold.

With the development of various technical processes and the effort to transmute the metals, there was associated a great philosophical folly, namely, the search for the philosopher's stone and the elixir of life. Before considering the doctrine of transmutation, the philosopher's stone and related symbolism, it is consequential to note some contributions of the Greek philosophers to alchemical thought. They were not chemists. Few observations or experiments were made because they preferred to argue from general principles to particulars rather than from particular observations to general principles. Nevertheless, they clearly enunciated without any experimental foundation whatever the fundamental principle of all sciences—the law of the conservation of mass—and portrayed qualitatively the atomic constitution of matter.

Empedocles of Agrigento (490–430 B. C.) divided all matter into four elements—fire, air, water, and earth—which were retained in the natural philosophy of Plato (427–347 B. C.) and of Aristotle (384–322 B. C.). It was due to the intellectual prestige of Aristotle that his idea of the transmutation of the four elements became the dominant motive of the period of alchemy. Fire, air, water, and earth were the roots of all things, endowed with the property of being without beginning, indestructible and homogeneous. From the mixtures of these four elements, which carried, respectively, the principal qualities, heat, cold, wetness, and dryness, arose all substances as we perceive them. The properties

¹ Gift of the Senior Engineering Class, 1921, University of Cincinnati, to the Chemistry Building.

² "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," Vol. I, p. 11. Longmans & Co., 1922.

³ Georges Steinheil, Paris, 1885.

of substances were attributed to the fundamental properties of the elements of which they were composed. Hence, elements were transmutable one into the other by the abstraction of certain qualities and the substitution of others.

The transmission of Greek philosophy to the peoples of the west was the result of the conquest of Spain (711 A. D.) by the Arabs, who contributed enormously to the increase of chemical knowledge. Geber,⁴ the 8th century Arabian chemist, developed the Aristotelian conception of the constitution of matter so as to account for the observed differences between the seven metals and to supply a theoretical basis for their transmutation. The four elements of Aristotle were retained as the ultimate constituents but the substances *mercury* and *sulfur* were assumed as the more proximate ones; mercury being the vehicle of the qualities of ductility, fusibility, and luster; and sulfur the bearer of the property of combustibility. Accordingly, the change of one metal into another should consist in the addition or withdrawal of one of the two constituents, sulfur and mercury, or in its purification.

Geber's Two-Principle doctrine held sway for seven centuries. Basil Valentine (second half of the 15th century) added a third principle or element, *salt*, representative of that which is permanent and unaltered by the action of heat. This Three-Principle doctrine became dominant for two centuries. It was accepted entirely by Paracelsus (1493-1540?) who made alchemy the servant of medicine.

The great work of Paracelsus was in effecting a breach with tradition and setting physicians and alchemists free from the bondage in which they were held by convention. He borrowed his medical treatments from barber-surgeons, old women and quacks, and employed powerful and dangerous medicines prepared from mercury, opium, and antimony more boldly and successfully than his predecessors. Paracelsus taught that the object of chemistry was not to make gold but to ameliorate disease. The art of making drugs, the motive of the Iatrochemical Period, thus became one of the original branches of alchemy, but it was frequently obscured by combined searches for the philosopher's stone and the elixir of life.

Paracelsus also promulgated the Three-Principle

⁴ Freund's "Study of Chemical Composition," Cambridge University Press, 1904, and J. Campbell Brown's "History of Chemistry," Churchill, London, 1913, are chief sources in following descriptions.

doctrine so vigorously that it became associated with his name. It is a question whether these three principles—sulfur, mercury, and salt—were accepted by chemists instead of the four Aristotelian elements or alongside with these. Since "elaborate ambiguity, direct contradiction and studied vagueness are the characteristics of alchemical style," it would be useless to attempt to prove anything by directly quoting alchemical manuscripts. Nevertheless, the following excerpt from "A New Light of Alchymia," 1607, by Michael Svandivogius, is typical of medieval speculation relative to the interrelationships of the four elements (Aristotelian), fire, air, water, and earth, and the three principles (Paracelsian), sulfur, mercury, and salt. (Note arrangement of symbols in Fig. 1.)

