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HOW MERCURIAL THERMOMETERS ARE MADE.

The word thermometer, as everybody knows, of course, means "heat measurer," and yet the word, in its etymological signification, conveys what is, or, at least, may be, an erroneous notion of the actual results obtained by means of this useful and interesting little instrument. That heat should be accurately measured, implies that we should be able to start from zero, or no heat. The zero upon our ordinary Fahrenheit thermometers is only thirty-two degrees below the freezing point of water, and this temperature, as is demonstrated by the use of instruments capable of indicating a relatively very low degree, is still as evidently heat, and a good deal of heat, though not so much as that of our scorching July days. We have no more authority for saying that the lowest degree registered closely approaches the lowest, in the nature of things possible, than we have for asserting, that the highest degree attained or measured is the highest degree possible. All that the thermometer does, is, assuming that the cause is proportional to the effect, to indicate by a regularly adjusted scale, the expansion and contraction of a certain substance—for instance, alcohol or mercury—and from this expansion and contraction, we infer that the cause or condition of it—that is, the increase or decrease of heat is proportional to the result. It would not be erroneous to say, that the thermometer measures the relative increase or decrease of temperature, but it does not, and can not, measure heat itself. Yet the uses of the instrument are as various and beneficial as if heat were as absolutely measured, as we can measure the pressure of the air by the barometer, or the specific gravities of liquids by means of the hydrometer. All results, dependent exclusively upon heat, will be uniform, for the same degree of heat, and, using this law, we can reason from one result to another, the results, of course, having been first obtained by experiment, and registered for use.

As an illustration, having once discovered and noted the fact, that water boils in the open air when the mercury of a thermometer, immersed in it, has expanded to the point of 212° on the scale, we may always count on the concomitance of these results, the boiling of water, and the registered expansion of the mercury, except under the following circumstances, which, so far as we know, have yet received no explanation. After a thermometer has been exposed for some weeks to the ordinary temperature of the air, if it be suddenly exposed to the temperature of boiling water, its freezing point will often be found to have lowered from one to two degrees. This has been observed in some of the standard thermometers of the Royal Society, London, and by various experimenters. It is sometimes two or three weeks before the freezing point corresponds again with that on the scale.

The determination of the temperature at which different physical results take place is of incalculable advantage to science and the arts, notwithstanding what has already been said, that the thermometer really does not measure heat at all.

It is not intended to discuss here, however, either the history, theory, or uses of the thermometer. Our object is to describe the manufacture of the instrument, the indications of which have so much to do with our physical comfort or discomfort, and which are so important to nearly all processes in the arts.

A mercurial thermometer is a very simple instrument. A small glass tube, with a bulb at one end, containing mercury, and a graduated scale, constitute all that is essential to it, yet in this, as in many other cases, simplicity begets difficulty. To make this simple combination perform its duty accurately, is by no means an easy matter. The first difficulty met with, is the want of uniformity in the diameters of the bores of different tubes, and the varying size of the bore in almost every tube. It is scarcely possible ever to find one the caliber of which is the same throughout its length, and, if so found, it is the result of pure accident. It is obvious, therefore, that unless some means of eliminating the errors which would arise from this source, be adopted, nothing like accuracy can be expected in the indications of the instrument. As the character of the bore cannot be altered, the desired result must be obtained in another way.

The method employed to obviate this difficulty is called "calibration." Tubes are selected tolerably free from imperfections, and a column of mercury, of one inch or less in length is introduced into it. The tube is then attached to the frame of a dividing engine, and put in connection with flexible rubber bags, to which pressure is applied, and regulated by screws. The air pressure in one bag being reduced, while it is increased in the other, the mercury column may be forced to and held at any part of the tube.

The mercury being thus brought to the portion of the tube where the graduation is proposed to commence, the exact position of one end of the column is marked upon the tube, a microscope with cross wires being employed to aid the eye of the operator in performing the operation with exactness. By means of the rubber bags, the mercury is again forced along until the end of the column, where the first mark is made, is brought under the microscope cross wires, placed at the other

end, and so on throughout the entire length intended to be graduated. The varying lengths of the column which are accurately measured in the different positions are recorded, and indicate the variations in the caliber of the tubes. A permanent mark is made at the end, as at the beginning of the calibration.

