

which fits him to seize the idea behind the theorist's symbols and forms, and strikingly apply it to the everyday problems in which his interests and labors lie.

The brain of the genius who can fasten upon the practical consequences of an idea brought forth by the mere thinker is one of the very highest order, and he deserves the merit he receives, and the world is quick to reward him in its substantial way, although the world is little able to discriminate, and is willing to believe the scribbler of any magazine article who prophesies plausibly a sudden demolition of the laws of nature which the labors of the greatest thinkers have placed on the most enduring bases. Just now we can see an example of such a thing with regard to the law of the conservation of energy; we are threatened with most improper doings by liquid air, and we have not yet forgotten the Keely motor. It is to the credit of the scientist that he is willing to give his life to the prosecution of learning for its own sake, and that, too, when an understanding and appreciation of his labors must be given to few. How common it is to hear that man who has made some application of value (measured in money or utility) lauded above the originator of the idea. One hears of this or that inventor of the electric lamp or dynamo, but not of Faraday, who made an electric arc fifty years earlier, and produced the electric current by induction and foreshadowed all its applications. One hears of a Hertz or a Marconi, with their electric waves and wireless telegraphy, but how seldom of a Clerk Maxwell, whose seething brain put forth the thoughts of which these things are but adaptations. How often is Lord Kelvin's name connected with the problems of submarine cabling? One is almost tempted to say that the person of so-called average intelligence gives in his heart greater credit to the inventor of "See that hump?" than to the discoverer of the law of gravitation. Surely equal credit must be given to the originator of an idea with him who applies that idea to the purposes of mankind; and it must come home to us how necessary is the existence of a close bond between these sets of workers, so that each aids the other and to each is given the credit which is his due.

Now I believe that not only will the founding of a physical and astronomical section bring about good results of this kind to the Franklin Institute, but I consider that it is only a beginning in the direction in which such an institution should be expanded. It should have its staff of professors, whose only duty it should be to pursue original investigation, and the results of whose work should be made known to the world through the Society. Of course such things cost money, and being a practical people we hesitate to give our money to what we please to call impractical purposes. I hope, however, that we have come to the conclusion that a full return for the money so spent is bound to come back to us in overflowing measure, though in indirect and unseen ways. It seems that our benefactors who give of their wealth to advance education are unwilling to pay for pure science; they willingly give their money to found and endow libraries, they give freely to art collections and to museums; but what case can we recall of the founding of a laboratory for research only, a place where a Rowland could be put and told to go ahead regardless of expense and enrich the world's treasure-house of thought? The German government has such an institution, and yet I would be sorry to see ours try to imitate it; for it would be difficult every four years to find a man of the right political complexion to take a well earned turn at the "job." At the Reichsanstalt, to which I refer, and with which Helmholtz was connected in his later years, is a vast equipment, with its experts, to be counted not by units, but by hundreds, who devote their time not only to standardizing apparatus, but also to the devising of the best and simplest forms of instruments and to the production of new ones; and in addition to all this is Prof. Kohlrausch, with a staff of fifteen or twenty assistants, whose only aim is original research in the field of physics. All the products of these men's brains and the results of their labors are given freely to the world. I know of nothing similar in this country in the domain of physics; Harvard College has one of its departments, the astronomical observatory, devoted entirely to research. Prof. Pickering and his associates give no lectures and no instruction in the observatory; they are expected simply to use their best efforts to promote our knowledge of astronomical science, and to this end are provided with a staff of forty assistants, and a fully-equipped observatory and library. What better thing could be done by one of our moneyed men, eager to utilize his great wealth for the good of mankind, than to found, in connection with this and similar institutions, a professorship in physics, assuring to one qualified to fill it a liberal stipend (for even a Newton must eat) and all the appliances and assistants his genius can employ?

Perhaps this has carried us too far into the future, and whether we shall ever come to this I do not know; but at any rate I believe that the Franklin Institute has made a move to-night which will redound to its credit and usefulness, and I have taken great pleasure in being present at its inception.