We will now descend unto the Principles of things. . . . But how they are produced of the four elements, take it thus. . . . The Fire began to act upon the Air, and produced Sulphur, the Air also began to act upon the Water, and brought forth Mercury, the Water also began to act upon the Earth and brought forth Salt. But the Earth since it had nothing to work upon, brought forth nothing, but that which was brought forth continued and abided in it. Wherefore there became only three Principles, and the Earth was made the Nurse and Mother of the rest. . . . These three Principles are altogether necessary because they are the near matter. . . . The remote are the four elements out of which God alone is able to create things. . . . By the due separation, and conjunction of these Nature

produceth as well Metals, as Stones in the Minerall kingdome; but in the Vegetable Kingdome Trees, Herbs, and all such things; also in the Animal Kingdome the Body, Spirit, and Soule, which especially doth resemble the work of the Philosophers. The Body is Earth, the Spirit is Water, and Soule is Fire, or the Sulphur of Gold.

Thus was alchemy in the 16th century complicated by religious ideas. It was even argued that the exact and natural sciences proceed by induction and deduction while the occult and spiritual sciences proceed by analogy. Following out this line of thought the alchemists produced the following remarkable trilogy:

MATERIAL WORLD	
Sulfur	
Mercury	
Salt	
HUMAN WORLD	
Body	
Soul	
Spirit	
DIVINE WORLD	
Father	
Son	
Holy Ghost	

Each of these was a trinity in unity, and a unity in trinity. In each world was a distinct design: in the material, the perfection and the metals; in the human, the

