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Contents.

(Illustrated articles are marked with an asterisk.)

THE SCIENTIFIC AMERICAN SUPPLEMENT.
Vol. II., No. 2.
For the Week ending July 8, 1876.
TABLE OF CONTENTS.

PRACTICAL APPLICATIONS OF THE SPECTROSCOPE.

The uses of the spectroscope may at present be divided into eight classes. The first use is the observation of the luminous colored lines in the spectra of flames, which lines, as it is well known, appear in sets or systems, each substance producing a set of lines, peculiar to itself and not appertaining to any other substance: so that by this means many of the component elements of a substance may be determined by direct observation, without the necessity of going through the laborious process of chemical analysis. Another advantage is that the minutest quantity of material is sufficient for this method: a quantity so small that it would not suffice for a chemical test made in the ordinary way, even if assisted by the microscope.

The second process is effected by enclosing the substance to be examined in a gaseous or vaporous condition in a glass tube, rarefying the gas or vapor, and illuminating it by the passage of an electric spark. Then special lines will appear, which differ, in some instances, from the lines produced by the same substance in a flame, and this by reason of the higher temperature: the local temperature of the atom when exposed to the electric current being the highest we can produce. The current does not heat up the tube, because its quantity of heat is too small, notwithstanding that it is of great intensity. It is evident that any substances easily volatilized, or gases, are adapted to this method of investigation.

The third class of spectroscope observations is especially adapted to solids, and consists in observing the spectrum of the electric spark passing between electrodes of the material to be investigated. Thus the spark passing between two copper electrodes will show the copper line, between iron electrodes the iron lines, etc. The spectrum seen in this way will also be affected by the spectrum of the atmosphere, gas, or vapor between the electrodes, through which the electric spark forces a passage.

A fourth class of observations may be made with the above method, using not the spectroscope, but a microscope with a spectroscopic eyepiece. The easiest way to submit the material under investigation to this test is to reduce the metal to the state of thin foil or plate, cut out a few pointed strips, and attach them to an ordinary glass slide, with the points a distance of $\frac{1}{8}$ of an inch or less apart; then connect them with the poles of a small induction coil, and bring the space between the metallic points into the field and focus of the instrument. Then apply the spectroscopic eyepiece, let the current pass, and the peculiar spectrum of the metal will be seen.

A fifth use of the spectroscope is by attaching the spectroscopic eyepiece to the telescope in place of the microscope: this constitutes one of the most important uses of the spectroscope, and has given rise to a new branch of science, astronomical chemistry; and by its means we have been able to determine the chemical constitution of the sun, stars, and comets, and also of the atmosphere of most of the planets.

A sixth use of the spectroscope consists in the observation of the absorption spectra, when the light forming a complete spectrum is made to pass through a colored transparent medium. A colored glass or a colored liquid is in fact a kind of filter, which lets rays only of a certain color pass, and obstructs all the others. White light consisting of all rays of light, as is proved by its analysis by the spectroscope, we can change it into red by removing all the orange, yellow, green, blue, and violet rays, and this is what a purely red glass or a red liquid accomplishes; we can change it also into blue by removing all the red, orange, yellow, green, and violet rays, and this is what a purely blue glass effects. If, however, we test different colored media in this way with the spectroscope, we find that there are very few pure colors, as most of them will not extinguish all the colors different from their own: thus, for instance, indigo, which is blue, will not extinguish all the red, and its color therefore contains red in its composition. Red blood will not extinguish the blue, but only a portion of the green, forming two broad bands in that part of the spectrum, called the blood bands. These bands are so characteristic of blood, belonging to no other substance whatsoever, that they serve as the basis for legal evidence as to whether suspected spots are blood or not. Some substances, like chlorophyllin, the green coloring matter of leaves, produce a series of such absorption bands in different parts of the spectrum, quite self-characteristic and distinguishing them from all other substances of apparently the same color.

As a seventh class of observations, we may consider the absorption bands produced by colored gases and vapors, such as nitric oxide (especially when heated), chlorine, bromine vapor, iodine vapor, etc., all of which produce peculiar absorption spectra.

