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Contents:

(Illustrated articles are marked with an asterisk.)

THE NATURAL HIGHWAYS OF TRAVEL.

While in other countries the artificial means of intercommunication are works undertaken, completed, owned, and managed by the government, our policy has been to leave these matters to private enterprise, or to the management of corporations chartered for the purpose; although where the work was a matter of national necessity, or advantage, appropriations in aid have been made from the public treasury, and privileges have been granted to the stockholders who raised the principal means and carried forward the work. In many cases this assistance is judicious, and whatever may be the opinion as to the extent to which corporations may be thus aided, it is certain that such work as is necessary to keep open and in order our natural highways, as navigable rivers, belongs properly to the national government.

The rivers and lakes that form our splendid system of natural intercommunication are, and should be, free to all, and no company or corporation, should be allowed to obstruct them for their own benefit. The right of locomotion, even if not laid down in any bill of rights, declarations of independence, or constitutions, is one as inalienable and unquestionable as that of breathing. Especially is this right necessary in a country like ours, of such vast territorial extent, of such diversified topography, varied climate, and difference of products. By cheap and unobstructed communications the sectional interests become national and the parts become a whole, exemplifying our national motto, *E Pluribus Unum.*

We, therefore, regard the obstruction of a navigable stream as a national rather than a sectional calamity, but a calamity nevertheless, whether viewed in a general or local sense. If the resources of engineering talent were exhausted, in carrying railways or common roads across navigable estuaries and rivers, only by means of short span bridges supported by frequent piers, or bridges of too low an elevation to admit the passage of vessels without raising or swinging a draw, there might be reason in thus obstructing natural highways for the benefit of artificial ways deemed to be more valuable. But where a single span of trestle work or arch is not feasible, the suspension system is practicable, in most cases; or if neither of these is advisable, or possible, a tunnel may be substituted. There are few localities where the tunnel may not be used. It may be built on shore, in sections, if required, and sunk to the bed of the river, or on piers laid for its support, of sufficient hight to level the inequalities of the river bottom.

The superior cheapness of water carriage, especially for heavy and bulky freight, should be sufficient inducement to preserve intact our navigable rivers, and to improve them by the removal of obstructions that accumulate by natural agencies, rather than to add to these obstructions by building piers in the water way to act as *nuclei* for the accumulation of silt and the formation of sand bars. That this is the effect of such structures no observing person can doubt. Above the pier the current deposits its load of sand, gravel, etc., making an elongated Λ-shaped shoal; and below, the cross currents, by their eddies, do the same thing, so that on either side, in time, there is deposited an island of an elongated lozenge form, its longer diameter extending many yards both up and down stream, the pier itself being the center. Such obstructions, if formed by nature, either in the channel or on its borders, would be deemed, as they are, obstructions, and demand removal. That they are the result of artifical erections does not remove the objection to their formation. It is certain that, from what cause soever these obstructions occur, they are inimical to navigation, and to means of intercommunication, and, therefore, unworthy of toleration. Our rivers should be free, as free from artificial obstacles as from legal exactions.

THE SCIENTIST, INVENTOR, AND MECHANIC.

Not seldom the functions of these three great departments of human knowledge and progress are merged into one, so far as general opinion may reach, while the fact is they may be as distinct as any separate departments in any one art. The scientist deals with the qualities of matter and the laws which govern them separately or in combination. He is, or should be, in close communion with Nature, a student in her school, and a progressionist into her mysteries. He grasps the bare crags of knowledge, climbs to their summits, or explores their caverns. He notes the substances with which Nature works and the methods and agents of her working. Sometimes from the knowledge thus gained he becomes, himself, an inventor, but usually his investigations are too absorbing for him to relax his efforts in this direction, and he is satisfied with the almost endless vistas that open to him as he clears away the rubbish left by previous explorers and surmounts the obstacles placed by Nature herself. It is a noble department of human endeavor, as its demands are large, its obstacles formidable, and its rewards glorious. Moreover its field, although patiently worked by his predecessors, is ample enough for the exercise of all the energy and determination of the scientific explorer. However many may have scoured the ground before him, there are points of interest they have never seen, and mines of wealth they have never discovered—only dreamed of. But even if the scientific explorer is content to traverse paths already worn bare by the feet of his predecessors, he will not infrequently find unnoticed flowers by the roadside and rejected gems in the dust of the way. He prepares the way, by his accumulations of facts and his series of theoretical suggestions, for the inventor, who asks only the opportunity and means to give a living form to the scientist's discoveries.

