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(Illustrated articles are marked with an asterisk.)

THE MEASUREMENT OF HEAT WITH THE THERMOMETER.

Two classes of instruments are employed for the measurement of heat, namely, thermometers and pyrometers. Thermometers are only employed to measure comparatively low temperatures, and we shall confine our remarks entirely to this class in the present article.

Modern physics having demonstrated that heat is merely a mode of motion in matter, the principles upon which its measurement depends are, perhaps, more difficult to understand than the false theory prevalent before the establishment of this doctrine. So long as heat was considered a substance, even though an imponderable one, it was not difficult to understand how its absorption into a body might definitely enlarge that body, as wood is enlarged by the absorption of water. Why a body becomes enlarged by the increased motion of its particles is more difficult of comprehension. If we, however, drop the consideration of the why in this case, and confine ourselves to the law or manner in which this expansion takes place, we may arrive at definite and practical results. It is, nevertheless, proper to state that the ultimatum which science has reached in regard to the reason for this expansion is, that heat is in some way opposed to cohesion. At present it is entirely futile to seek to go further than this. The fact, however, that such expansion takes place in both solids and liquids, and that it is, within certain limits, sufficiently uniform in certain substances to become a means of measuring the temperatures to which these substances are exposed, is the basis of thermometric measurement.

But another point must be distinctly borne in mind; thermometers only measure sensible heat. Thus one pound of steam at 212° Fah. contains heat enough to raise five and one half pounds of water to the same temperature, a fact easily demonstrated by experiment. It follows that the absolute or total number of heat units contained in any substance, must be determined by some other means than the thermometer, and that a degree on the thermometer cannot be considered a unit of heat. What then is a unit of heat? It has been agreed to consider the amount of heat necessary to raise one pound of water from 32° Fah. to 33° Fah. as a unit of heat, and although doubtless there are some small sources of error in the method, it is sufficiently accurate to regard the amount of heat necessary to raise one pound of water one degree, anywhere between 32° Fah. and 212° Fah. as a constant quantity.

It is also a correct inference that any particular substance in a uniform state, as regards the cohesive power of its particles, must exhibit the same temperature so long as it maintains that condition, since heat is the opposite force to cohesion. The more heat the less cohesion, and *vice versa*. Water, when passing from the liquid to the solid state, maintains such a uniformity of condition; its temperature may, therefore, be regarded as constant. It also maintains the same uniformity of condition while passing from the liquid state into steam at the boiling point. The freezing and boiling points of water may therefore be considered as the two prominent landmarks of temperature from which the amount of expansion of some uniformly, or nearly uniformly expanding substance, as mercury, immersed in water in the two conditions named, being noted on a scale, divisions may be arbitrarily made each way on the same scale, which will indicate temperatures above or below these points.

The Centigrade scale makes the hight of a mercury column immersed in freezing water, zero, and divides the distance between this point and the hight of the same column immersed in boiling water, into one hundred degrees, while the Fahrenheit scale makes the first named hight 32 degrees above zero, and divides the space between this hight and the hight at which the mercury stands in boiling water, into one hundred and eighty divisions, or degrees.

How it is possible to determine the amount of heat in any body from thermometric indication next claims our attention. The following law has been established. The *total amount* of heat in any body is the sum of its latent heat and its sensible heat. The latent heat is determined by the known capacity of the body under examination, at given temperatures to absorb heat, or, in other words, to render it latent. This term, latent heat, is not a good one, though we are still obliged to use it for want of a better. We use it only to distinguish the heat which, acting within a mass of matter, and expending its energy in antagonism to cohesive attraction, cannot be recognized by sensation, like the free or sensible heat. The latent, or specific heat of various bodies has been made the subject of careful study, and tables of reference have been constructed to afford a ready means of computation; but the specific heat of all bodies is changed by any cause which lessens or increases the distance between the particles which make up their mass. The compression of steam lessens its specific heat while it increases its temperature, and *vice versa*. The specific heat of steam, then, is only constant at *a constant pressure*.