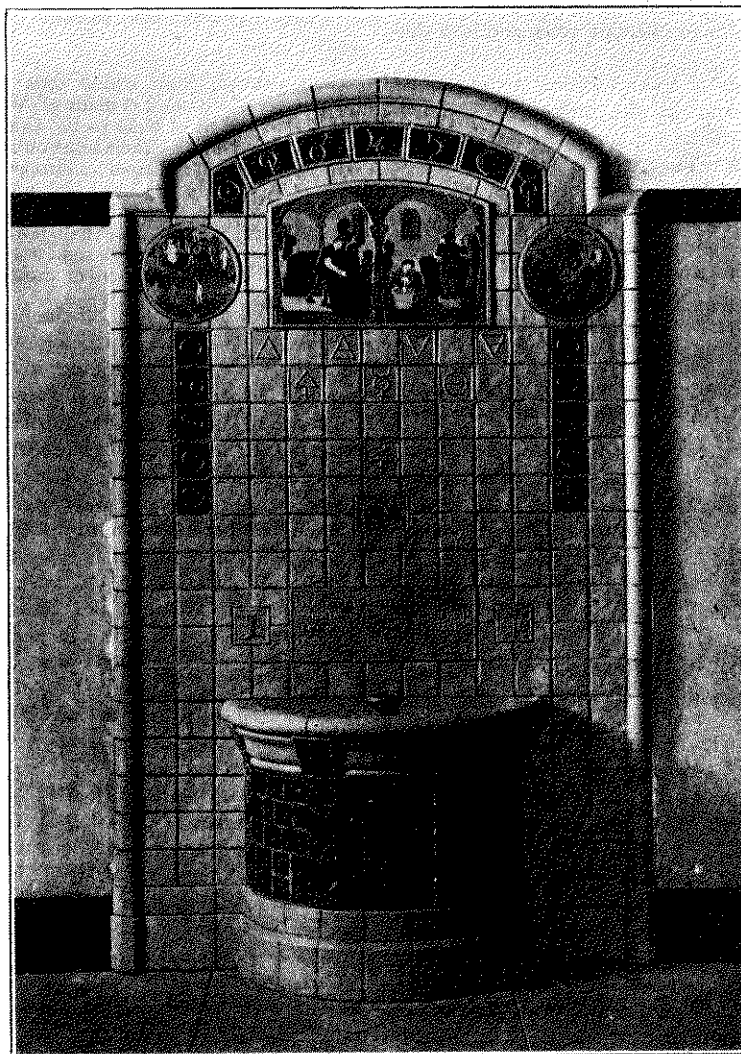


FIG. 1—THE FOUR TRIANGULAR SYMBOLS FROM LEFT TO RIGHT REPRESENT THE FOUR Elements: FIRE, AIR, WATER, AND EARTH. THE THREE UNDERLYING SYMBOLS REPRESENT THE Three Principles: SULFUR, MERCURY, AND SALT. THE SYMBOL FOR Phlogiston IS BELOW THAT OF MERCURY. DIMENSIONS: 5' 2" X 8' 4"

perfection of the soul; in the divine, the contemplation of the Deity in His splendor.

The mystic alchemists interpreted the Three Principles in their own fashion. Mercury, the passive and female principle, was *matter*; sulfur, the active and male principle was *force or energy*; and salt, the middle term in the proposition, was *movement*, which applied force to matter. In other terms, mercury was the *subject*; sulfur, the *cause*; and salt, the *effect*. Such, in brief, was the involved philosophy of the alchemists.

Symbolism highly typical of the alchemical transmutation doctrine and the philosopher's stone motive is found in the circular plaques in the upper left- and right-hand sections of the fountain (Fig. 1). The one to the left is a reproduction of a drawing taken from Kelly's medieval work, *Theatre of Terrestrial Astronomy*. Its subject, the *Mutual Conversion of the Elements*, represents a black rock, on the top of which stand the variously colored figures of Saturn, Jupiter, Mars, Sol, Venus, Mercury, and Luna. On the black plain in the foreground are Mercury and Luna, labeled *Hermaphrodita*, with a crescent on her head. To the left of Mercury and to the right of Luna close observation detects the symbols of mercury and sulfur, respectively. The four elements blow from the four corners upon the place where Mercury stands with Luna. This plaque illustrates how the latter alchemists, who were astrologers as well, laid special stress, as did the earlier Chaldean alchemists, upon the influences of the seven heavenly bodies, each producing the metal it typified. Paracelsus even pretended to be able to calculate when and how this planetary influence took effect.

A description of the doctrine of transmutation would not be complete without some account of the philosopher's stone, which was "the universal medicine for giving perfection," the constant aim of the alchemists. They treated the symptoms of the metals as the doctor treats those of a sick man when he does not know the cause of his patient's illness. They tried to remove the symptoms of illness and induce those of health or perfection. As the centuries passed,

the alchemists became more and more extravagant in their visions, and attributed unlimited powers to the philosopher's stone, such as making precious stones, curing diseases, prolonging life, and controlling elemental spirits. It could preserve health, raise the dead, make the old young, turn the coward into a hero, strengthen the memory, and sober the drunkard! [BROWN]

The circular plaque of the upper right-hand corner of the fountain (Fig. 1) is a copy of *The Birth of the Philosopher's Stone* from *Der Hermetische Triumph*, Amsterdam, 1689. The alchemists assumed that the material of the stone or elixir embodied: 4 angles in its virtues: fire, air, water, and earth; 3 angles in its substance: sulfur, mercury, and salt; 2 angles in its matter: the fixed and the volatile; 1 angle in its radical principle: the *prima materia*. The sum of these angles is 10, which number in their Cabala, or mystic system, was held to express the material of the philosopher's stone. A close inspection of the heterogeneous details of the plaque reveals most of the angles just noted. There are fire, air, water, and earth. The symbol of sulfur is immediately above that of mercury which consists of intertwined serpents. The hermetically sealed flask beneath, or the philosopher's egg, in which prolonged heating operations were conducted, is above fire. The sun and the moon, *i. e.*, gold and silver, direct their rays or influence into the egg. The opinion prevailed that the philosopher's stone must be produced by the union of metals, and *a fortiori* of the perfect metals gold and silver.