The inventor must have a practical mind, whether he has a practical knowledge of mechanics or not. The constructive faculty is absolutely necessary to the inventor. He takes the facts discovered by the scientist and gives them form, which the mere student never could have done. In his hands the crude or bare facts of scientific investigation, in connection with the experiments necessary to their development, assume form and may be brought forth into useful shapes to bless and assist toiling millions, instead of merely astonishing and entertaining gaping audiences. The curious experiment becomes under him the useful possibility; the discovery of the student becomes to him a suggestion of practical use; facts, or even possibilities, are to him living realities.

But it is the mechanic who elaborates the idea of the inventor. He it is who clothes it with a practical form, furnishes it with nerves of steel and muscles of iron, and endows it with life and motion. Without his skill the result of the scientist's search and of the inventor's thought would be comparatively valueless. Indeed, his skill is frequently the only means of making the inventor's idea useful. In short, the mechanic, who as the model maker elaborates the inventor's idea, is often the real inventor. The crude, unworkmanlike contrivance of the inventor, that in his unskillful hands is merely a travesty on a machine, is made to assume form, proportions, elegance, and efficiency. So valuable is mechanical skill to the perfection of an invention that it is not surprising that practical mechanics constitute the large proportion of inventors. But if valuable inventions are often made by unskilled persons, it is seldom they are successful until after they have passed through the hands of the mechanic; and sometimes the addition or alteration, made by the mechanic and modestly termed an improvement, is the element of the inventor's success.

THE PRESERVATION OF TIMBER.

Perhaps the solution of no modern engineering problem has been more earnestly sought than a cheap, reliable, and universally applicable method of preserving timber. Although methods have been devised which approximately fulfill these conditions, there has yet been nothing attained that is suitable for universal adoption in architecture and in other branches of the arts.

It would appear at first sight an easy matter to preserve wood from decay, when it is remembered that the chief causes of decomposition, at least the chief immediate causes, are changes in its hygrometric condition. Rapid successions of dampness and dryness will speedily destroy most species of timber. There are a few species which are naturally protected by essential oils contained in their texture, but such woods are too rare and valuable for general use.

The physical characters of different kinds of timber afford the clue to the difficulties in solving this problem. Wood is a porous material of great absorbent power upon nearly all kinds of liquids. Many kinds will absorb their own weight of water under favorable circumstances, and part with a large portion of it again when exposed to warm currents of air. To preserve such woods from decay implies the stoppage of the pores, by filling them with some impervious substance or the saturation of the timber with some antiseptic material.

No process based upon either of these principles has as yet been discovered not attended with some drawbacks. Either the process is expensive, or the texture and grain of the wood suffer change, or its natural beauty is marred so as to render it unfit for ornamental work. The latter consideration may be left out of the account, when wood is to be applied to the coarser purposes of engineering, as piles, railroad-ties, pavements, etc., but the item of expense tells more heavily in these cases than in ornamental work, where the cost of the material is a small item in the cost of the structure.

But natural decay is not the only destructive agent against which it is desirable to provide. One of the greatest objections against wood for building purposes is its liability to destruction by fire. Many processes have been devised to remedy this evil, and although a recent Italian process has been favorably spoken of as being free from the objections pertaining to processes of earlier date, it is quite probable that further news respecting it may not be so favorable.

So far as we are aware, no process has ever been discovered that could be very cheaply applied to both the preservation of wood from decay, and also from fire, and which at the same time could be relied upon as certain. The most simple and the cheapest method adopted, has been that of the application of fireproof paints; but paints are liable to crack upon exposure, and from the natural shrinking and springing of timber, and thus give access to moisture. This method has been only partially successful.

