4. Citric acid, even in very small amounts, renders the action of these tablets much more rapid and the disinfected water much more palatable; but seems unsuitable for incorporation in one tablet with the chlorine disinfectant.

DISCUSSION.

CHAIRMAN EDWARD KREMERS stated that the two-tablet idea in disinfection reminded him of an object of historical interest in the Historical Drug Store of the Wisconsin Historical Society, namely, a large container of tablets containing manganese dioxide and sodium chloride. When chlorine was to be generated, sulphuric acid was added to some of these tablets. The label on the container bears the name of Dr. E. R. Squibb, who devised this method, and was employed for the War needs of that period (about 1860).

F. E. STEWART: What microörganism was used in testing out the disinfecting power of these tablets?

BERNARD FANTUS: Typhoid organisms. We carried out the experiments not only in distilled water infected with typhoid organism, but also in tap water. The details of this part of the work will be published in the *Journal for Infectious Diseases*.

EDWARD S. THATCHER: May I ask Doctor Fantus whether he confined his attention to typhoid bacilli?

BERNARD FANTUS: When tap water was used there were other bacteria present. Hence, when the tap water was sterilized, a number of other organisms had also been destroyed.

L. F. KEBLER: As the important thing is to make the drinking water safe, it is necessary to avoid the use of too much of the disinfectants. I presume the taste would be the final deciding factor, but I have been wondering what would be the effect of too much of the disinfectants. An experience with too much copper sulphate for a like purpose came under my observation. This is a matter of importance.

H. C. HAMILTON: In my experience, I have found that it was more difficult to disinfect tap water than distilled water. The presence of chemicals cuts down the effect of the disinfectant.

Referring to the remarks of the last speaker, copper sulphate is effective for treating water containing vegetable growths, but not so efficient for killing bacteria.

BERNARD FANTUS: In the sterilization of tap water I found much greater variations than in the disinfection of infected distilled water. Some days it was more difficult to sterilize tap water than distilled water, on other days the reverse was true. This was due to the variations in the Chicago water supply.

F. E. STEWART: It is highly essential to ascertain how many bacteria are present in water, and whether a bacterial count was made to determine the number of the bacteria present in the drinking water.

BERNARD FANTUS: In the water disinfected in my experiments there were 30,000 to 90,000 bacteria per mil.

THE EVOLUTION OF CHEMICAL SYMBOLS.

BY INGO W. D. HACKH.

Evolution is progress, progress is the transition from the incomplete to the complete, an increase in value, either spiritual or material. The evolution of scientific knowledge illustrates best "how human knowledge grows" and progresses. To a student of any science its historical development will be of great benefit in understanding the ideas and conceptions involved. The development of chemical symbols, for example, offers a miniature history of chemistry and is an interesting topic in more than one respect.

In the dark epoch of the middle ages as the alchemists attempted to gain wealth and eternal life by the search for the philosopher's stone, man's position to the material world was entirely different. At that time man was still laboring under the conception that by some secret formula he could change the natural laws governing the material world. He thought to impress his belief what "should be" upon matter and thus worked out an elaborate system of a philosophy of nature, intermingled and permeated with mystic and superstitious ideas. In all alchemistic writing one comes constantly across this intermingling of spiritual ideas and material conceptions. The symbols used to designate certain substances were allegoric and symbolic of spiritual ideas, like love and hate, male and female, light and darkness, etc. The masculine and feminine principles were imparted to the substance itself. Matter became animated and possessed life. There are many evidences that the experiments were conducted as a kind of sacred rite, accompanied by prayers and chastisements. It has been shown, *e. g.*, that the common abbreviation for *recipe*, ℞, was originally the sign for Jupiter, the supreme deity of the Romans, for before mixing the ingredients, it was necessary to pray first for the successful conclusion of the manipulation. Even the very name, "crucible," for the common laboratory utensil, indicates the fact that before the alchemists applied heat to their mixtures in their earthen vessels, they made the sign of the cross—Latin *crux* (gen. *crucis*) and prayed for success. Very often explosions and breakage occurred, and of the casualties we have no record. No wonder that the alchemists were held in fear, for they conducted strange operations with flames and noises, prayers and death.

