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Contents:

(Illustrated articles are marked with an asterisk.)

TIME AS A MEASURE OF FORCE.

In an article in our last issue, on "Vis Viva and Inertia," we alluded to an able paper upon the subject of "Motion and Resistance," by Prof. Henry Morton, and made a brief quotation from it. The paper referred to contains, also, the following paragraph:

"It may be objected that the time of action is not the true measure of a force, but rather the distance which it causes a body to move in a given time. But that this is not so, will be seen when we consider that any velocity once implanted in a body, needs no force to maintain it, so that all the motion afterwards executed by reason of that element, is a clear gain having no equivalent of expended force as its representative."

This paragraph contains the very partial enunciation of an important and fundamental law, and as it is evident, from the connection, that the author, when speaking of force as a positive, also considers with it its negative, resistance, his position is unassailable. Distance is not a measure of motion.

But the real meanings of the correlatives, force and resistance, are but dimly comprehended by many even who essay their discussion. Force is regarded by many as a hidden property, distinct from the ordinary and easily discernible properties of matter as seen in its aggregated state. Others seem to regard it as an exterior and occult influence, which compels matter, but does not reside in it. Others, more rationally, we think, consider it as being simply motion of matter. But the latter is true, if true at all, only in a limited sense. In this limited sense force implies resistance; cannot exist without resistance. This is evident from the illustration contained in the above extract from Prof. Morton's paper, that is, a body moving forever without resistance, from a previously applied force. It is, then, only while motion is imparted from masses to masses, from molecules to molecules, from atoms to atoms or molecules, from molecules to molecules or atoms, from atoms or molecules to masses, or from masses to atoms or molecules, that motion becomes a force. If motion is recognized, in this limited sense, as force, the true idea of resistance is expressed by saying that a body, by impact, loses motion or imparts it to masses, molecules, or atoms. In this view of the subject the relations of force and resistance exist together, and time is a measure of both, or either.

Momentum, amount of motion, expressed in the works on physics, by M V, which is the weight of a body multiplied by its velocity, is not an absolute expression, unless we establish a unit of velocity. The mathematical expression of a unit of velocity is found by dividing the entire number of units of distance by the number of units in the time required for a body to move through that distance. It is $(D \div T)$, in which D represents the distance, and T the time. It is at once seen that neither time (T) nor distance (D) is a measure of momentum (M V), when considered separately; and the momentum of a body, or its amount of motion, is a constant one for all times when velocity $(V = D \div T)$ is constant, and M is also constant.

So far as motion is concerned, considered simply as motion and not as force, time is no measure of it. As soon as a body begins to impart its motion, or, as is the common method of expression, "to overcome resistance," time alone may be a measure of the motion received (force), and the motion imparted (resistance), the equality of which has long been recognized by physicists in the expression, "action and reaction are equal." For if the entire amount of motion imparted and received be uniform during a period of time, the motion imparted during a unit of that time will be an exact measure of the whole motion imparted; and the motion imparted for a unit of time is only found by dividing the entire amount of motion imparted by the time.

The author of the article on "Vis Viva," in the *Chemical News*, from which we made an extract in our article on "Vis Viva and Inertia," in our last issue, seems to have reached a somewhat similar conclusion, when he asserts that, "as he understands 'vis viva,' it relates only to change in velocity, and does not apply to the maintenance of a uniform velocity after it has been once attained." Now, change in velocity is purely and simply the subtraction from, or addition to, the motion of a body—of motion considered as quantity—and as (if the views of the identity of motion and force be correct) this, of necessity, implies force and its correlative, resistance, we see how "vis viva" can only relate to *change of velocity.*

There is little doubt that the differences which arise upon topics like these, between those who attempt their discussion, originate more from the inefficiency of language than from the real views entertained respecting them. The language of scientific discussion should be cleared of many terms that now are only sources of embarrassment. Some of these may be noticed, more especially, in a future article.

THE BURDEN OF MEMORY.

Appleton's Journal contains in its first number a calculation, by Berthelot, the eminent French organic chemist, of the number of combinations which may be made of acids with certain alcohols. He says, if you give each compound, thus possible, a name, and allow a line for each name, and then print 100 lines on a page, and make volumes of 1,000 pages, and place a million volumes in a library, you would want 14,000 libraries to complete your catalogue.

