Science Familiarly Illustrated.

Natural Qualities and Peculiarities of Glass.

This material is as old as reliable history. The fable which ascribes its invention or discovery to the accidental fusion of an alkali with seashore sand by a fire made by shipwrecked Phœnician sailors is not worthy the degree of credence we usually yield to Pliny's relations. Glass beads and imitation gems have been found with Egyptian mummies which must have been interred over 3,000 years ago. In fact, at Thebes was discovered a glass bead of rare purity which had the name of a monarch inscribed upon it who lived 1,500 years before Christ. Glass lenses, bottles, and vases have been found in the ruins of Nineveh, and it is not improbable that glass was known long before it was manufactured into articles of use or ornament; for in the process of the reduction of metallic ores and in the baking of pottery the vitreous debris must have been noticed. According to Theophrastus the manufacture of glass was practiced 370 years B. C., and the processes of grinding, coloring, and gilding were then in use. Colored glass was used in church windows in the eighth century, and in the time of the crusades the art of ornamenting and decorating articles of glass was introduced from the East. Works were established at Murano, near Venice, and for a long period the Venetian glass was justly celebrated for its elegance. Many of the ornamented objects made in Venice have been lately reproduced; that known as the Venetian ball, so popular now for use as a paper weight, being an instance. They are made by combining pieces of colored glass to imitate flowers, etc., and introducing these into globes which are compressed or flattened upon the designs by the blower drawing in his breath and thus exhausting the air from the interior. The lens form of the envelope has the effect of magnifying the ornamental objects. Frosted glass is produced by dipping the hot glass, before blowing, into cold water, reheating it and blowing before the cracks on the exterior are closed by fusion. Probably the finest specimens of ornamented glass now made are those manufactured by the Bohemian peasantry. The cause of this excellence is partly the superiority of the materials existing in Bohemia and partly to the wonderful skill in manipulation attained by patient and constant practice.

Glass is a chemical combination of silica, potash, lead, lime, alumina, and other substances intended to produce silicates of these bases. The colors are produced by metallic oxides. The specific gravity of glass varies with its composition from 2·4 to 3·6. When cooled it is exceedingly brittle, but when softened by heat is very tenacious and may be molded at will. It can be drawn into threads of extreme tenuity, and in this form has been woven into silk, producing an elegant effect. These threads are quite elastic, as is also a solid globe; even hollow balls have been dropped upon an anvil from a hight of ten feet, when they would rebound to at least one-third of that hight without sustaining a fracture. This quality of elasticity when in the form of thread has lately given rise to the story of an attempt by a French chemist to unite masses of these elastic threads by partial fusion, with the object of producing a flexible glass. The project is too ridiculous to merit serious remark. When glass ceases to be brittle it will probably lose some of most valuable properties, which seem to be inseparable from this objectionable quality.

On The Manufacture of Malleable Castings as Practised in Europe.

The material generally employed in European founderies for the manufacture of malleable castings. is Scotch pig iron, which, however, must be free from sulphur and phosphorous. Though the brand of the pig is kept secret as much as possible, the writer has detected that the various shops are using different brands. The melting of the pig is performed in crucibles of plumbago, holding about sixty pounds each. They are covered with a lid of chamotte for the purpose of avoiding the falling in of coke, which by a subsequent removing would evidently cause a loss of heat. The hearth of the furnace is constructed of chamotte stone, and having a width of two or three feet square, is adapted but for four crucibles. Blast is not employed, it having been found that time is saved only at an expense of fuel, the natural draft through the flue being quite sufficient. We have it already noticed that the fused iron is cast into the forms at the highest obtainable heat; to recognize the same requires some experience, however. The workman knows that the charge is ready by simply dipping a red-hot iron rod into it, on the withdrawal of which a scintillation takes place. The crucibles are then lifted out from the furnace, and when the surface of the fluid mass is skimmed, the molding is commenced with. Small pieces, as keys, locks, and parts of sewing machines, are cast in sets with a common gate, from which they are detached again after cooling. In casting a larger and more complicated model, we have to examine beforehand where the so called *suckers* are to be formed in the sand; they form reservoirs, are filled in casting, and when the piece cools down it sinks from them. If this is obviated, cracks are produced at the spot where the molding of a sucker would have been necessary. Though these cracks are often so small that they cannot be perceived, they make their appearance when the casting has gone through the second process, which we will describe hereafter. Those reservoirs are made at the elbows of levers, at the edges of bent pieces, and wherever the dimensions vary rapidly; however, care is taken not to heat them off too soon, as the castings are exceedingly brittle unless thoroughly cooled.