To the mind of the alchemist, matter was thus animated, and according to the properties of matter, these were either masculine or feminine. Upon these conceptions the strange and mystic theories were constructed and embodied in symbols. The symbols differ greatly for one and the same substance, and the tracing is therefore extremely difficult. An old volume of 1783, which is said to be based upon a work of 1549 and a manuscript of 1300, gives a great number of these symbols, some of which are represented in Fig. 1. One can see the great diversity, which makes the tracing of the origin of these symbols very difficult.

The search for the philosopher's stone, or alkahest, was at its height during the fifteenth century, and as pointed out above, attained the dignity of a religion. In fact, many reputable bishops and fathers of the Roman Church were professed alchemists. This intimate association of alchemy with religion, of mysticism and theosophy, of chemical operations and rules for the conduct of life, is clearly shown by the writings of Raymond Lully (1235–1315), Albertus Magnus (1193–1282), Arnoldus Villanovus (1240–1313), Basil Valentine and others. Naturally their quest remained unsuccessful.

A new direction of thought was initiated by the founder of Iatro-Chemistry, Phillipus Aureolus Theophrastus Paracelsus Bombastus *von* Hohenheim, who lived from 1493 to 1541 and whose eventful life is most interesting and adventurous one. One writer says of him "he lived like a pig, looked like a drover, found his greatest enjoyment in the company of the most dissolute and lowest rabble, and throughout his glorious life was generally drunk;" another writer, however, describes him as "a man of noble character and intentions, a Christian humanist and ambulatory theosophist, who hoped to inspire mankind with a love of conscientiousness and veracity, and to restore the suffering to health."[1]

[1] Hendrick, "Everyman's Chemistry," 1917, p. 195.

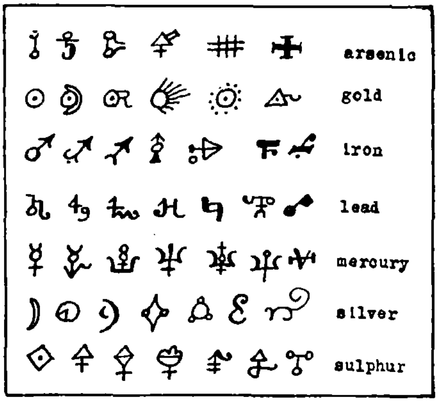

FIG. 1.—Alchemistic Symbols of the 15th and 16th Centuries.

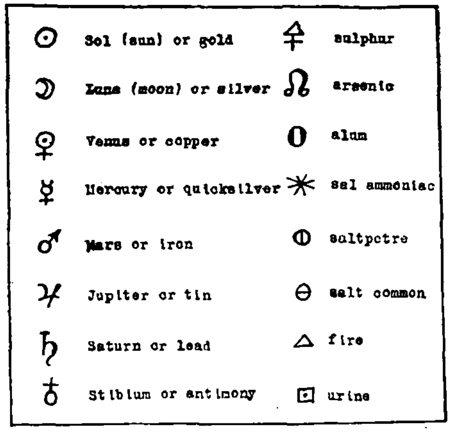

FIG. 2.—Alchemical Symbols of the 17th Century.

True it is that he violently attacked the physicians, adhering to the old traditional treatments, and the alchemists, who searched for the transmutation of metals. His doctrine was that the knowledge of alchemy should be applied to the healing of diseases. To this end he established his allegorical and pantheistic philosophy of harmonies, which centered around Soul-Mercury-Water-Nymphs, Spirit-Sulphur-Air Sylphs, and Body-Salt-Earth-Pigmies. As a physician he worked with various results, the fatalities were ignored and his successful treatments exploited by his followers. Slowly chemical knowledge was diverted to medicine and pharmacy.