The science of chemistry is perhaps the most striking example of the rapid accumulation of facts so characteristic of the present age. Hosts of investigations in every field of research are unearthing treasures of knowledge and adding them to the accumulated scientific wealth of the world. The burden which the memory is called upon to bear is already so heavy, that it could scarcely be possible for any man, however gifted by nature, to carry with certainty, those pertaining to any one department of science, even though his entire life were devoted to it.

This fact explains the increasing demand for works of reference. Encyclopedias, hand-books, compilations of tables, and various and multiplied helps to memory abound; new books of like character are constantly issued, and those which already exist, need constant revision, to keep pace with the march of discovery.

It is quite evident that only a small fraction of the mass of facts can ever be stored up in any individual memory; the attempt to remember them would occupy thrice the years allotted to the life of mankind. If only part can be remembered, it becomes important to know what *ought* to be remembered, and what must be left to the works of reference.

While facts are almost numberless, principles are few. We can then, easily remember principles, and a knowledge of general principles is the key to research in books for facts we do not know; it is also the means whereby we can test the truth or falsity of the statements contained in such works. It would be strange indeed that errors should not creep into any extended work of reference; nay, it is strange that so few errors are committed. But if a fact be erroneously stated, the error will almost surely be discovered by considering it with reference to the principles which underlie it. We should therefore first seek to remember principles, and after them, just as many facts as we can.

But to every individual there is a choice in the facts which are to be remembered. Those which are of the most frequent application in his business or profession, are the ones he will be most likely to choose to remember, and with good reason. The life-long student (there are a few such still to be found) will choose such facts as he must frequently refer to in his studies. But facts to be most easily remembered, require thorough and careful classification.

To classify properly is however a task of skill—skill only acquired by a proper appreciation of the true end of all classification, namely, convenient reference. A business man classifies his notes, receipts, letters, etc., and places each kind of document in its proper pigeon hole; but this classification might be carried so far as to utterly defeat the purpose it is designed to subserve. The pigeon holes might be so multiplied that a letter, or note, or receipt could be picked out of a single bundle sooner than a particular pigeon hole could be found among the entire number. Of course this is supposing a very extreme case, but it illustrates the point we wish to make, namely, that too much classification is as bad as too little.

A great many people have too many pigeon holes in their memories; more have too few; and a few, those who seem largely gifted by nature in power of memory, have neither too many nor too few; but no single man has room in his memory for everything. All must more or less have recourse to their book shelves.

A poor recourse it is in many cases. Down comes a huge volume, the title of which in broad letters on its back, shows that the fugitive fact we are after, is or ought to be within its covers. We turn to the back part to find the index, but we don't see it. Perhaps it is at the beginning. We hopefully turn over the leaves of the book to find it there, and discover nothing but a meager table of contents. We throw down the book in infinite disgust; if we have got to hunt two hours for that fact, unless it be of great importance, we conclude to do without it. We relieve our feelings by heaping anathemas upon the author, who maliciously thought to force us to read his entire work, before we should have our fact. We look for another book. Ah how different! A copious and carefully compiled index—by its help we unearth our fact, in less time than we occupied in searching for an index in the former one. Good! We dust it carefully and place it close to hand, and put the other away among the rubbish. As action is the soul of eloquence, so an index is the soul of a book of reference, and we admire both large souled men, and large souled books.

Books of reference are a necessity of the age. In fact all books on scientific or technical subjects, are books of reference and are more or less used as such, according to their worth. Authors should not lose sight of this fact. It is not enough that the subject should be ably handled, it should be so arranged that any passage may be found with the greatest facility. When this last and essential requisite is added to merit in other respects, it is a well-tempered, well-sharpened professional tool, which, if lost, or destroyed, is certain to be replaced, to the profit both of the one who manufactured, and him who uses it.

IDIOSYNCRACIES.

The peculiarities of constitution and temperament, and particular susceptibility to external impressions and influences, possessed by different individuals and included in the general category of idiosyncracies, have been a puzzle and a snare to the theoretical physiologist since the days of Galen. Such peculiarities are not confined only to the body, but are frequently to be detected in the mind.