It will be seen, that if the spaces successively occupied by the mercury be divided into an equal number of equal parts, anyone of these parts will indicate a corresponding increase of volume, although the bore of the tube may vary in its diameter.

The required dimensions of the bulb are found, approximately, by weighing a measured length of the mercurial column, and computing the capacity of the bulb from the known expansion of mercury and its specific gravity.

The bulb may be formed upon the tube previous to the calibration, or afterwards attached. In the former case, however, the thermometers have their scale divided after the determination of the freezing and boiling points, and no tubes can be used except such as are found to be approximately perfect. In the latter case, the arbitrary scale, as marked from the calibration, may be reduced after the determination of the freezing and boiling points into the Fahrenheit scale, by the application of a simple algebraic formula.

The freezing point is determined by placing the bulb in finely pounded ice, from which the water is drained away as it melts. The boiling point is obtained by placing the bulb in steam having the same elasticity as the atmosphere, a peculiar apparatus, devised by Regnault, being generally employed for the purpose.

In putting in the mercury, a small reservoir of paper or glass is fixed upon the upper end of the tube. Heat is then applied to the bulb, which, driving out the air through the mercury, the latter, as soon as the bulb is allowed to cool, descends through the tube, being forced by the pressure of the external atmosphere. The upper end of the tube is then heated and drawn out, ready to be sealed hermetically. The mercury is then boiled in the bulb, to expel all trace of air, and, while it is in a state of ebullition, the tube is sealed by directing the flame of a blowpipe against the upper end, which fuses the glass and closes the aperture.

The reader must not imagine that all the manipulations we have described are performed on all thermometers in a perfect and accurate manner. A very large majority of these instruments, in common use, are entirely worthless for any scientific investigation, although they furnish, perhaps, sufficiently accurate indications for the regulation of the temperature of apartments, and for other ordinary purposes.

IS THE KNOWLEDGE OF ENGLISH GRAMMAR NECESSARY TO THE WRITING OF GOOD ENGLISH?

A correspondent writes us that the practical working men of this country need a practical grammar in order to enable them to attain that facility and accuracy of expression, essential to a lucid communication of their ideas. The present works upon the subject, he thinks, are overburdened with rules, observations, and quotations, and are not adapted to the use of such as wish to learn to write and speak correctly in the shortest possible time, and without the aid of a living teacher.

As this bugbear of grammar is, we know, preventing many valuable ideas and suggestions from receiving the publicity they deserve, we propose to devote a brief space to its demolition.

First, then, we say that the use of correct and forcible language, either in writing or speaking, is purely a matter of habit. No one in writing can afford to stop and apply grammatical rules to every word and phrase he employs, and no writer does this. If he had these rules all at his tongue's end, they would not enable him to use good language, unless good language is the daily habit of his life. Many of these rules are of extremely doubtful character, so far as the English language is concerned, and more are so loaded down with exceptions that they are practically useful only to critics in defining and pointing out errors of style and construction in such literary productions as depend for their merit more upon their style than anything else. The use of good language cannot be put on and off like a coat. He who accustoms himself to loose forms of expression to-day will to-morrow speak loosely when he perhaps desires to be accurate.

Many of our most able writers and speakers know little or nothing of grammar as a science, and one of the most forcible writers among the contributors to our present magazine literature has recently written a series of articles for the *Galaxy*, in which he has sought to prove that most of the definitions and so-called rules of English grammar are shams; even going so far as to entitle one of his articles "The Grammarless Tongue," meaning by the expression, grammarless tongue, our vernacular. It must be confessed, too, that he made out a pretty strong case.

If, then, the use of good English is not to be learned from "English grammars," how is it to be learned? We answer, by familiarizing ourselves with good language, by studying the meaning and derivation of words, by the habitual reading of such authors as are accepted authorities in the use of language, and whose writings have established its usage. This will not avail, however, if an attempt is not made to shake off bad habits, and acquire good ones.

But it is not necessary to possess the most happy style of expression to communicate important facts. An old professor used to remark that most people of moderate education can write and speak forcibly if they have something to say, meaning that they must possess some complete idea, well thought out, before they attempt to utter it. A man having an idea thus mentally wrought out, may misplace capitals and mis-

spell words, but he can scarcely fail to make himself understood; for his thinking has been done in language, and the natural expression of the idea must be nearly or quite as clear as his thinking. But if he try to assume an artificial style quite foreign to that which he is accustomed to use, ten to one he will fail to make himself understood.