It will now be seen that the total amount of heat contained in any body can be determined by the assistance of a thermometer, only when its specific heat for all temperatures has been predetermined. This has been done for many substances, including water and steam, to which the application of heat measurement is of the highest importance, as it is only by such measurement that questions of economy in steam generators can be settled. The amount of water evaporated from a constant temperature per pound of combustible consumed, under a constant pressure, being the only reliable test of the economy of a steam boiler. When the evaporation takes place at 212° the required uniformity of pressure and consequently of temperature is easily maintained, which would not be the case if an engine were driven by the steam generated, or if an attempt were made to produce the steam at a constant higher temperature. The temperature of the feed water may be easily maintained at a constant point, either at 212°, or at a lower temperature, and the amount of this water which a pound of fuel will convert into steam at 212° is an exact index of the power of the boiler to transmit heat through its shell into the contained water.

A NEW METHOD OF SETTING TIRES.

The old method of tire setting, as our readers are well aware, consists in first expanding the tires by heat and then allowing them to contract upon the wheels. In this way a powerful—sometimes too powerful—pressure is brought to bear upon the wheel, consolidating its parts and increasing what is known as the dish of the wheel.

A patent has been recently taken out in England for an entirely new method of setting tires without heat, which, while we are not prepared to admit the value claimed for it, is sufficiently ingenious to warrant some notice; and if on trial it should be found to answer the purpose, it will really be an important improvement.

The invention is based on the general principle that action and reaction are equal. In a wagon wheel the tire cannot exert any greater pressure upon the woodwork than the woodwork exerts upon the tire. If then, the woodwork can be contracted and permitted to expand against the interior of the tire, the same effect would be produced as is now obtained by the contraction of the tire.

If a wheel be laid flat, and supported only by a circular bearing on which the side of the rim rests, no other part being supported, and downward pressure be applied to the hub, a contraction of the rim will take place relatively to the dish given to the wheel by the pressure on the hub, provided the rim were so firmly attached to the spokes, and the spokes to the hub, that no withdrawal could take place.

As, however, the parts of a wheel are not so strongly attached to each other as to overcome the resistance of the rim to pressure, the method we are describing employs also external pressure upon the rim of the wheel, an hydraulic pump being employed to generate the required pressure.

As the pressure is applied and the wheel contracts, it is made to descend into a funnel-shaped support, so that when the external pressure is taken off of the rim, the pressure upon the hub, giving dish to the wheel, being still maintained, the contraction of the rim is kept up till the tire is placed around it.

The hub being next released from pressure, the elasticity of the woodwork carries the hub back to its normal position with reference to the other parts of the wheel, a general expansion takes place, and the tire becomes permanently set.

It is said that the method can be applied with great rapidity and that the results seem satisfactory. It can, within certain limits, be applied to wheels of different diameters, and with greater economy than the old method of heating, a saving in time and labor, as well as a total saving of fuel being secured.

Our readers will concede the ingenuity of the system, but will probably share our doubts in regard to its excellence; nevertheless, it may prove upon extended trial to be just the thing required. If so, it will be another demonstration, that even in those things long generally regarded a having reached the limit of improvement, there is still scope for inventive genius.

THE EDUCATION OF THE HAND.

People, with a few unfortunate exceptions, have each two hands. We should not mention this fact, were it not that in the education of youths, only one seems to be generally considered. Children are told to hold their knives in the right hand when cutting their food, and when this necessary operation is completed, to lay it down and use their forks while eating, still employing the right hand. The only further instruction they receive in regard to the left hand, is to keep it clean in common with the right hand, and not to get into the habit of thrusting it into their pockets. They are taught that whenever one hand only is required, the preference is to be given to the right. Thus the left hand is, with the large majority of people, a comparatively useless member, employed only to supplement the other in all manual operations.