[Abstract of remarks of Dr. T. C. Mendenhall, President Worcester Polytechnic Institute, Worcester, Mass.]

Dr. Mendenhall spoke substantially as follows:

The excellent and carefully prepared address of Prof. Abbe leaves little to be said by those who follow him. It is a real pleasure, however, to be able to congratulate the Franklin Institute on the realization of a plan which is a recognition, tardy though it may be, of the intimate relations between the mechanic arts and physical science, or, as some of us would be inclined to say, the dependence of the former upon the latter. When I read the subject for discussion, I wondered how it could be a subject of discussion at all, for I am sure everybody knows and admits that progress in the mechanic arts rests upon and is measured by progress in the physical sciences. But it is no ordinary event in the history of either that the Franklin Institute, which may be justly considered the foremost organization in the country whose primary object is and always has been the higher development of the mechanic arts and the encouragement of American invention, has organized a special section for the better development of its interest in the physical sciences. When one reflects upon the splendid work of the Institute in its chosen field, the outlook for the future of

this new section of physics and astronomy is most promising, and we are all confident that much important work will here be done.

It is impossible to speak in this hall without constantly recurring thoughts of the pioneers of American science.

It is entirely natural that the present should appear to be the golden age, and among the historians of science in this country it is too common to pass over the seventeenth and eighteenth centuries as relatively unimportant.

As a matter of fact, some of the most brilliant of America's contributions to science were made before the beginning of the nineteenth century and, counted in proportion to the population, the number of eminent scientific men in those days was fully as great as now, and along some important lines their share of the world's work was greater. Perhaps the first contribution from America to the proceedings of a scientific society was the first communication of Gov. John Winthrop, of Connecticut, to the Royal Society of London, of which he was one of the earliest members.

Another Winthrop, of the same stock, Prof. John Winthrop, of Harvard College, was also a frequent contributor, and doubtless did more to kindle and keep alive the fires of colonial enthusiasm for physical science during the eighteenth century than anyone else. But the one great figure of that period was one whose name and deeds are inseparably related to this city and in whose memory this institution was founded. The world has produced few, if any, more brilliant men than Benjamin Franklin. It is with only one phase of his intellectual activity that we are interested to-night, and in that alone, as a physicist or natural philosopher, no one will deny that he must be reckoned among the very foremost. There is one quality of his scientific work to which I want to invite especial attention; it is the almost ever-present practical end toward which nearly every investigation was directed. On account of the great luster of his researches in electricity, it is often forgotten that he enriched nearly every department of physical science, and although he evidently did not lack capacity for that keen enjoyment of discovery which depends upon discovery alone and is indifferent to practical results, it is everywhere evident that with him the possibility of turning a scientific experiment or principle to good account as a means of bettering the condition of his fellows was paramount. There is a certain class of scientific men, not large and not increasing, we are glad to note, among whom it is the fashion to speak with what they believe to be a "fine contempt" of applied science, and who, having never succeeded in discovering anything of any particular value or use, pride themselves on pursuing science for the sake of science. And we have all heard of the mathematician who thanked God that he had at last discovered a formula of which it would be utterly impossible ever to make any practical use. But this doctrine has not been held by those most entitled to distinction in the annals of science, and Franklin was a notable example of those who believe that the noblest ambition by which a man of science may be stirred is the ambition to discover laws which may be utilized in the amelioration of the almost necessarily harsh conditions by which mankind is surrounded.