It is impossible to give here anything like a detailed notice of the various wood-preserving processes. A whole class of them is included in the impregnation method, in which different chemicals possessing antiseptic properties have been forced by pressure or absorption into the pores of the timber. Sulphate of zinc, sulphate of copper, corrosive sublimate, creosote, carbolic acid, coal tar, etc., have been employed, the three last with the best results yet attained, so far as preservation from natural decay is concerned. None of these processes have been without failures in some instances. So far as these failures relate to the creosoting of wood, they are doubtless due to the imperfections in the method of performing the work. Sulphate of copper has also been used quite successfully but is expensive. The use of coal tar products is the cheapest method yet devised, but it is obviously unadapted to use where a finish is to be given to wood. The smell of timber thus preserved is also an objection to the process. We see then that anything like a perfect process for preserving timber under exposure to high temperatures and variations in hygrometric condition is yet to be devised. It may be that it is impossible to invent any method that shall cover all the conditions of the problem. The rich reward, however, which most certainly awaits the fortunate discoverer of such a method, ought to stimulate experiments in this field and give the world something far ahead of anything yet proposed.

VENTILATION IN BUILDINGS.

The topic of ventilation has been discussed and re-discussed, and a library might be collected of books and lectures and reports of learned societies upon the subject; yet churches, theaters, school houses, and private houses, judging from universal complaints, still remain unventilated. We hear, indeed, from time to time, of success in the use of apparatus for ventilating capital buildings, or parliament houses, but when circumstances compel us (as they do occasionally) to visit some such place, we find but little to praise in this respect. We however moderate our disappointment when we reflect how very difficult it must be to keep a pure atmosphere in these places. For the most part buildings in which people congregate are ventilated about as well as a certain horse car, the unwonted brilliancy of whose lamps elicited some inquiry on the part of a curious passenger. The phenomenon was explained by the scientific conductor's pointing out some flues admitting fresh air from the outside to the small cells inclosing the lamps, in order, as he learnedly stated, that the foul air from the lungs of the passengers might not totally extinguish them.

The amount of learning displayed in discourses on ventilation would make even our scientific conductor open his eyes. Few indeed who have not given a lifetime to the study of this important subject, can be aware of the intimate relations existing between the geological periods and the scientific mode of getting bad air out of a room and replacing it with pure air. It would be still more preposterous to suppose that ordinary practical minds could be able to grasp this subject without being first well grounded in the cosmical theories of La Place, and the "Principia" of Newton. In short the subject embraces, if the harangues and discourses of Professor this or Doctor that are any index to its magnitude—all the knowledge as yet attained by mankind, with a very large proportion of what is yet unattained.

An English journal states that Dr. Edward Smith, F. R. S., read a paper on ventilation before the Society of Arts, on the evening of the 24th of February, in which he treated the subject *comprehensively without recommending any particular plan.* Treating the subject comprehensively is the mode. Of what use is it to descend to particulars when so much science can be displayed in generalities? Of what use is it to teach others if we fail to show that we ourselves are learned?

The fact is that the science of ventilation is small, the art is easy, and the learned discourses which have lately dragged their tedious lengths along in the *Journal of the Franklin Institute*, and have burdened the pages of many other scientific journals, as well as the patience of their readers, are called for no more than learned discussions upon the problem how to avoid cutting two holes in a back door to let out two cats, one being a large one and the other a small one.

We have many times urged the supreme folly of treating the subject in the ridiculous manner described, and have given rules, the simple observance of which will insure well ventilated apartments. To apply these rules requires common sense, mechanical skill in construction, and arithmetic; "only these and nothing more." It seems, however, that upon this as upon many other subjects upon which we write frequently, we must repeat our lessons often. There is no subject upon which we receive so many inquiries.

First, then, the fundamental law upon which ventilation is based is, that hot air rises and cold air descends. It follows if the pure air admitted to a room be heated by a furnace, the impure air which is cooler will settle to the bottom of the apartment, at which the registers for its escape ought to be placed. If the room be heated by radiation, as with steam apparatus, stoves, etc., and the pure air be admitted cold, the registers should be at the top of the room.

Second, good ventilation can not be secured by using long flues, unless mechanical appliances, as fans, etc., or apparatus for heating them are employed. The air gets cold before it passes through them, and consequently ceases to rise, or rises but slowly. The best thing for this purpose is an open grate at the bottom of the room having for its chimney the flue through which the foul air is desired to pass.

Third, strong winds over the unprotected external mouths of flues, are apt to reverse or obstruct currents. The mouth of every flue should be covered with a hood so adjusted that it can rotate with the wind. The winds blowing from any quarter will thus aid rather than impede the egress of air from them.