The writer of this article is a descendant of families distinguished through several generations, both on the maternal and paternal side, for idiosyncracies, and is himself affected by a peculiarity to which his family physician can testify, and which will hardly be credited by other physicians. Opium in large doses is to him a cathartic. Very few cases of this peculiarity are to be met with. We once heard a distinguished professor of *materia medica*, assert in a lecture the possibility of this action of opium upon persons of peculiar constitution, unconscious that a living example of the fact was listening to his words. All idiosyncracies are of course remarkable as seeming exceptions to general laws, and there is nothing more so about the one mentioned than any other, except the rarity of its occurrence. We have met, indeed, with a physician of this city, who has known a similar case in Europe, but this is the only other case of the kind we ever heard of. On the whole we are inclined to think idiosyncracies much more common than is generally supposed, many escaping notice on account of their unimportant character.

One of the most common classes of idiosyncracies are those connected with eating and drinking. Almost every one is acquainted with somebody who cannot eat honey without subsequent distress at the stomach. Not quite so common are those who cannot eat the flesh of certain kinds of animals. A number of cases are recorded of those who could not eat mutton without poisonous effects. An instance of this kind once came within our personal knowledge. Supposing it to be purely the effect of imagination, the mutton was once smuggled into mince pies, usually made with beef, and thus disguised was eaten, by the person affected, with quite serious results. Violent pain in the stomach and sickness, followed by copious vomiting, in fact nearly all the symptoms of irritant poisoning succeeded the eating of the mutton in this case, and although the vomiting relieved the more distressing symptoms, the effects were felt for several days. Similar effects from eating mutton are recorded in the books.

Even the most mild, and apparently most harmless, articles of food may prove baneful to some people. Rice, cheese, eggs, and various kinds of fruits, as strawberries, oranges, and melons, have been known to invariably produce ill effects upon some peculiarly constituted individuals. There is scarcely one of our physical faculties that may not exhibit these idiosyncracies. Sight, smell, the sense of touch, and even hearing, may be thus perverted. How often we hear of certain sounds that they "set ones teeth on edge." We have read somewhere of women so sensitive to the effects of such sounds that the whistle of a thread drawn through stiff cloth in sewing was positively unendurable. Nay, there seem to be instances where deleterious effects are produced by commonly harmless objects, when their presence is recognized by no sense in particular. Instances of the latter kind are perhaps as well or better authenticated than any others. Effects of this class are generally connected with the presence of animals, as cats, rabbits, etc., the near approach of which is noxious to the persons affected, as is also quite frequently the touch of their furs.

All that we have stated is based upon the best authority and may be relied upon as perfectly credible. Now, how, we ask, disregarding such facts, can medicines be prescribed by rule, as is the too common custom, without occasionally evil, nay, even disastrous results?

We have often had opium prescribed in the ordinary full dose with the view to produce the ordinary, but exactly the opposite effect, invariably resulting to us from its use. We have seen the feet and limbs of a young lady whose skin is peculiarly susceptible to poisonous effects, so swollen and inflamed from the effects of mustard drafts, as to excite fears of the worst consequences. We have seen similar effects from the application to the skin of carbolic acid. We have stood by hundreds of sick beds and have seen numberless doses prescribed, and hardly ever have heard a physician ask how certain medicines usually effect the patients. As a consequence, we have seen patients completely prostrated by the action of drastic purgatives, in doses that would not perhaps have seriously injured the average patient. We have seen others completely narcotized by doses of morphine, that would only have quieted a cough in most; and so on to the end of the chapter.

We are well aware that book doctoring is held at its proper valuation by the leaders in the medical profession, and that to such, the really skillful, even the slightest peculiarity of temperament is not deemed unworthy of attention; but there are too many, far too many, who put all patients on the same plane, and confine themselves rigidly to one routine of treatment.

No less are idiosyncracies of mind and disposition to be regarded in imparting instruction to the young, or in our everyday dealings with our fellow men. Most mental peculiarities are easily discovered by the practiced student of human nature, and it as much our duty in our attempts to instruct and reform others, to avoid nauseating them mentally as it is that of the physician to avoid over-dosing those he is attempting to heal.

STEAM BOILER INSPECTION AND INSURANCE.