In Fig. 2 the symbols of the Pharmacopoeia Batanea (1694), by William Salmon, a quack of the 17th Century, are reproduced. These symbols already show an emancipation from mystical allegories, for although the astronomical signs are preserved, the symbols now denote the metals and substances and are used as abbreviations for them, *e. g.*, antimony is mentioned as stibium, and not as "earth."

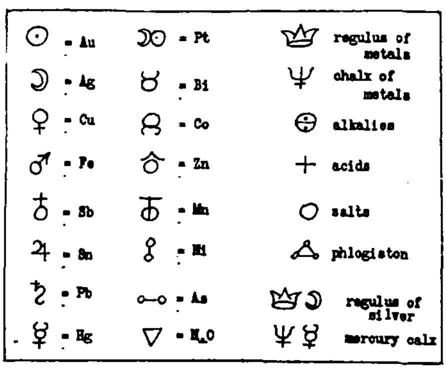

FIG. 3.—Symbols of Torbern Olof Bergmann (1735–1784).

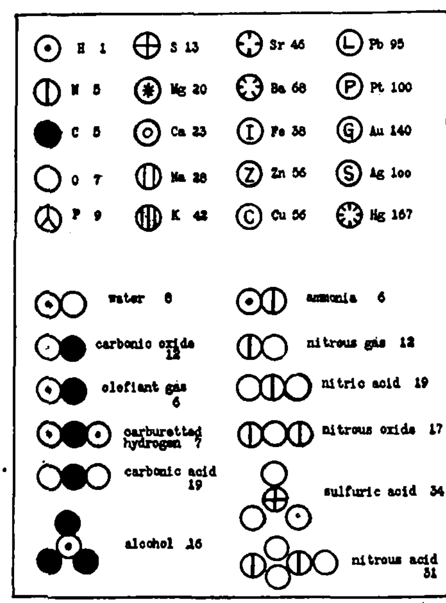

FIG. 4.—Symbols of Dalton (1766–1844) showing the old "relative weights" and terminology.

Further development is seen in the symbols of Bergmann, Fig. 3, who published in 1783 his "*Opuscula physica et chimica.*" These symbols form a part of a very elaborate system by which chemical knowledge of that day was represented. They were in use at the time of the founding of modern chemisty, for Lavoisier and Berthellot used these and similar signs.

The chemical experience of mankind had now attained such a state when the atomic theory was in the air, for already Bergmann had observed the replacement of metals in solution, and Lavoisier tried to explain this by affinity. Richter and Fischer worked on acids and bases, on neutralization, and introduced the term stoichiometry, but it was for Dalton to lay the foundation of the atomic theory.

Dalton's symbols (see Fig. 4) appeared in 1808 in his "New System of Chemical Philosophy," and were the result of his studies on the composition of marsh-gas and ethylene and the oxides of nitrogen. Thus the cornerstone of modern chemistry was laid upon the fundament established by Lavoisier.

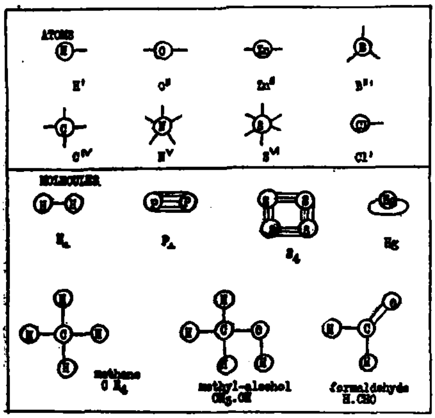

FIG. 5.—Graphic Notation of Kekule, Naquet, Frankland and others.

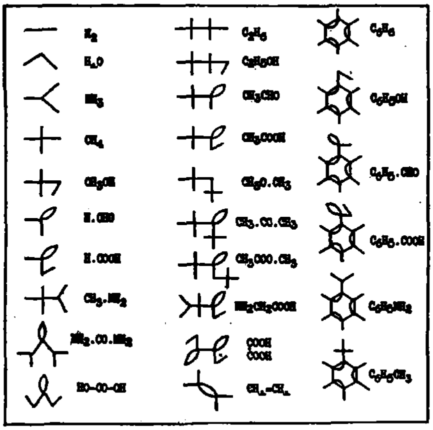

FIG. 6.—Some Simple Structure Symbols of Organic Compounds.