Without pausing to inquire into the origin of this senseless custom, it is sufficient for our purpose to say that it has no foundation in the anatomy of the hand, or in any natural peculiarity of the human mind. To the anatomist both hands are alike gifted by nature, and constitute most beautiful and complex machines. So much does the power and dominion of man over inferior animals, crude materials, and natural forces, depend upon the hand, that were it possible to deprive the human race of this important member, and put in its stead a mere paw, or a hoof, it might well be asserted that man would soon find a common level with the beasts, notwithstanding his superior intellect. This assertion, of course, does not admit the possibilty of using the foot as a substitute for the hand, which has been successfully done in several remarkable instances.

Should any one of our accomplished book-keepers, editors, or any other class of professional men, accustomed all his life to write with his right hand only, get that hand crushed by an accident on his way home some evening, the inconvenience, loss of time, and perhaps loss of lucrative position that would be likely to accrue before he could recover its use, or in case of its total loss, before he could acquire the art of writing with his left hand, would be a serious matter. Many a young man found the loss of the right hand a serious matter during the recent war, and many another has thanked God while submitting to the surgeon's knife, that it was only the left arm that had to be sacrificed.

As well might we teach children to hop about on the right foot, to keep the left eye closed, and to stop the left ear with cotton, as to teach them to magnify the value of the right hand at the expense of the left. Nor, in renouncing this absurdity, would it be necessary to violate existing social conventionalities. The fork may be held in the right hand when eating, and the knife may take its place in cutting food. These are small matters, observed only for conventional reasons. In driving on country roads we always turn out to the right, but on that account we do not consider a spavin on a horses left leg, any less serious than one on his right leg.

The first thing then to be considered in the education of the hand is the establishment of both hands on an equal footing. We may next pass to the consideration of its uses and structure.

The hand is essentially the organ of touch. Few people appreciate the vast amount of information we obtain through this one avenue to the mind; what subtile ideas of texture and quality in material, of comparative weight, of unseen motion and temperature, are obtained solely through the sense of touch. Fewer still appreciate to what an extent this sense can be educated. The blind substitute it for sight, and are enabled to gain ideas, and perform feats of manual skill through its exercise which are indeed surprising to those who see. Surgeons cultivate this sense till by laying a finger upon an artery throbbing under a stratum of overlying tissues, they can judge how deep to make the incision over it, without endangering the blood-vessels. Moreover, all very skillful surgeons use the knife in either hand with equal facility.

Such nicety of touch is essential in all very nice and delicate manipulations. And here let us note a fact first brought to our notice by a very skillful German watchmaker, to wit, that the practice of punishing children with the ratan or ferule on the hand, prevalent in many of our schools, must necessarily be detrimental to this sense. It was his custom when taking his children to school, to request the teacher to adopt some other mode of punishment than this barbarous method, explaining that as his children were to be bred to the art of watchmaking, it was essential that their delicacy of touch should remain unimpaired. While we do not intend to discuss here the much debated question of the necessity of corporal punishment, in the training of children, we will say that if such punishment is ever needed, nature seems to us to have provided for the emergency, and that no delicate nerves, muscles, and bones need be endangered in its administration.

We should extend this article too much, were we to attempt a minute analysis of the anatomy of the hand; but we assert that the most complete education and development of its powers can only be obtained through a perfect knowledge of its parts, and their offices. This fact has been appreciated by at least one of the authors of piano-forte methods now in use in the schools, and also by private music teachers; and in a long experience and observation upon this subject we have found that pupils progress much more rapidly both in music and penmanship, who are first prepared by a knowledge of the structure of the hand, and by special exercises calculated to develop the weaker muscles, and to render each independent of the others. In the education of the fingers, the first thing the instructor has to surmount, is not only natural but artificial inequalities in their strength and mobility. The fingers are not naturally of equal power, and the relative dis-