At a meeting of the Directors of the Hartford Steam Boiler Inspection and Insurance Company, held at their office in Hartford, March 31st, the following report of business done in the month of February, was read by the President: "Visits of inspections made, 180; number of boilers examined, 332; external examinations, 261; internal examinations, 84—while, in addition, 18 were tested by hydraulic pressure; number of defects in all discovered, 226; number of dangerous defects, 26; furnaces out of shape, 13; fractures, in all, 21—3 dangerous; burned plates, 20—2 dangerous; blistered plates, 53—2 dangerous; cases of incrustation and scale, 45; cases of external corrosion, 23—3 dangerous; internal corrosion, 3—1 dangerous; internal grooving, 6; water gages out of order, 6; blow-out apparatus out of order, 2—1 dangerous; safety valves overloaded, 22—3 dangerous; pressure gages out of order, 14—8 dangerous; boilers without gages, 1; cases of deficiency of water, 3. In the month's work four boilers have been found in such condition as to be positively dangerous, and beyond repair. These four have been condemned, and are being replaced by new boilers. In one of the cases of internal corrosion, noted above, an internal examination revealed to the inspector plates so badly weakened that upon sounding them with a hammer a hole was broken entirely through. This shows the importance of careful internal examinations. Many cases similar to the above have been found in localities where laws requiring annual inspections to be made are in full force. State and municipal inspection laws require only the hydraulic test to be applied; hence incrustation, scale and internal corrosion are defects which such inspections take no cognizance of.

"We must again revert to the subject of *overloaded safety valves*. Twenty-two have been found; while three were entirely inoperative—from excessive loading and neglect. One spindle was very crooked, and extra weighting was resorted to. In another the valve was corroded fast in its seat, and was raised with great difficulty. In another the fulcrum joint was corroded fast, and in raising the lever the connection was entirely broken out.

"Now, although a manufacturer may think he has a very careful engineer, and that inspection is hardly necessary, he must admit that a man whose business it is to thoroughly examine boilers, internally and externally, will discover defects which another would pass over. While many and serious defects have been discovered by the company's inspectors, no risk has been assumed except where the boilers have been put in good repair. Among the 2,500 boilers under the care of this company, slight damage has occurred to one in the city of Providence, during the month. Our inspector from this office visited the establishment at once, and made careful examination of the ruptured sheet; repairs were immediately made, this company assuming the expense."

DEATH OF JAMES HARPER.

The recent sudden death of James Harper, senior member of the celebrated publishing house of Harper & Brothers, of this city, has taken away from us one of our most honored and respected citizens. His death resulted from injuries received by being thrown from a carriage while taking a drive. His funeral, which took place upon the 30th of March, was largely attended by the most prominent citizens of New York, and was further honored by the closing of the different houses in the book trade throughout the city. He was, in many respects, a remarkable man, and his life was one long example of the beauty of all social and Christian virtues, combined with business and literary judgment, to a highly exceptional degree.

Applications of Steel Castings.

A few days ago we saw a number of specimens of steel castings imported by Philip S. Justice, of this city, which showed a degree of tenacity and ductility seldom found in steel forgings. The castings were of varying thickness, form, and weight, and had been subjected to forging, bending, percussion when cold, hardening, tempering, etc., all the tests that would be used to determine the toughness of the best wrought iron, and some that would be inadmissible with steel forgings. The result was wonderful. Cored castings were brought together under the hammer, and drawn out without showing any evidences of unsoundness. The castings showed no blow holes or evidences of want of homogeneousness, but were in all respects as sound as any forgings. They finished under the file or on the lathe elegantly. It is claimed they can be made as thin as one-sixteenth of an inch with facility. Their solidity may be conceived from the fact that hydraulic cylinders, unlined, of fourteen inches inside diameter, two feet ten inches long, and only two and a half inches thick, stand a test to which one of cast iron eight inches thick, would succumb.

These castings have been used in England for some time, but have only lately been introduced into this country. The applications of this method of working steel are numberless, or at least equal in number and similar in character to those of cast iron, and calculated to supersede wrought iron and steel forgings to a very great extent.

BEET ROOT SUGAR.

No. IV.

TECHNOLOGY.—PART I.