It is difficult to address a body of scientific men in this place without thinking of another great name, that of one who stood almost at the beginning of that long and unbroken line of astronomers for which our country is justly famous. And in thinking of Rittenhouse in Philadelphia one is likely to turn from the contemplation of his splendid career as an astronomer to that incident so characteristic of the men of his time, in which the man of science became, at the behest of the Committee of Safety, the clockmaker again designing and casting clock-weights in iron which were to be exchanged with the inhabitants of the City of Brotherly Love for leaden weights, to be moulded into bullets, which contributed to the founding of a new nation. During the life of that nation the most marvelous changes have been wrought in the material condition of man and his relations to the planet which he inhabits. We have ourselves witnessed so many of these changes that detailed reference to them is unnecessary, but we may profitably inquire concerning the underlying cause of such a prodigious revolution. To my mind it is found and found only in the discoveries in physical science, and in their application to the control and direction of the forces of nature. Man lives in this world only by the continued transformations of energy, and his comfort and happiness depend largely on the amount of energy he is able to transform. It is not long since his only supply was that furnished by the muscles of his own body, but during the nineteenth century he has been able, thanks to physical science, to draw upon almost inexhaustible sources from without, and this is why he has progressed by leaps and bounds that have exceeded the most extravagant imaginings of our ancestors. This progress cannot be attributed to war, for war has existed since the dawn of history, and it has failed to lift man above the slavery of unintelligent toil. Nor is it due to religion, nor literature, philosophy or art, for all have flourished for ages without materially altering the relation of man to his environment. Science, with its unerring processes of observation, experiment and precise measurement, has inaugurated the peaceful revolution in social relations and material conditions, which the nineteenth century now passes on, still incomplete, to the twentieth.

The pen has conquered the sword, but the yard-stick is potentially the master of both.

What is asserted to be the oldest brick in existence was recently exhibited at a meeting of the Académie des Inscriptions et Belles-Lettres, of Paris, by M. Henzy, the keeper of the Louvre. It is supposed to date from the fortieth century before Christ and was discovered at Tello, the ancient Sirpulo, in Chaldea, by the French archaeologist de Sarze. The brick in question was curved in shape, and, while it had been baked, it did not show any signs of having been pressed or moulded. The mark of the maker was merely the impress of his thumb, and the specimen is, without doubt, one of the earliest marks of civilization ever discovered. As brick making is the earliest of the known arts, this particular piece must mark very nearly the dawn of civilization.—N. Y. Evening Post.

A NEW GLASS, AND ITS USES IN THE ARTS.

By WILLIAM DULLES, Jr.

GLASS in connection with chemistry has proved of little use, except in the laboratory, and in that for the smallest and simplest forms of chemical work. Its advantages are due of course to its great power to resist acids, whether liquid or in fumes, and electricity. Its transparency gives it further advantage in watching solutions, reactions, precipitations, and formations, while the fact that it can be given a perfectly smooth, compact surface makes it of pre-eminent sanitary value. Its limitations, however, are very marked, and are due to the difficulties which arise in treating it and forming it into shapes. Its most marked limitation is its fragility.

It has, however, other disadvantages growing out of practical conditions in its manufacture. When melted, it is not in any sense liquid, but rather plastic, cooling very rapidly, and thus preventing, under ordinary conditions, its being moulded into very large sizes. An added difficulty is its propensity to break from defective annealing.

Glass hollow ware has almost universally been produced by the process of blowing. It is a matter of astonishment that a man can become so skillful in blowing as to produce such an immense variety of blown tubes from the smallest pipe up to the window glass cylinder, and preserve a very accurate calibration.

The strength of glass is of course of two types, one mechanical, due simply to its thickness, enabling it to resist blows; the other internal, due to its chemical composition and annealing, enabling it to resist heat and cold and chemical influences. This is illustrated by the very familiar test tube, extremely fragile mechanically, and yet peculiarly strong for practical laboratory use.

The reason of course why a thin glass, well annealed, will resist intense heat is found in the fact that, glass being a very poor conductor of heat, the contraction and expansion caused by sudden heat will make the glass far more likely to break when thick than when thin. Collateral to this is the necessity for the test of heat and cold that glass shall be of uniform thickness, so that the contraction and expansion will not be different in the different parts of the same article. As a result, it has proved possible to make cylindrical glass articles in much larger sizes than any other shape, and blown jars and tubes have, as stated, been made in quite large sizes, though as a rule with less thickness of walls, and correspondingly less mechanical strength.