Fourth, they, as well well as the flues for the admission of pure air, should be made of a size proportionate to the requirements of each particular case. Here the arithmetic comes in, and the data are as follows:

The number of respirations in a healthy adult per minute, is from 14 to 18. The average amount of air taken into the lungs at each respiration is about twenty inches. From this air the oxygen is removed, and its place supplied with carbonic acid at the mean rate of ·0435. From these figures it is easy to calculate the rate at which fresh air must be admitted to supply the demand or (as admission of fresh air implies in any proper system of ventilation the removal of foul air) the rate at which the foul air ought to be removed. The size of the escape flues ought to be proportioned to the size of the room, and the number of people it is intended to contain, which can be easily done by any competent architect. To those who are not competent we say, err if you must on the safe side, make the hole large enough for the adult cat and the kitten will also be accommodated. Of course if a building is not constructed so as to admit of proper ventilation, it will be impossible to ventilate it properly, a statement so logical that even Dr. Edward Smith, F. R. S., will not dispute it.

Fifth, the admission of pure air should be so adjusted when the air is not previously heated that all sharp drafts shall be avoided. This can easily be done by causing it to enter through wire gauze, breaking the currents by screens, etc., in the application of which means, common sense is of much more value than large scholastic acquirements. Thus ends our discourse upon ventilation, which if not so learned, will, we are confident, do more good than that of Dr. Edward Smith, F. R. S., before the Society of Arts, above mentioned.

TASTE AND SMELL--A NEW THEORY.

A scientific gentleman, in a recent conversation, broached to us a theory of taste and smell, which, so far as taste is concerned, is, we think, new. A similar theory in regard to smell has been propounded by Piesse, and is, we think, the true one.

The theory of odors hitherto accepted, has been, that invisible particles, emanating from bodies, and coming in contact with the olfactory nerves, produce the sensation of smell. Substances to be odoriferous, need, therefore, to be volatile to a certain extent.

Taste, says one author, "is merely a more delicate kind of touch." The nerves of the whole interior of the mouth are the ones supposed by some to be endowed with this "delicate touch," while others limit the nerves of taste to certain parts of the mouth, of which the tongue is chief. In general, substances insoluble in the fluids of the mouth, are regarded as being destitute of taste.

The nerves of special sensation have been a subject of most profound study on the part of physiologists, who have never yet been able to find in their anatomy or composition anything to account for their peculiar functions. Knowledge bearing upon the subject, therefore, relates principally to the external phenomena of special sensation, and it is to these that the theory of which we write entirely pertains.

The phenomena of sound have all been referred to vibrations of sonorous bodies, transmitted to the complex mechanism of the ear, by solid, liquid, or gaseous media, or a combination of such media. The phenomena of sight are also referred to vibrations of luminous bodies, transmitted to the eye by a medium called ether. In these sensations actual contact of the body, which is the primary cause of them, is known to be unessential. The new theory of taste and smell brings these sensations also into the category of impressions produced by vibration. In other words, these sensations are attributed to vibratory motions in external bodies, a knowledge of which is communicated to the mind through the nerves of taste and smell, in a manner analogous to that in which impressions caused by light and sound, are transmitted to the mind. In the case of taste, it is possible that no medium exists that can convey its impressions; the communication of such impressions must, if this be the case, be immediate, that is, the tongue must touch, in the popular sense, the thing tasted. There are, however, difficulties connected with this hypothesis, viz.: How are we to account for the absence of taste when insoluble substances are placed on the tongue? How, if fine division and intimate contact with the nerves of taste is essential to this sense, are we to account for the absence of taste when certain gases are taken into the mouth? Certainly, in the latter case, we have the minutest subdivision and as perfect contact, as is physically possible to obtain. It becomes evident, then, that there are bodies incapable of affecting this sense, as there are bodies which are non-luminous to the eye, and others which, to the ear, are deficient in sonorousness.

But, supposing no known medium to be able to convey impressions of taste to the nerves of that sense, the theory of vibrations does not, on that account, become untenable. We are far from believing, however, that the subject has been studied sufficiently to pronounce with certainty upon this point.