As a complete account of the various modern processes for manufacturing beet root sugar would fill several reasonably sized volumes, it will be impossible for us to exhibit them in all their multitudinous details in the pages of the SCIENTIFIC AMERICAN, where they would stand in the way of the publication of a large amount of useful and interesting reading matter of a more varied nature.

For this reason we shall have to confine ourselves to the illustration of the most recent and perfect methods of manufacture only, which we shall strive to do, as concisely as possible, without omitting any item of importance.

We will add, the specifications and detailed estimates for the establishment of a sugar factory, calculated to work an average of 150,000 lbs. of beet root per twenty-four hours, during a campaign of from four to five winter months, and corresponding in the United States to the average product of the cultivation of 500 acres in beets. This important subject has never, to our knowledge, been fully elucidated in any printed work on the making of sugar, and may be found of value to parties intending to start this branch of industry in America.

PRODUCTION OF STEAM.

Beet root sugar works consume a large amount of steam for driving engines which propel root-washers, hydraulic pumps and presses, pulpers, water pumps, centrifugals, etc. Steam also conveys the juice and sirups from one place in the building to another, and is the agent used for evaporating and boiling them.

The quantity of heating surface needed is generally estimated at about 250 square feet for every 10,000 lbs. of roots worked during 24 hours, or the H. P. is supposed to correspond to 50·8 lbs. of water evaporated per hour, or 6 lbs. of water for every square foot of heating surface of the boilers.

Practically, we have found that a well-managed modern sugar factory employing vacuum pans, both for the concentration of the juice and for its final boiling down, and capable of working 150,000 lbs. of beets every 24 hours, necessitates 120-H. P. boilers, and 17·216 feet of heating surface to the H. P.

The pressure of steam through the whole works ought never to exceed three atmospheres, or 45 lbs. to the square inch.

From the above, we derive the information that the steam department of a 500-acre beet root sugar factory and its cost in gold, will be as follows:

1. Three steam boilers of 40-H. P. each, with two internal pipes and one flue, calculated at 17·2 feet of heating surface per H. P., with fire boxes, grates, safety valves, gages, anchors, steam valves, H-pipes, etc., complete. Cost, $3,700.

2. Two steam drums, superposed over the boilers, with fittings complete, serving as reservoirs for the return steam from all parts of the works. Cost, $260.

3. One small 4-H. P. donkey engine, driving two feed pumps, each of which is capable of supplying a 120-H. P. boiler. Cost, $520.

The total valuation of the appliances for the production of steam in a 500-acre factory, is thus seen to reach $4,480.

WASHING AND PULPING OF THE BEETS AND EXTRACTION OF THE JUICE.

As soon as the works are in perfect readiness for a start, which will generally take place during the latter end of the month of September or during the month of October, the steam is "got up" in the boilers to 40 or 45 lbs. pressure, and the beets to be worked are at once, and regularly, carted in.

Each empty wagon or cart employed for the conveyance of the beets from the trenches to the factory is carefully weighed, and its number and weight noted. Every time this wagon reaches the factory with its load of beets, it is reweighed, and the weight of the wagon being deducted from the total, furnishes at once the amount of beets carried in for consumption. The wagons and their loads are weighed on large platform scales placed on the roadside near the works. In this manner, during the whole campaign, an exact account is kept of every load of beet entering the works, and of every pound of beet consumed.

The quantity and percentage of sugar made is thus controlled, and in case of some fault in the processes of manufacture, it is at once made manifest. Much valuable information is also furnished by these data as regards the relative value of different fields or portions of land, and the amount of beets grown on them; information which may be made available during following seasons.

The beets as they are brought in are placed in piles alongside of the beet root washer. This is a long, cylindrical, slightly inclined revolving drum, constructed of parallel rods of iron, so distanced as to allow the water and small rootlets to pass between them without permitting the passage of large fragments or of small-sized beets.

This drum revolves in an iron tank, furnished below with a manhole door, which allows it to be occasionally cleaned out; this refuse being carted off as manure.

The proper speed for a root washer is from ten to twenty revolutions per minute.

The more water employed in washing the beets the better, but the supply of both roots and water must be as regular as possible.