The ideas of the constitution of the philosopher's stone were conflicting, and the opinions of the alchemists as to the number of operations involved in its synthesis are various, but the process was made to imitate the operations of Nature and accordingly was prolonged through seven stages, each corresponding to the influence and invocation of one of the seven planets. Thus for each planet, the philosopher's egg was heated a fixed

number of days, the total operation occupying no less than 217 days, or over seven months. The perfected philosopher's stone was reputed to be a red powder which, when projected upon a quantity of molten base metal in a crucible, would transform it into an ingot of pure gold.

This survey of the alchemical period may be fittingly concluded by directly quoting the estimate of J. Campbell Brown:

When we reflect upon . . . the philosophy and aims of the alchemists, we perceive how foolish it would be to sum them up in a single epithet. The men belonged to distinct classes. There were mystical or religious alchemists who made use of terms of art merely as parables, and alchemical processes as allegories. Their real subject was the human soul; their true object the guidance of mankind to salvation. But these were few. There were philosophical alchemists, steeped in the doctrines of Aristotle, who sought by the transmutation of base metals into gold to prove their great thesis—the unity of all things. There were scientific alchemists, whose desire was to discover the properties and combinations of metals, and the best methods for their manipulation. And there were mercenary alchemists, who hoped to find in the philosopher's stone the key to a store of unlimited riches. Unless we keep these different classes in mind, and differentiate clearly between them, we shall never understand all that is implied in the title 'alchemist.'

The mystic symbolism of these circular plaques is offset by the larger, central double-panel reproduction of a Medieval Soda Plant. The original illustration appears in the *De Re Metallica* of Georg Agricola, who records the following self-explanatory description:

The solution from which soda (natron or hydrous sodium carbonate) is obtained is made of sweet water percolated through earth that is full of soda or lye from the same being percolated through oak ashes. Each solution is caught in tubs and poured into quadrangular copper caldrons and boiled till it condenses to soda. Then it is poured out into casks which contain copper wires, to which the soda adheres and hardens and becomes copper-green, or what we call borax, to use a Moorish name. Pliny tells us that formerly soda was mixed with copper rust and rubbed with copper in copper mortars.

The third and fourth or the Iatrochemical and Phlogiston Periods in the History of Chemistry are practically synchronous, extending from the beginning of the 16th to nearly the 19th century. The Iatrochemical Period is marked by the motive to produce and investigate medicinal substances by chemical means, and the production of chemical compounds in the search for new medicines, rather than the alchemical search for the philosopher's stone which was not, however, entirely abandoned. The philosopher's stone motive became the *elixir vitae* motive. The symbolism described is typical both of the Alchemical and Iatrochemical Periods.

The Phlogiston Period is marked by a more sincere and precise search for chemical truth, and especially by the rise, development and fall of a remarkable theory of combustion which brought together as related processes a number of diverse phenomena that at first appeared to have nothing in common, namely, combustion, acidification, respiration, reduction, and the solution of metals in acids. All combustible substances were assumed by G. E. Stahl (1660–1734), the founder of the phlogiston theory, to consist of the product of combustion plus a hypothetical, inflammable substance termed "phlogiston," which corresponded to the fire matter of the ancients or to sulfur of the alchemists. Substances in burning lost the phlogiston. Lavoisier later demonstrated *quantitatively* that combustion was due, not to the loss of phlogiston, but to a direct combination of the combustible substance with the oxygen of the air, and thus at one blow overthrew the phlogiston theory and established the oxygen theory of combustion.

The symbol for *phlogiston* is near the center of the fountain, below the symbols for the four elements and the three principles (Fig. 1) and above Lavoisier's famous apparatus in which the synthesis and analysis of mercuric oxide were demonstrated.

A word of appreciation is due the phlogiston theory for the great service it rendered in effecting the correlation of diverse phenomena and promoting the development of chemistry along scientific lines. While the phlogiston theory was radically wrong, we must realize, as Whewell states, that "If our hypothesis renders a reason for the agreement of cases really similar, we may afterwards find the reason to be false, but we shall be able to translate it into the language of truth."