Finally we may add an eighth class of observations, that of opaque substances visible by reflected light. Observations of this class are in many instances best made by the microscope armed with a spectroscopic eyepiece; and such observations are best made in direct sunlight. When the sun shines on a piece of white paper placed under the spectro-microscope, the complete spectrum will be seen; but if on the paper a colored spot be present, and this be brought into the field, at once absorption bands will appear, which will of course differ, not only for substances of every color, but also for substances of the same color, if they be composed of different ingredients. A useful application of this property was recently made by Dr. P. H. Vander Weyde, and was mentioned by us on page 293 of our volume XXXIV. Dr. Vander Weyde was a witness in a case before the courts, involving an amount of nearly $100,000, which depended on the question whether the signature certifying a check was genuine or not. One of the arguments brought forward to show that the signature was forged was that the blue ink with which it was written was of a kind different from that used at the bank where the check was claimed to have been certified. Fortunately the different kinds of blue used for inks can easily be distinguished, one from the other, by spectroscopic analysis. Indigo will absorb the whole spectrum except the blue and red; blue verdigris will absorb all except the blue and green; permanent blue will leave, besides the blue, part of the violet visible; Prussian blue will absorb all except the blue. The spectra are of course modified and even disturbed by the enlargement of the coarse fibers of the paper on which the writing is done; and the spectral colors are, in some spots, darker or more intense, in others paler and almost colorless; but after careful comparison with the spectra of various inks, the peculiar absorption of the Prussian blue is seen to be so characteristic that no doubt was left but that the ink used for the check in question was of the same kind as that used for other checks acknowledged to be genuine. The researches described of course cannot settle a matter of the kind in dispute, and are not claimed to do so. All that was intended was to disprove the allegation of the defense that the inks were different; and this it did most effectually, notwithstanding that the spectroscope could not show that the ink of the different signatures proceeded from the same inkstand.

WHY ARE WE RIGHT-HANDED?

There is, in Sir Charles Bell's Bridgwater treatise, a quaintly-worded passage in which the author endeavors to deal with the reason why we normally use the right hand in preference to the left. After a surfeit of Haeckel and Darwin: after, as must be the case when one attempts to keep *en rapport* with modern scientific thought, becoming fairly imbued with the notion that distinct creative acts never took place, and that the fire mist and the primal germ are our legitimate ancestors in unbroken line: there is something positively refreshing to turn back to earlier writings, and there to find a material theory contemptuously dismissed in order that the author may anchor his faith to the idea that man was created right-handed by Divine intention. He says that "the preference of the right hand is not the effect of habit, but is a natural provision, and is bestowed for a very obvious purpose"; but what that purpose is he fails to make clear, except inferentially in the statement that "there ought to be no hesitation which hand is to be used or which foot is to be put forward; nor is there, in fact, any such indecision." Any one who has ever witnessed the amusing spectacle of a squad of raw recruits learning the goose step will be disposed to combat this last assertion. It requires longer teaching than would be imagined to impress upon the embryo soldier that the left foot is first to be moved. Experience goes clearly to show, besides, that the average individual steps off indiscriminately with either foot; and hence the selection of the left foot, merely to secure uniformity in the military files, has been made, though the very fact again is curiously at variance with the above author's intimation that a heaven-implanted instinct teaches us to put the right foot forward.

We have mentioned Bell's treatise, not, however, for the sake of the theory which he maintains, but for the one which he rejects in a few brief lines. "It is affirmed," he says, "that the trunk of the artery going to the right arm passes off from the heart so as to admit the blood directly and more forcibly into the small vessels of the arm. This is assigning a cause which is unequal to the effect," he adds; and probably supposing that no other causes would ever be combined therewith to bring it up to equality, he curtly pronounces it a "participation in the common error of seeking in the mechanism the cause of phenomena which have a deeper source," said source being supernatural. For the man who discovered the functions of motion and sensation pertaining to the brain and spinal marrow: who located the sensory nerves, and those which form the wonderful telegraph commanded by the will, and who showed that the nerves of the different senses are connected with distinct portions of the brain, so implicit a belief in the active interference of an Unknown Power with human mechanics is indeed strange. It is to this faith, however, that must be ascribed this neglect to prosecute the investigations which, very recently carried through by a French physician, Dr Fleury, of Bordeaux, have adduced facts showing that our natural impulse to use the members on the right side of the body is clearly traceable to probably physiological causes.

Dr. Fleury, after examining an immense number of human encephala, asserts that the left anterior lobe is a little larger than the right one. Again he shows that, by examining a large number of people, there is an unequal supply of blood to the two sides of the body. The brachio-cephalic trunk, which only exists on the right of the arch of the aorta, produces, by a difference in termination, an inequality in the waves of red blood which travel from right to left. Moreover, the diameters of the subclavian arteries on each side are different, that on the right being noticeably larger.