The corpuscular theory of light has been discarded as failing wholly to account for optical phenomena. In like manner have the theories of phlogiston and caloric successively given way to more enlightened views. Both light and heat are now considered as modes of motion.

If now we retain the corpuscular hypothesis for the sense of smell, we suppose that to be the most delicate of all the senses, for by it we may, without artificial help, detect quantities of matter so small that they can be detected by no other sense, even though aided by the most powerful instruments science has been able to devise or art to construct. If we consider the act of smelling as only a more delicate kind of touch, as it has hitherto been thought, we suppose the power of sensation in the olfactory nerves infinitely superior to any others. Some illustrations will make this appear in a stronger light. A grain of musk exposed for six months in a large room, communicates its odor to all the bodies in the room, *without any sensible loss of weight*. If a handkerchief thus perfumed with musk, be exposed to the most critical examination by the microscope, no musk can be detected deposited in its fibers. But, it may be said, the odoriferous principle exists in a gaseous state. If this were so, it might be reasonably supposed that delicate chemical tests would afford a trace of its presence, but they do not. Does not, then, the vibratory theory conflict less with the facts in this case than the theory of emanations? The only grounds we have upon which to base the hypothesis of emanations is a sensation produced, and we have the same ground for believing that light and heat are emanations.

But, it may be asked, how can the smell in the handkerchief be accounted for if the musk be not present? To this it is answered, in the same way that sensible heat in a body is accounted for, after it is removed from a contact with another heated body, or fluorescence in bodies after exposure to sunlight. These phenomena are referred to the continuance of vibrations in bodies after the exciting cause is removed. It does no violence to analogy to suppose the same cause as continuing the effect of an odor, after the primary cause is removed.

A bar of block tin, when rubbed, emits a peculiar smell. No test, however delicate, can demonstrate the presence of metallic particles in the air or of the oxide or salts of tin, in this experiment. Applying the same reasoning adopted in relation to sound, heat, and light, it is extremely difficult to believe that smell, in this case, in produced by actual contact.

It is well known that perfumes blend harmoniously when combined according to a scale, which may be represented by a gamut, in which different odors correspond to different musical sounds; and the other analogies between smell and sound are indeed very striking, as is shown by Piesse, in his work on "The Art of Perfumery," second section.

A wide field of study and experiment is here opened, and, we have no doubt, that in future works on physics, the subjects of odor and taste are destined to find a place by the side of heat, light, sound, and electricity.

BEET ROOT SUGAR.

No. III.

CULTURE OF THE BEET.

CLIMATE.—Few of our cultivated plants thrive under more varied conditions of climate than does the beet. It is grown in Europe, from the shores of the Mediterranean to very near the Arctic circle, and from the Atlantic to the Caspian Sea, so that in few portions of the United States would meteorological conditions offer any obstacle to its successful cultivation. The relative season for sowing, so that it can be harvested in the right time, can be so regulated by the intelligent cultivator, according to the degree of latitude, so as to suit the exigences of the manufacturer.

Heat and moisture being needed in considerable quantities for its perfect development, very cold or very dry localities will alone prove antagonistic to its profitable production as a sugar plant.

The seed germinates at a temperature of 44° Fah.; the root rots on thawing if exposed to a cold much below the freezing point.

SOIL.—The beet vegetates in all soils, but a sandy loam or an argillaceous soil is the best suited to its nature. In chalky soils or very sandy ones, its development is stunted. It prospers in light, silicious ground if this be rich in humus or in manure. A medium consistence between stiff and light is the best for it, but too stiff soils are preferable to too light ones.

The soil for beets must be loose, fresh, and free from stones. If water is contained in the subsoil, it must be artificially drained.

A certain amount of lime in the soil is advantageous, but it must contain no *excess* of potash or soda, as these salts have a deleterious influence on the ulterior production of sugar during the process of manufacture.

It is best, for many reasons, not to grow beet as a first crop on newly-cleared lands. This plant having a long, taper root, the radicles of which penetrate far down into the ground, the necessity of a deep and well-pulverized soil is apparent.

PREPARATION OF THE GROUND.—The instructions for this purpose may be summed up as follows: Plow deep in the autumn or early winter; better twice than once. This may best be done by means of two successive plowings with an ordinary plow or by the use of a subsoil plow. The following spring pass a heavy iron-toothed harrow over the land, and follow this soon after by a scarifier. After this, spread your manure equally over the land and plow it in to a depth of four or five inches.