We trust no correspondent or reader will hesitate to communicate anything he deems of value to us for fear of making grammatical or orthographical errors. Let the aim be merely to express the ideas clearly, and we will be responsible for all the rest.

DEPRECIATION OF AMERICAN VITALITY.

Dear reader, during this terribly exhausting devitalizing weather, we have steadily kept to a pre-adopted resolution that we would leave the discussion of the "heated term" entirely to the dailies and health journals; and, although the above heading might at first sight lead to the belief that our stock of subjects is so far exhausted that we are compelled to resort to a rehearsal of the oft-repeated platitudes which annually appear at this season, about the heat, and the dust, and the way to avoid sun-stroke, and how to keep cool, and how to get a good sleep in hot weather, etc., etc.; we assure you that we have something more weighty to discuss.

We Americans are charged with a "decrease in vitality;" not at this particular season, but in general. We plead "not guilty to the charge."

What is the evidence of our decreasing vitality? The report of a life insurance company, which shows that out of forty-four deaths occurring during the past year among its insured, eighteen had been insured only three years.

This a cotemporary takes as ample evidence of the decrease of "American vitality," and gives us a column-and-a-half homily upon our sins of omission and commission, which in its opinion are fast bringing the nation into a state of physical degradation.

In defense of our plea, we call attention to the following facts. First, that the present competition among life insurance companies, and the methods in which many of them transact business, are such that we wonder the proportion of deaths occurring among their insured is not greater than it is. Second, the fact that we, as a people, bear and endure more than formerly, is an evidence of increasing rather than decreasing vitality.

Only consider for a moment the burdens of dress which our increasing civilization imposes. Think of the bunion-breeding boots, the chest-compressing corsets, the fashionable, black silk, headachy hats for males, and the almost entire absence of hat for females. Think of the horrible heaps of hair bunched upon the heads of our women, and the merciless exposure of the necks and legs of American children.

Think of the indiscriminate way in which we bolt our food at all hours, and how that food is adulterated, and how abominably it is cooked. Think of the gallons of tepid enervating drinks we swallow, and the annual consumption of alcohol and tobacco.

Think of the system of tasking and cramming from books, which we call education, and how our daughters graduating at eighteen from seminaries of learning, are expected to have mastered, or done their best to master, all the dead and living languages, the sciences, literature, and metaphysics.

Think of what frightful drafts upon the hours of natural rest are made by the balls, routs, and parties of fashionable society.

Think of how our young men plunge either up to the neck in dissipation, or rush without stint into business in the mad race for riches.

Think of how all this rush and bustle, this highly seasoned mental and bodily food feeds the passions, and begets a craving for the excitement which in turn, instead of satisfying, feeds the craving.

Think of our swift journeys by land and sea. Think how the telegraph brings all countries near, and how events, the news of which thirty years since would have scarce reached us in months, are now retailed by the news mongers next morning before we get down to breakfast, demanding increased activity of brain, and keeping the mind constantly at work.

It is safe to say that an average American of to-day lives more in one year than he could have done in ten, a half century ago.

And yet he stands it pretty well. To be sure, his nerves are rather sensitive, and he finds it hard to sit still. You will nearly always see him dancing his cane, or drumming on the table, twitching his legs, whistling, or humming a tune. But even these additional drafts upon his vitality are honored by his constitution in a way that shows that although he may, and often does overdraw the account, that account must be a large one at the outset of his career.

No! American lives may be shorter than formerly, although we think there is not good evidence of even this; but vitality must be on the increase, or the drains made upon it would make us all bankrupt.

We rest our case. What say you, gentlemen of the jury?

SCIENTIFIC INTELLIGENCE.

CURE FOR LEAD POISONING.

In some of the large establishments of France the best antidote for lead poisoning was found to be a lemonade made of weak sulphuric acid, but after a while the workmen became disgusted with the taste of this liquor, and refused to drink it. It was observed that two workmen in one of the factories were entirely exempt from lead colic, and, upon inquiry, it transpired that they made free use of milk. The director of