It was Anton Laurent Lavoisier (1743-1794) who effected this translation. His advent and achievements mark the establish-

ment of chemistry as a science, to which he contributed more than any previous investigator through quantitative methods of procedure. Lavoisier's theories and works initiate the fifth, or the Quantitative Period, in the history of chemistry. Using the apparatus noted in the small panel at the center of the fountain—a retort, resting on a charcoal furnace, with a curved neck communicating with a bell jar—Lavoisier effected the quantitative synthesis and analysis of mercuric oxide. This work not only established the oxygen theory of combustion but demonstrated quantitatively for the first time the principle of the conservation of mass.

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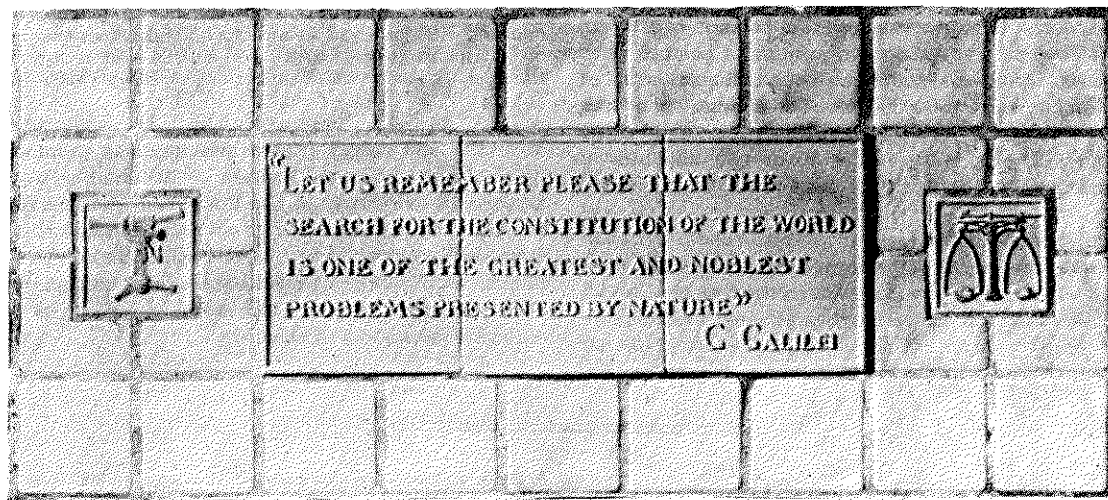


Fig. 2

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In relation to Lavoisier, also note the four tiles in the circular rim of the drinking basin of the fountain, which illustrate a special glass vessel of alchemical origin termed a "pelican" and used for prolonged heating operations involving the circulation and condensation of vapors. In such a vessel, formerly used as the philosopher's egg in which alchemists endeavored to generate the philosopher's stone, Lavoisier boiled a given weight of pure water for 100 days and demonstrated that the earth which appeared in this water was from the disintegration of the previously carefully weighed vessel, and not due, as was generally believed, to the transmutation of water into earth. This, of course, undermined transmutation ideas. He further proved that water was not an element, but a compound of hydrogen and oxygen, and defined an element as a substance which we have *not as yet* been able to resolve into other substances.

Brief note must now be made of the concomitant rebellion against the Aristotelian and transmutation doctrines which held sway throughout the Alchemical, Iatrochemical, and Phlogiston Periods. Pronounced instances of this rebellion became common toward the end of the 17th century and are especially noted in the works of Van Helmont, Francis Bacon, René Descartes, Pierre Gassendie, Robert Boyle, and Isaac Newton, most of which tended strongly toward the reestablishment of the conceptions of the Greek atomistic philosophers, Democritus, Epicurus, and Leucippus. These ancient writers held a view of

their compounds, which was both qualitative and quantitative. A circle with a dot at its center stood for one part by weight of hydrogen. A plain circle stood for the weight of oxygen (5.66 parts according to Dalton) which combined with one of hydrogen. The ten circular figures, five in each of two parallel vertical rows, one row on each side of the fountain, are Dalton's symbols for the most common elements: on the left—oxygen, iron, calcium, sodium, and potassium; on the right—magnesium, hydrogen, carbon, mercury, and sulfur.