The left lobe of the brain, therefore, being more richly hematosed than the right, becomes stronger; and as, by the intersection of the nervous fiber, it commands the right side of the body, it is obvious that that side will be more readily controlled. This furnishes one reason for the natural preference for the right hand, and another is found in the increased supply of blood from the subclavian artery. The augmentation of blood we have already seen suggested above; but the reason for it is here ascribed to the relative size of the artery, and not to any directness of path from the heart. Dr. Fleury has carried his investigations through

the whole series of mammifers; and he finds that the right-handed peculiarity exists in all that have arteries arranged similar to those of man. At the same time, such animals, notably the chimpanzee, the seals, and the beavers, are notably the most adroit and intelligent.

THE PATENT DRIVE WELL.

The long pending litigation in connection with the patent drive well has reached its first stage of settlement by the decision of Judge Benedict, U. S. Circuit Court, this city, an abstract of which we publish in another column.

Judge Benedict gives many interesting particulars concerning this invention, sustains the patent of Nelson W. Green therefor, and awards to him the honors of priority. This decision, unless hereafter reversed by the Supreme Court of the United States, brings all drive wells heretofore put down without the consent of Green, his assigns or agents, within the category of infringements. The number of wells now in use, not authorized by the original patentee, is very large; consequently the aggregate amount of royalties to be collected by the owners must be great. We have heard it said that the total sum was over two millions of dollars.

The Green patent has heretofore been resisted on the ground that the invention was insufficient to support a patent, as it only consisted in running a tube down into a pool of water and applying a pump, which was an old idea, in common use long prior to the grant of the patent. Another reason for resistance was the alleged prior invention of Byron Mudge, who was one of Green's assistants in the early trials of the improvement. Judge Benedict holds that these and all the other alleged grounds of opposition to Green's patent are untenable.

The early history of the drive well is interesting and instructive. It appears from Judge Benedict's decision that Nelson W. Green, the inventor, was the Colonel of the Seventy-Sixth Regiment, which he had formed, then—1861-62—stationed at Cortland, N. Y. Rumors were current that the rebels intended to carry out a general system for killing off the Union troops by poisoning all the wells as fast as the men advanced. It was to defeat this nefarious project that Colonel Green invented the drive well, which he immediately tried in his own camp grounds, with complete success. From this beginning the invention has spread not only over this country, but throughout the world; and the war departments of nearly all governments now attach to their military branches special corps and wagons to convey and operate the American drive wells wherever their armies move. One of the witnesses stated that one hundred and fifty thousand of these wells were in operation in New York State alone. Over a hundred and fifty patents have been granted for improvements. The drive well ranks almost next to the sewing machine in point of utility as a domestic apparatus. In thousands of localities it is only necessary to drive, with a mallet, a tube down through the kitchen floor into the ground, in order to command an abundant supply of pure water; thus the dwelling, the barn, and other parts of one's premises may be quickly and cheaply supplied. We have seen one of these wells inserted and finished, and animals drinking from the water it supplied, all within half an hour from the time the operator began his work.

Modern improvements, as all must admit, are highly useful and convenient to society in general; but it cannot be denied that they are sadly destructive of the romance and poetry that twine about the good oldfashioned ways of doing things. Take the drive well, for example. The lad of the rising generation clacks a squeaky pump handle, bends himself double, and sticks his face under a rusty spout, in order to get a drink of water. He knows nothing about the delights of the bucket, and the original method of water lifting, so charmingly described half a century ago by Woodworth:

"The old oaken bucket, the iron-bound bucket,
The moss-covered bucket which hung in the well.
How ardent I seized it with hands that were glowing,
How quick to the white pebbled bottom it fell,
Then soon with the emblem of truth overflowing,
And dripping with coolness, it rose from the well.

How sweet from the green mossy brim to receive it,
As, poised on the curb, it inclined to my lips;
Not a full blushing goblet could tempt me to leave it,
Though filled with the nectar that Jupiter sips.
The old oaken bucket, the iron-bound bucket,
The moss-covered bucket arose from the well."

DANGEROUS ARCHITECTURE.

The Chicago Chapter of the American Institute of Architects has lately found occasion to discipline a well known member for a violation of professional ethics, involved in supplying a couple of contractors with working drawings of a building now in progress, and receiving pay therefor, when no fees should be received, it appears according to their decision, other than from the client. We have no desire to criticize the architectural code of ethics, the refinement of which the above serves well to indicate; but the question suggests itself as to whether in that code there is any provision whereby the architect who builds houses which, in point of sanitary precautions, are death traps can be called to an accounting. If not, we submit that it is time that some check of the kind were devised. Quite recently in this city, we have seen the heirs of an eminent architect suing the people for $800,000 fees for plans and superintending the building of an edifice, only partially completed, which is little more than a nest of airtight boxes, and which is so badly constructed that sanitary experts now insist that improvements involving heavy expense, pointing almost to a radical change in plan, must be made before it can be pronounced healthy. Several of our most eminent judges have been rendered dangerously unwell through holding court in the rooms, to the great detriment of public business.