Care must be taken that at the lower outlet of the root washer, where the beets fall on an incline plane, interstices be left wide enough for the superfluous water to escape before it reaches the pulper, where its presence would cause irremediable damage.

On leaving the root washer, or rather the incline below it, the beets are pitched into the jaws of the pulper, where they are seized between revolving cylinders, armed with spikes or or knife blades, which rapidly reduce them to a fragmentary form. These fragments pass into the pulper proper, which consists of a double revolving drum, driven by belting. It is constructed by *tightly* fitting into two circular iron end plates, alternate series of small saw blades with projecting straight teeth, and carefully-made wooden rulers 0·39 of an inch broad and 0·78 of an inch high. The saw blades are toothed on both edges, so that by reversing them, one side can be employed after the other has been worn off. The teeth are from 0·156 to 0·195 of an inch in length, and measure 0·078 of an inch from tip to tip in the same row. The thickness of the saws is about $\frac{2}{50}$ of an inch.

The steel of which these saws are made is tempered in such a manner as to cause them to be stiff and hard without being easily broken.

Immediately in front of the revolving drum, whose speed must be from 600 to 700 revolutions per minute, is placed a stout, finely-attached blade of steel facing the points of the saw teeth, and adjusted so nicely as to leave no holes or intervals through which any fragments of beet root would find their way.

This precaution alone prevents solid particles of beet from getting into the woolen sacks during the subsequent pressing, an accident which would be sure to be followed by the bursting of the sacks and wasting of pulp over the spots where the lumps are to be found.

A newly-set pulping drum always produces a rough pulp, in which a portion of the vegetable cells remain untouched; a consequence of this fact is that a larger quantity of juice is actually extracted from pulp made by a pulper which has had some usage, and whose teeth have become worn, than from a new one.

The pulp to be of good quality must be thin, and present no rough or angular "grain" when pressed between the fingers. A limit, however, exists to the advantageous divisibility of the beet root, which is reached when the teeth of the pulper are nearly worn away, and the pulp becomes "pasty," and will ooze through the meshes of the wool sacks when pressed, a circumstance attended with very serious consequences.

A small stream of water, regulated by a cock, is allowed to run constantly on the top of the drum, and to mix with the pulp, where it effects a partial maceration. The influx of this water is to be so regulated that the juice which is expressed will indicate 4·5 to 4·8 degrees of Baumé's densimeter.

The pulp is received in front of the pulper in a small reservoir.

At this point the further processes of manufacture may vary according to the system of extraction of juice adopted. Four of these are now practiced in Europe; they are as follows:

1. The use of powerful hydraulic presses.
2. The employment of centrifugal machines.
3. The method of maceration.
4. The diffusion process.

Without entering here into a discussion of the relative merits of these various processes, which, when well conducted, have in all cases produced the same amount of sugar from the same amount of beets, we shall simply state that the second materially increases expenses for the fuel used during evaporation, on account of the large quantity of water which has to be added to the juice, and that the two last processes need an amount of care and skill on the part of the laborers, which is difficult of attainment.

The system of extracting the juice from the pulp by means of hydraulic presses, worked by pumps driven by steam power, is simple, easily managed, and efficient. In order to effect this, the pulp is first put into bags made from the wool which grows on the bellies of sheep. These bags are 33 inches deep by 22 inches broad, and the quantity of pulp put into them is a shovelful, or a quantity which, when slightly flattened, will not exceed the thickness of a finger.

The sacks are piled up one over the other, separated by sheet-iron trays, and are first submitted to a preliminary pressure in a rapidly-working press, which extracts a large quantity of the juice contained in the pulp. They are then transferred to the hydraulic presses, where the remainder of the juice is squeezed out.

When working in the proper manner, the table of beet root sugar presses must ascend in from five to six minutes, and stop for several minutes before beginning to descend. Too rapid rising of a press destroys the sacks. If the pulp has been sufficiently pressed it will look and feel dry, and will not weigh more than 18 per cent of the weight of the beet root which produced it.

The expressed juice, both from the first press and from the hydraulic presses, is run through pipes connected with funnels or "chapels" into an iron reservoir united by means of a valve or cock, with an upright boiler, called a "*monte-jus*" which we shall describe in our next article.

Specifications and valuations in gold for the washing,