Harrow and roll with an iron roller so as to equalize the surface and break up clods, and the field is ready to receive the seed. These last operations must, if possible, be performed before the month of April.

SOWING.—Our instructions in this case are: In the first place, purchase your seed, fresh imported, from a reliable dealer, or import it yourself until you can make your own (which will require two years). The amount needed per acre will be from ten to twelve pounds, which can be purchased in New York, at present prices, at 50 cents per pound, for small quantities of from ten to fifty pounds, with a very liberal discount for larger amounts.

The seed, before sowing, is soaked in water for 24 hours, and piled up into small heaps until signs of approaching germination are manifested. It is then rolled in fine dust-bone black, which forms a dry adherent coating.

The land by this time must have been very carefully "marked," or laid out in regular superficial lines or grooves running at right angles to each other. This is done by means of a special implement drawn by a horse. These lines are so distanced that those in one parallel series are placed at one foot six inches, and those in the other at one foot ten inches from one another. One beet root is destined to be grown at the angle of each quadrangle formed by these intersections, so that one acre of land produces between 21,000 and 22,000 beets. The marking has to be done with great accuracy, as the subsequent horse hoeings would be impossible if the regularity of the rows was imperfect.

The seed is sown by manual labor or by horse power. In the first case this is done by special hand machines, which rapidly deposit the seed along with a minute quantity of some dry, pulverulent fertilizer at the angle of the square "marked," as above described. It is then covered by passing a roller over the ground.

More generally, however, the seed is drilled into the land by a sowing machine, drawn by one or two horses, that sows several rows at a time. These machines, of which many various kinds are at present in use in Europe, generally open a groove in the ground, drop the seed in a continuous stream into this groove, deposit along with it a small amount of superphosphate or other finely-comminuted fertilizer, and finally cover the seed, all in one operation. The seed ought to be buried at a depth of from 1½ to 2 inches.

If the season is propitious, the young plants will show themselves above the surface in from eight to twelve days.

The time of year for sowing the seed must, in the United States, vary according to localities, from the 1st of March in the Southern States to the first week in May in the Northern. The average for our Middle States, East and West, would correspond to about the 15th of April, or as near to this date as circumstances will allow.

CARE OF THE GROWING CROP.—Very soon after the young beets have fairly shown themselves, or even before this, if weeds are thick, and the original drill lines or marks are still visible, a horse hoe is lightly run across the field between the 18-inch rows.

This implement is made to take from three to five rows at one time, in which cases it is, respectively, drawn by one or by two horses. As soon as this operation has been performed, the small beet plants are "thinned" in the rows by means of a broad-bladed hand hoe, which is by two successive strokes of the laborer made to clear a little less than one foot ten inches of the space to be left between two plants in the same row. With skillful drivers this operation may also be performed by the horse hoe; the implement in this case being so constructed as to allow of varying at will the distance between the hoes.

A workman, or woman, with a small, short-handled grubber now follows, and stirs the earth carefully around each plant, so as to loosen the soil, and to leave only one beet at the end of each determined interval.

A few rows of young beets must be left in each field untouched, or only "thinned," in order to allow by transplantation the filling up at some future period (generally after the second hoeing, or when the root has attained about half an inch in diameter) of any vacant spaces in the line produced by the non-germination of seed, late severe frosts, or other accidental causes. The transplanting is done by hand, and the replanting with a blunt-pointed, hard, wooden borer, great care being taken not to injure the young roots when taking them up or during their transportation. These last operations are often satisfactorily performed by means of a "*deplantoir*," or "transplanter," a special instrument constructed for the purpose.

After this period, two successive horse hoeings will, in most cases, generally suffice to keep the ground clear of weeds until the foliage of the beet itself will become a self-protector by smothering all spontaneous vegetation between the rows. In some instances, however, when the soil is particularly foul, or when it has become caked by the combined influence of excess of rain and heat, it may become necessary to repeat the hoeings once or twice more, and it may prove beneficial to "earth up" the beets, either by means of special contrivances adapted to the horse hoe itself or by using a very light mold-board plow.