Architects and plumbers deserve to be gaged by different rules from other professions and trades, for the reason that the largest part of their work is out of sight; and many a bad defect may be rendered invisible until it asserts itself through the fair exterior. We know when a physician does his work well, and we have a remedy against him for malpractice. So also the law protects us against ignorant or conscienceless lawyers; but there are few cases where the owner of property has refused to pay his architect on the ground that the design is radically bad. The defense that the proprietor accepted the plan, which the professional gentleman would urge, seems to us a specious one, for it presupposes an expert knowledge in the layman, whose only object in consulting the architect is to obtain expert assistance. A precisely parallel case would be that of an engineer who should defend himself against a charge of waste or bad fitting or bad material, in the engine entrusted to him to build, by saying that his client had selected that type of engine in preference to others submitted.

We are quite aware that there are a great many painstaking architects who know the faults of their brethren and lament them; but that does no help matters. What we want is a class of architects who can do something more than put the confused notions of their clients into tasteful shapes. It is their business to be sanitary engineers as well as architects; and it is time that the fact were generally understood that it is a worse fault to put abominably designed drains and ventilating arrangements in a building than to make the exterior a combination of all known styles, and the interior richer in hallways than in apartments. Here are two cases of flagrant malpractice which we take from the recent report of the Massachusetts Board of Health. A conspicuous public building, costing nearly $200,000, became pervaded with a nauseous odor, which grew apace until the occupation of the edifice was rendered dangerous. Under the cellar floor were found some square cesspools, into which various drain pipes entered, and from which a brick drain, covered with flat stones, led. One of these reservoirs of filth overflowed and saturated the concrete pavement, so that the stench remained permanent for a long time after the cesspool was abolished. What good service the cesspool served is past comprehension; and the brick drain, in these days of smooth pipes, evinced the ignorance or cupidity of the planner. Another architect put a huge brick drain under a building for the length of 200 feet. It was too large for self-cleaning, and consequently became a prolonged cesspool. In addition to this, another reservoir was arranged outside the building, where the sewage of five hundred persons was allowed to accumulate. And all this in the immediate presence of a good and sufficient sewer.

Now these defects might well have resulted in epidemics and deaths. Who is answerable? The landlord, we have heard it recently stated; and even in public journals, tenants have been urged to sue the proprietors for damages when illness or death occurs in their family through faulty construction in the house. Legally, the landlord may be responsible; but we cannot consider him morally so, certainly, in such cases as are above cited Would not then, the American Institute of Architects do the community a service by bringing members who evince ignorance in the matters we have pointed out to a rigid account? Certainly there is no code of ethics which will not warrant the stern censure of men who, by careless or incompetence, not only bring discredit upon their profession, but imperil the lives of their fellow beings. It is needless to say that such censure should be so marked as to result in a withdrawal of public confidence from the person disciplined.

THE CENTENNIAL EXPOSITION.

The judges in group 21, on metal, wood, and steel working machinery, have nearly completed their work. Out of 600 exhibits in their group, more than 300, it is reported, will receive bronze medals with written certificates of excellence. Attendance at the Exposition now averages from 20,000 to 30,000 people a day; but a decrease is expected during the harvesting season, which will be followed by larger crowds than have yet appeared, during the cool fall months. It seems reasonably certain that, financially, the Exposition will make some profit rather than show a deficit. The hotel and boarding housekeepers of Philadelphia are not reaping the rich returns so confidently expected. When the immense throng, attracted by the opening day ceremonies, visited the city, speculators thought their opportunity had come, and prices were exacted in accordance with their elevated notions. When the people dispersed after the ceremonies, they advertised the condition of affairs; and as a result, those houses which charged exhorbitantly are now avoided. Thousands of visitors who intended residing in the city during their short stay now strain a point to find accommodations in the suburbs, or even in New York. It is reported that the permanent increase in Philadelphia does not now exceed 10,000 people, and that dozens of lodging houses, fitted up near the Centennial grounds, have been closed from lack of business.

Dom Pedro has again visited the Exposition, and has made a minute survey of its contents. The marvelous work of the Walter press, on which an edition of the New York *Times* is daily printed, is said to have astonished him more than all else. The Tunis *café*, that of the strange musicians and dancing woman, was recently shut up by the authorities, because visitors were compelled to purchase a little cup of coffee for twenty-five cents, in order to gain admittance. This was considered virtually requiring an admission fee, which is contrary to the regulations.