A few years later Berzelius substituted for Dalton's geometrical hieroglyphic symbols, the more convenient and simple representation by letters now universally employed. Dalton's criticism of Berzelius' modification of his symbols is quaint: "Berzelius' symbols are horrifying; a young student in Chemistry might as soon learn Hebrew as make himself acquainted with them."

The achievements, both theoretical and practical, of the pure and applied chemistry of the Quantitative Period are far too numerous and extended for an outline. In fact, the chemistry lecture and laboratory courses of the universities of both hemispheres barely begin to convey an understanding of what chemistry is and what it does. Be this as it may, the fountain recognizes the function of chemistry's two foremost instruments, the spectroscope and the analytical balance, in promoting the motive of chemistry and other natural sciences. This motive, the motto of the fountain in the central horizontal panel, has been aptly expressed by Galileo Galilei, the inventor of the astronomical telescope, in the words, "Let us remember, please, that the search for the constitution of the world is one of the greatest and noblest problems presented by nature." (Fig. 2.)

To the left of this motto is the spectroscope, to the right the analytical balance. The use of the spectroscope in conjunction with the astronomical telescope reveals the constitution of the world. Practically every element known in the earth has been identified in the sun and in various heavenly bodies through spectro-photography and spectrum analysis. The deli-

cacy of the spectroscopic test is the most extreme known, since it reveals the presence of one part of sodium vapor in twenty billion parts of air. This corresponds to our being able to detect a fragment of common salt weighing 0.0000000001 oz.!

On the other hand, the advent of the analytical balance enabled chemistry to become an exact science since through its use the quantitative composition of hundreds of thousands of compounds has been accurately determined. Specially constructed balances rival in sensitiveness the extreme delicacy of the spectroscope. For instance, Ramsay and Gray attacked the problem of determining the relation between the weight of an atom of the radium emanation, niton, and one of the rare gases, argon. This necessitated their making a balance capable of displacement from the central or zero position of balance when the minute load of a hundred-thousandth of a milligram is placed on it. This amounts to 0.00000004 oz. Thus Ramsay and Gray were able to deal with a very tiny bubble of niton weighing one fourteen-hundredth of a milligram, or about two-millionths of an ounce, and thereby show that the atomic weight of niton is about 222.

These facts serve to indicate how the spectroscope and the balance, only two of the chemist's numerous instruments, aid most substantially in the search for the constitution of the world, which, as Galilei states, is one of the greatest and noblest problems presented by nature. Undoubtedly, the extent of our knowledge of the constitution of the world and of matter,

which also implies energy, determines the extent of the adaptability of both matter and energy to humanity's needs.

The Alchemists sought to make gold; the Iatrochemists to make medicines; the Phlogistonists, the immediate forerunners of chemistry as a quantitative science; sought more definitely for truth itself, which search culminates in an ethics of science. P. V. N. Myers in his "*History as Past Ethics*"⁵ states that

Among the particular virtues which science has fostered is philosophical veracity or love of truth. . . . The man of science must be a truth-lover, a truth-seeker, and a truth-teller. He must take every pains to find out what is the exact fact, and then make a scrupulously veracious report of what he has found. It has in the creation of this scientific conscience, which pronounced the habit of accuracy, open-mindedness, impartiality of judgment, love of truth for truth's sake a supreme virtue, that science has rendered one of its greatest services to morality.

Thus Chemistry, pure and applied, the fundamental science of matter and energy transformations, may promote both the physical and the moral welfare of mankind. Its symbolism, as partially portrayed in the Rookwood fountain herewith described, readily lends itself to an artistic creation, which, it is hoped, will commemorate the good will of the donors of the fountain in establishing a university tradition and mark a unique achievement in ceramic craftsmanship serving as a symbolic outline of the history of chemistry.

⁵ Ginn & Co., 1913, 353.

National Exposition of Chemical Industries

The following program of the 1922 Exposition supplements that given in the August issue of *THIS JOURNAL* and gives the plans as far as they have been completed. The dates for the meetings of the various chemical organizations are still only tentative.