The molding boxes are either set vertically or almost so, the former position always being used for smaller molds. Four or six of them are fastened together with clamps, and placed with the gate upwards. Molding is done very carefully, in order that the article obtain a smooth surface, and cleaning be possibly avoided after the "heating." This process is intended, as well known, to give to the castings all the properties of forgeable iron. The same consists in embedding the castings in hematite powder, and exposing them in cast iron boxes, called mufflers, to red heat for several days. Formerly founders were of the opinion that round mufflers were preferable to square ones, but now they employ square boxes of one inch iron, a cover being attached to them to protect their contents from the atmosphere. As to the heating oven, it is of simple construction, the fire gases being allowed to play around the boxes which are placed in the back part of the oven, a good fire is made at once, and after this packing is done in regular intervals. The castings are left inside for three, four, or five days, according to their size, and one oven is made to hold 700 to 900 lbs. The boxes with the large castings are exposed to the greatest heat, while those with the small ones are subjected to the lowest temperature. If it be thought that they are heated sufficiently, they are left to cool gradually, and after having been unpacked the castings are cleaned according to necessity.

REFFELT'S EDUCATIONAL APPARATUS.

The slate and blackboard are efficient aids to education; their usefulness being mainly based upon the fact that none of our senses are so sensitive or retentive as to details as that of vision. To see is to believe—to be convinced—an occular demonstration being one admitting of no reasonable doubt. For this reason "object lessons" have become a deservedly

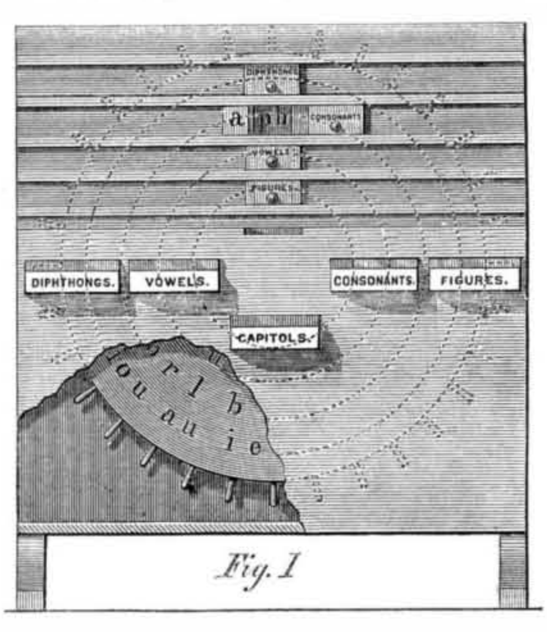

Fig. 1

favorite means of imparting instruction, and fulfill admirably the work demanded. The mechanic, even, however educated he may be, prefers always a model to a drawing or diagram; the work to be done being presented in every position, as well as in detail.

Acting on this principle, the inventor of the devices shown in the engravings accompanying this description has constructed convenient appliances for the school-room or the family, designed to facilitate the acquirement of the relation of numbers and the knowledge of the elements of a language.

Fig. 2

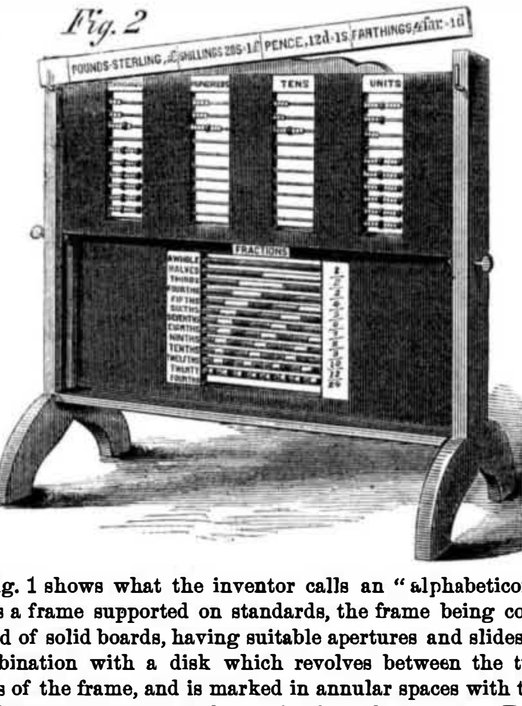

Fig. 1 shows what the inventor calls an "alphabeticon." It is a frame supported on standards, the frame being composed of solid boards, having suitable apertures and slides in combination with a disk which revolves between the two sides of the frame, and is marked in annular spaces with the dipthongs, consonants, and vowels of any language, as English, German, French, etc. It may contain, also, the arithmetical characters from 0 to 9, inclusive. By turning the disk by means of handles inserted in its periphery, either of the letters or characters may be brought before the appropriate aperture in the side of the frame. The apertures may be covered, or partially covered, by slides. Cases attached to the sides of the frame may be made to hold such additional slips of letters, or other characters, as may be desired after those on the disk have been fully learned. If, for instance, the slide over the vowels is opened, the pupils see only that letter which is brought opposite the aperture in the side of the frame, but by turning the disk all the vowels may be successively brought to view. When sufficiently acquainted with any one of the series the scholars may be introduced to combinations of vowels, consonants, and dipthongs, by the presentation of the proper characters in combination to form syllables, words, and sentences. The patent for this apparatus dates January 2, 1866.