It is said that the judges on machine tools are seriously puzzled to know how to award proper distinctions. The competition is so remarkably close, and most of the tools are so good, that the judges assert that nothing but the most severe tests will enable them to arrive at impartial conclusions. Some time ago, in an editorial, we deprecated the habit workmen have got into of nickel-plating their productions, and suggested that, for objects exhibited at the Centennial, it would be much more satisfactory to finish with the file and scraper. These tools are difficult to handle; but when skillfully managed the results they give speak very plainly for the ability of the workmen. The Putman Machine Company, of Fitchburg, Mass., seem to have adopted this advice, and a number of excellent machine tools are thus finished. Plain surfaces, handles, wheels, and gearing are all brilliantly finished; and many an expert mechanic has been heard to inveigh somewhat contemptuously against "this shiftless habit of nickel plating" before bringing his eyes close to the metal and discovering the virgin surface.

ACCURATE TOOLS.

A prominent feature of the display of the Pratt & Whitney Company, of Hartford, Conn., is the gages, the accuracy and fit of which are remarkable. A specimen of the work of the finely made tools manufactured by the above concern is exhibited in a pistol, which is shown in the condition in which it left the machines, without having undergone any subsequent finishing operation. Both the finish and the fit of the parts are excellent.

We have already stated that the general arrangement of the Exposition is such as to render it not easy for the visitor to obtain readily a comprehensive view of any one class of objects. For this reason it is difficult to realize, until one has become familiar with the general aspects of the display, how complete the collection are. Take, for example,

FISH.

To acquire all the available information of an icthyological nature, it is necessary to visit almost every department and section. Scores of fish of various species may be studied alive in the aquaria of Agricultural Hall, or may be seen frozen in the refrigerators. Or, if the visitor desires to study fish more comprehensively, he may, by stepping over to the Government Building, examine a large series of finely colored plaster casts of ocean edible, and other fish. Superb collections of fish, prepared in alcohol, as scientific specimens, are to be found in the Norwegian and Swedish sections, and besides these are stuffed fish in endles variety.

If fish as food be the object of an investigation, the visitor may examine every preparation of it that can be conceived. France has a remarkable collection of fish preparations, and, in fact, almost every nation which catches fish has a representation at the Centennial. Japan forwards smoked salmon, done up in bags, like hams. China sends powdered fish, and Norway a similar exhibit of fish meal. From Oregon comes salmon packed in cans of various sizes and sorts.

If it be desired to know about the many articles, useful in arts and industries, derived from fish, the visitor may see oils obtained from various fishes, isinglass, with sizes and glues, fish skins tanned to excellent leather, besides scores of other utilizations, down to delicate fancy work ornaments made of fish bones and scales.

Fishermen will find tackle, from the heavy surface and trawl lines used in the cod fisheries down to the delicate gossamer threads and flies for trout. Then there are the more important implements used by whalers and others, such as the common harpoons, gun harpoons, lances, and walrus spears, besides the rakes and tongs used by oystermen. Nets of all kinds, some made of bamboo, some of whalebone, some even of human hair, may be seen; and with them all the various traps and pots, rods and reels, artificial bait, fishing baskets, boats of every conceivable shape, from kyales up to whaling vessels; all the inventions for curing fish, refrigerators, apparatus for drying fish in the sun, models of smoke houses, all the machinery for producing fish oil, and for preparing fish guano; may be foundin the collection.

Should the visitor prefer devoting himself wholly to the scientific consideration of fish, he can look at the Agassiz collecting tank, and the preserving mixtures, by the aid of which fine specimens can be brought from far-off lands. He can see how Professor Baird models his casts of fish out of *papier machē* and plaster, and also examine the methods for drying the skins of fish for scientific use, and even the photographic instruments employed to take pictures of fish. Then there is the subject of fish culture, including the pans, pails, spawning vats; and later in the season, the actual habits of the fish during the spawning may be watched. Allied closely to the subject of fishes are those of sponges and seaweed, of pearls and pearl oysters, and of corals. We have only indicated the extent of the collection as a whole. To describe the various specimens or the different appliances would fill a volume; the above, however, will suffice to afford a general idea of the time and labor which a careful examination of all the fish of the world, as gathered in the Centennial buildings, will require, and give the reader an idea of the task before him if he visits the Exhibition with the intention of studying the industries of this one class of exhibits.

To make aqua regia, distil together 16 ozs. spirit of niter and 4 ozs. common salt. Another way is to mix equal parts nitric acid and muriatic acid, or nitric acid 2 parts and muriatic acid 1 part.