Monday, September 11. 8:00 P. M.—Official Opening, Grand Central Palace Auditorium. Speakers, Wayne B. Wheeler, general counsel for the Anti-Saloon League; Charles H. Herty, chairman of the Exposition Committee and president of the Synthetic Organic Chemical Manufacturers Association of the United States; and others.

Tuesday, September 12. 2:00 P. M.—Program will probably be under the direction of the Synthetic Organic Chemical Manufacturers Association of the United States.

Wednesday, September 13. 2:00 P. M.—Program under the direction of the Technical Association of the Pulp and Paper Industry.

Thursday, September 14. 2:00 P. M.—Program under the direction of the Technical Photographic and Microscopical Society.

Friday, September 15. 2:00 P. M.—Program under the direction of the American Ceramic Society.

Friday Evening or Saturday, September 16.—A Symposium on Standardization.

All portions of the program held in the Grand Central Palace, with the exception of the dinners of various societies, will be open to all visitors at the Exposition. The annual dinners of the Salesmen's Association of the American Chemical Industry, and also that of the American Institute of Chemical Engineers, will be held on Wednesday evening, September 13. At the former, Herbert Hoover, Secretary of Commerce, will be the chief speaker. The Alpha Chi Sigma meets informally at dinner on Thursday, September 14.

The motion picture program includes the following in addition to those previously published:

The Story of Air Reduction. Courtesy of the U. S. Bureau of Mines.

The Manufacture of Newsprint Paper at the Spanish River Pulp and Paper Company Mills in Ontario. Courtesy of the G. H. Mead Company.

The Story of Natural Gas. Courtesy of the U. S. Bureau of Mines.

Dust Explosions. Courtesy of the U. S. Bureau of Chemistry.

Protozoa and Rotifers: Studies in Microscopic Animal Life. Courtesy of Philip O. Gravelle.

Extinguishing the Largest Oil Fire in the History of Casper, Wyoming.

Fire Extinguishing Tests on Blazing Oil Tanks at Port Arthur, Texas.

The All-Weather Fire Extinguisher That Won't Freeze.

An Industrial Firefoam Sprinkler System.

The last four films are the courtesy of the Foamite Firefoam Company.

Protecting Buildings against Lightning. Courtesy of Baltimore Copper Smelting and Rolling Company.

The program of the Technical Association of Pulp and Paper Industry and the Standardization program were given in full in August issue of *THIS JOURNAL*.

The program of the Technical Photographic and Microscopical Society is as follows:

Photomicrography in Pulp and Paper Research Problems. MISS ELOISE GERRY and E. M. DIEMER, Forest Products Laboratory, Madison, Wis.

The Photomicroscopy of Paint and Rubber Pigments. HENRY GREEN, New Jersey Zinc Co., Palmerton, Pa.

The Finishing of Motion-Picture Films. DOMINIC S. MUNGILLO, Craftsmen's Film Laboratory, New York.

Mechanics of Motion-Picture Apparatus. CLARENCE W. GIBBS, Victor Animatograph Co., New York.

The Motion Picture as an Aid to Industry. ALFRED B. HITCHINS, Director, Research Laboratory, Ansco Co., Binghamton, N. Y.

Microscopy in Leather Tanning. GUIDO E. DAUB, A. F. Gallun Sons Co., Milwaukee, Wis.

Use of the Microscope in Textile Work. ALBERT H. GRIMSHAW, Textile School, New Bedford, Mass.

Protozoa and Rotifers: Studies in Microscopic Animal Life. (Illustrated by motion pictures.) PHILIP O. GRAVELLE, South Orange, N. J.

The Federal Trade Commission has dismissed, without prejudice to its right to institute new proceedings, about forty complaints against nationally known business concerns which had been charged with maintaining resale prices similar to those in the Beech-Nut Packing Case. These cases were suspended until the determination of the Beech-Nut case, and in view of that decision and the age of the cases it has been decided to dismiss them and to institute new proceedings if new inquiries show it to be advisable.