Fig. 2 is a contrivance on a similar principle, but intended, more particularly, for teaching arithmetic. It consists of an upright frame divided into two parts, an upper and a lower section, which slide up or down in grooves in the uprights. The upper section consists of four divisions and five blackboards, behind which are four hundred balls of wood or other material, there being ten strings or wires in each division, and ten balls upon each string. Besides, for the more ready computation, every fifth ball in each string is distinguished by a color differing from those on each side of it. The balls in the first division, at the right, represent the units; those on the second, the tens; those on the third, the hundreds; and those on the fourth, the thousands. The balls remain behind the blackboards when not in use.

If it is desired to indicate, for instance, 6485, you bring out 5 balls in the first division, 8 in the second, 4 in the third, and 6 in the fourth. At the same time the number of balls in each division, with figures, is written on the respective blackboard. If a division at the right remains empty, a nought (0) is written on the respective blackboard. The fifth blackboard is used to write down, in large numbers, the tens of thousands, the hundreds of thousands, the millions, etc. On this apparatus the pupil easily learns how to write numbers correctly by figures, and to count upwards and downwards, by 1, 2, 3, 4, 5, etc.

Addition, subtraction, multiplication, and division, are performed in a similar manner, the method of which for each operation is easily learned by a little practice.

For the purpose of teaching the fundamental rules of denominate numbers. there belong to this apparatus 7 sticks, containing 14 tables of money, measures, and weights. When these sticks are fastened above on the apparatus the balls will represent the things named on the sticks. The use of the balls is the same as in the simple numbers, only that the number of units that it takes of the next lower denomination, to make one of the higher, is different. For convenience of the teacher and pupil, these numbers for every higher denomination are given on the respective sticks. By seeing them very frequently, the child will easily learn them by heart.

The second section of this apparatus consists of one division and two blackboards, behind which are twelve cylinders of equal length upon twelve strings or wires. The cylinder upon the first string is undivided, thus representing a whole one. The cylinder upon the second string is divided into two equal parts, thus representing halves. Upon the third string there are the thirds, upon the fourth strings the fourths, and so forth, to the tenths. The eleventh string contains twelfths, and the twelfth string twenty-fourths, because both are of great importance in the different transformations of fractions. The two blackboards serve to hide the fractions not in use, and to make upon them the needed fractional calculations. Fractions can easily be treated, when their fundamental principles are clearly understood. The apparatus shows that the nature of fractions supposes a division into equal parts. The appearance teaches that in the more parts the whole is divided, the smaller the parts will be, and in inverse proportions; thus, that with equal numerators, those fractions are the smallest having the largest denominators, and those the largest having the smallest denominators. It will be seen that a fraction can be considered as a denominate number, of which the denominator is the name, and the numerator the true number. It will facilitate the pupil's writing fractions in the common way, and counting upwards and downwards with fractions. The pupil will readily learn what is meant by fractions of a common denominator, and understand that only fractions can be added or subtracted when they have a common denominator, or when they are reduced to equivalent fractions having a common denominator. How this reduction is to be done can be clearly shown by the apparatus. The appearance teaches that a whole one is equal to two halves, to three thirds, to four fourths, etc.; that $\frac{1}{2}$ is equal to $\frac{2}{4}$, to $\frac{3}{6}$, to $\frac{4}{8}$, etc; that $\frac{1}{3}$ is equal to $\frac{2}{6}$, to $\frac{3}{9}$, to $\frac{4}{12}$, etc.; that $\frac{1}{4}$ is equal to $\frac{2}{8}$, to $\frac{3}{12}$, to $\frac{6}{24}$, etc., etc.; and in inverse proportion. It is readily shown by it that the value of any fraction is not changed if both numerator and denominator of it be multiplied or divided by the same number. In the same way it will be observed that multiplication of a fraction is accomplished by multiplying the numerator or dividing the denominator, and that division of a fraction is effected by dividing the numerator or multiplying the denominator. If the pupil clearly understands these principles of fractions, all other exercises in them will be very easy.

Mental arithmetic can be readily taught by this apparatus, the advantages of which will be easily apprehended by the intelligent pupil, as well as by the teacher.

The patent for this device is dated March 3, 1863. "Reffelt's First Book of Arithmetic" is a guide to its use, which is for sale by E. Steiger, No. 17 William street, New York city, and the apparatus can be obtained either of him or of the inventor, H. R. Reffelt, 74 Bloomfield street, Hoboken, N.J., or of Nathaniel Johnson, 490 Hudson street, New York city, either of whom will receive propositions for territorial rights. The letters patent were obtained through the Scientific American Patent Agency. The frames for counting and for working fractions may be made and used separately, and are furnished thus or combined. These devices were exhibited in the Paris Exposition, and were very favorably noticed by the London journals.