The essential element in the Appert process and the value of the glass produced is the successful meeting of the two difficulties thus far suggested. Mr. Leon Appert, himself a very well known glass expert and manufacturer, ex-president of the French Society of Civil Engineers and president of the Society of the French Glass Manufacturers, has devised and patented the machinery which bears his name. The well known St. Gobain Company took up the practical development of the matter, and has for some years been producing in very large quantities, with perfect success, rectangular and cylindrical jars and pipe of all sizes.

By means of a mould and core, mutually adapted to the form required, glass jars and pipe of symmetrical shape can be made, handled, and subsequently annealed. In the pipe there is no question as to making a bottom, but jars involve this decidedly serious problem, and special appliances are needed to secure a flat bottom and of true thickness properly in accord with the thickness of the said walls. Behind the mechanical operation is the composition and temperature of the glass itself, which is so controlled as to make possible the moulding of large jars in cylindrical shape up to say 40 inches high and 20 inches diameter, holding 50 gallons, and in rectangular shape up to 16 inches by 21 inches by 22 inches, and holding say 24 gallons.

The making of cylindrical jars proves somewhat easier than the making of rectangular jars in this process, following the analogy of blown work, but the thickness of walls and mechanical strength are in no way impaired or modified as the size increases, thus guarding the mechanical strength. Rectangular jars are much more difficult to make, but, if made at all, they must be and are of strictly uniform thickness, maintaining this same thickness at the curving of all the sides.

An ordinary blown rectangular jar is made by blowing a balloon reasonably spherical or ovoid. If such a balloon is moulded into a true cylinder, it will have uniform radii from a given center, and the glass will form itself with reasonably uniform thickness of walls about the sides of the mould. When, however, such a balloon is placed in a rectangular mould, there will be at once radii of different lengths, and the glass will be distorted, making very thin corners at the longer radii with thick sides. The result is thus mechanically weak, due to the thinness of the corners, where danger from a blow is greatest, and the impossibility of annealing a jar with so great a difference of thickness in its walls. The production of such jars by the blown process is both unsatisfactory to the manufacturer and the user. The Appert process, while able to make small jars, practically begins where the blown jar ends, competing not with glass articles, but with jars made of other materials.

The variety of jars to be made is simply a question of moulds, though each jar has a tendency to develop some little peculiarity of its own in the process of manufacture, and make a history for itself at the factory.

It will be noticed that the jars have somewhat fluted sides, and the impression is given that the jars are not transparent. This, however, is an incident, and the glass itself has the transparency of plate glass, the inner surface being in every case perfectly smooth, and the outer surface capable of being ground and polished with any degree of smoothness that may be required. A piece of glass from a broken jar polished on what had been the outer side shows that the glass is perfectly clear, and that the smoothness of the inner surface as originally made cannot be distinguished from the surface that has been specially polished. The jars are always made with more or less of an upright or vertical panel which is clear, so that graduation will

be possible. It is at once apparent to practical users of such articles that the inside of one of these jars is illuminated because of the transparency of the glass, which is unmistakably an advantage over any other form of jar. The perfect smoothness of the inner surface, already referred to, is an added advantage. The glass is also of such quality that faucet holes can be drilled of any required size in any location. Portions of the sides can also be polished so as to allow observation as to what is going on in any special part of the jar.

The variety of industries in which chemistry is involved is so great that one cannot easily venture to enlarge upon the possible uses of this glass. Inquiries that have come to the manufacturers indicate a demand ranging from the strongest acids to the purest distilled water.

These jars withstand marked changes in temperature within reasonable limit, thus proving themselves equal to the practical tests of laboratory and chemical work.

There have been many patents taken out for making glass pipe. Its value as a resistant to electricity and chemistry, as well as in sanitary projects, makes its use most attractive. There must be great difficulty in moulding glass into a long pipe with a comparatively small core. This, however, has been accomplished, and it is a most interesting thing to see one of these moulds opened, showing a piece of pipe 5 or 6 feet high, with the changing colors, as it cools and is taken rapidly by the workmen to be prepared for the annealing process.