In 1814 Jöns Jakob Berzelius replaced the geometrical signs of Dalton by the initial letter or letters of the elements, and thus introduced the customary symbols of to-day. Chemistry advanced rapidly, and the work of Kekule, Liebig, Woehler, Dumas, Naquet and Frankland developed the graphic notation of Fig. 5 which developed into the structure formula. But before the chemical symbols became established as denoting a single atom and a definite atomic weight, they had to undergo during the period of establishing, the correct proportion of oxygen and hydrogen in water, the confusing use of the "barred notation," that is, in chemical formulas the old equivalents were designated by symbols, the new atomic weights by the symbols with a bar through them. This notation makes the reading of the literature of this time complicated and confusing.

A modern development of chemical symbols are the structure-symbols for organic compounds.[1] These structure-symbols are based upon the fact that the majority of organic compounds contain the elements hydrogen, oxygen, nitrogen and carbon. The respective valencies of these elements are one, two, three (or

[1] A Chemical shorthand, *Can. Chem. J.* 2, p. 135, 1918. Organic Symbols, *Science*, 48, p. 333, 1918.

five) and four, and differ therefore for each element. Upon this fact is based the system of structure symbols, and in Fig. 6 some of these symbols are given. It is evident that with this simple principle to each organic compound, a definite and different symbol can be given, for the atoms of the respective elements are thought to be points, and the points are determined by lines, thus where a line begins or ends an hydrogen atom is supposed to stand; where the line makes an angle or two lines come together, oxygen stands; where three lines meet or radiate, nitrogen exists, and at the point where two lines cross or four lines come together, an atom of carbon is thought to exist. While these symbols at first might seem to be complex, they make in reality the study of organic chemistry much simpler, for a little practice in deciphering and constructing these "valence-structures" will enable the student to form clearer images of the structure of a compound. They are the structure-skeletons; for any structure formula can then be taken, each atom has to be written down by its symbol, and the symbols connected by the bonds, and then all the symbols are erased and the bonds left standing will yield the "structure-symbol."

The elements H, O, N, and C, have been called bio-elements, for they constitute over 99 percent of all living matter, less than 1 percent is filled up by other elements. Similarly the elements which constitute the rocks and stones are mainly the oxides of Na, Mg, Al and Si, forming, as silicates, the larger part of the known earth crust, although of their structure we know little, for their composition is complex and defies the ordinary methods of structure-analysis. Nevertheless, the new researches on crystal structure, with the help of X-rays, will, perhaps in the future, throw more light upon the chemistry of the silicates, and if the structures should become better known and established, the same method of representation can be employed. Like in the structure symbols of organic compounds the valencies are made the basis in the system, so could also the valencies of Na —1, Mg —2, Al —3 and Si —4 be employed to form the basis of structure symbols for the rock-forming silicates, distinguishing them from the bio-elements, *e. g.*, by a circle.

The evolution of the chemical symbols is an interesting chapter of chemistry and illustrates the attempts of human mind to represent its conception of facts in a concise way, from the allegorical symbols of the alchemist, to the structure-symbols of to-day, which illustrate our present conception of organic structures.

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PROBLEMS OF THE MANUFACTURER OF MEDICINAL CHEMICALS DIRECTLY RESULTING FROM WAR CONDITIONS.*

BY B. L. MURRAY.

It may safely be said that all manufacturing enterprises in the United States have encountered problems directly resulting from war conditions. It is not possible that one industry, or indeed one individual, has remained isolated and unaffected by the war now four years old. We may not perceive in our casual observance of an industry, in just what manner war conditions have had their

* Read before Scientific Section A. Ph. A., Chicago meeting, 1918.