For practical uses glass pipe must be very strong mechanically, and yet not overloaded with weight, which greatly increases the expense. A further difficulty is to retain a true roundness of the glass, with the extreme tendency which glass has to distort as it cools. This, however, has been perfectly accomplished. Again we find in this pipe a peculiar and perfectly smooth inner surface. These pipes have now been made in lengths of 5 to 6 feet, with an inner diameter of 4 inches. When the diameter is increased the length is diminished, but pipe has been made and can be made with diameters of 10 inches to 21 inches in lengths of one meter. The great mechanical strength of all the glass made by this process is due to the fact that it is extremely hard, perfectly annealed, and of a sufficient thickness to resist any ordinary blow.

There are many other forms into which glass can be made for chemical uses, and plans are now under way for making special forms for special requirements of chemistry and allied industries. The question is one of development, and the construction of new moulds in order to widen the circle of its application.

Under the general heading of electricity, we find electric storage battery work, which has made use of these jars in Europe for several years, and is beginning their use here as rapidly as the jars can be furnished. Electrolytic plants also find the advantage of the purity and permanence of glass as well as electroplaters and all the industries where electricity is concerned.

Pipe commends itself for the transfer of high tension electric currents. Some made of the glass have been tested, and show a resistance of 35,000 volts when dry, and 20,000 when wet.

In chemistry proper, we find these jars available for all processes using acids, while the pipe in different sizes meets the difficulties met in piping acids and acid fumes, and can also be made into towers such as are used in nitric acid and similar factories. An interesting inquiry has come in regard to using this pipe for piping sulphuric acid fifty miles from a point of manufacture in the mountains to the line of the nearest railroad.

The vital point of course is that glass is made available in much larger sizes than ever known heretofore, and it is evident enough that the qualities that have made success so universal in small sizes will make a corresponding demand for anything of any size that can be made of this unique material.—The Journal of the Society of Chemical Industry.

IVORY PRESERVED IN COLD STORAGE.

No one can estimate the amount of ivory that is hidden in the ice fields of the frozen regions near the poles, nor more than guess at the length of time it has been thus preserved. With the rapid decrease in the herds of elephants in Africa, the search for remains of the mammoth increases. From time to time reports are published of finds of frozen carcasses of these huge beasts, valuable for the mass of ivory in their tusks, in the tundras of the far North, mainly in Siberia. Science does not explain how the giant animals were able to exist in a climate that has preserved their remains by freezing, or how they chanced to be thus overwhelmed.

This mammoth ivory, far from being a recent discovery, was known to the ancients, and has been used for centuries as an article of commerce and manufacture. The records show that as early as 1821 ivory of this kind to the extent of 20,000 pounds was marketed in Yakutsk, and that annual sales in that city, from 1825 to 1831, averaged over 60,000 pounds. In 1840 Dr. Middendorff, who visited the vast territory, estimated that the annual output of Siberian ivory reached 110,000 pounds, representing at least 100 individual mammoths. Baron Nordenskjöld estimated in 1875 that fully 20,000 Siberian mammoths had contributed their ivory to the world's markets since the conquest of Siberia.—Ice and Refrigeration.

In a paper on determinations of the refractive indices of solutions, communicated to the Isis Society, of Dresden, W. Hallwach gives an account of a differential method with grazing incidence, for which a double-throw refractometer has been used. The process described has been applied to solutions of brome-cadmium, sugar di- and tri-chloroacetic acid, and their potassium salts; and the author investigates the relation between the refractive index and the degree of concentration, with a view of determining whether it is influenced to any extent by dissociation. The experiments show that such an influence, if it exists, is too small to be measurable with exactitude. This result is at variance, in the case of brome-cadmium, with those obtained by Le Blanc and Rohland, but the discrepancy is attributed to an error.—Nature, 60, 329.

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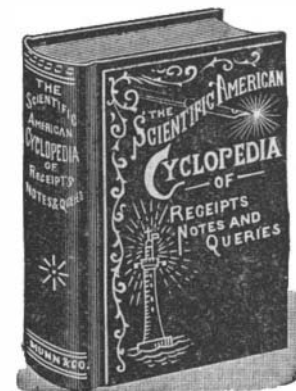
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