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HON. HIRAM SIBLEY.

Hon. Hiram Sibley, of the city of Rochester, a man of national reputation as the originator of great enterprises, and as the most extensive farmer and seedsman in this country, was born at North Adams, Berkshire County, Mass., February 6, 1807, and is the second son of Benjamin and Zilpha Davis Sibley. Benjamin was the son of Timothy Sibley, of Sutton, Mass., who was the father of fifteen children—twelve sons and three daughters; eight of these, including Benjamin, lived to the aggregate age of 677 years, an average of about seventy-five years and three months. From the most unpromising beginnings, without education, Hiram Sibley has risen to a postion of usefulness and influence. His youth was passed among his native hills. He was a mechanical genius by nature. Banter with a neighboring shoemaker led to his attempt to make a shoe on the spot, and he was at once placed on the shoemaker's bench.

At the age of sixteen he migrated to the Genesee Valley, where he was employed in a machine shop, and subsequently in wool carding. Before he was of age he had mastered five different trades. Three of these years were passed in Livingston County. His first occupation on his own account was as a shoemaker at North Adams; then he did business successfully as a machinist and wool carder in Livingston County, N.Y.; after which he established himself at Mendon, fourteen miles south of Rochester, a manufacturing village, now known as Sibleyville, where he had a foundry and machine shop. When in the wool carding business at Sparta and Mount Morris, in Livingston County, he worked in the same shop, located near the line of the two towns, where Millard Filmore had been employed and learned his trade; beginning just after a farewell ball was given to Mr. Filmore by his fellow workmen.

Increase of reputation and influence brought Mr. Sibley opportunities for office. He was elected by the Democrats Sheriff of Monroe County in 1843 when he removed to Rochester; but his political career was short, for a more important matter was occupying his mind. From the moment of the first success of Professor Morse with his experiments in telegraphy, Mr. Sibley had been quick to discern the vast promise of the invention; and in 1840 he went to Washington to assist Professor Morse and Ezra Cornell in procuring an appropriation of $40,000 from Congress to build a line from Washington to Baltimore, the first put up in America. Strong prejudices had to be overcome. On Mr. Sibley's meeting the chairman of the committee having the matter in charge, and expressing the hope that the application would be granted, he received for answer: "We had made up our minds to allow the appropriation, when the Professor came in and upset everything. Why! he undertook to tell us that he could send ten words from Washington to Baltimore in two minutes. Good heavens! Twenty minutes is quick enough, but two minutes is nonsense. The Professor is too radical and visionary, and I doubt if the committee recommend the sum to be risked in such a manner." Mr. Sibley's sound arguments and persuasiveness prevailed, though he took care not to say what he believed, that the Professor was right as to the two minutes. Their joint efforts secured the subsidy of $40,000.

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This example stimulated other inventors, and in a few years several patents were in use, and various lines had been constructed by different companies. The business was so divided as to be always unprofitable. Mr. Sibley conceived the plan of uniting all the patents and companies in one organization. After three years of almost unceasing toil, he succeeded in buying up the stock of the different corporations, some of it at a price as low as two cents on the dollar, and in consolidating the lines which then extended over portions of thirteen States. The Western Union Telegraph Company was then organized, with Mr. Sibley as the first president. Under his management for sixteen years, the number of telegraph offices was increased from 132 to over 4,000, and the value of the property from $220,000 to $48,000,000.

In the project of uniting the Atlantic and Pacific by a line to California, he stood nearly alone. At a meeting of the prominent telegraph men of New York, a committee was appointed to report upon his proposed plan, whose verdict was that it would be next to impossible to build the line; that, if built, the Indians would destroy it; and that it would not pay, even if built, and not destroyed. His reply was characteristic; that it should be built, if he had to build it alone. He went to Washington, procured the necessary legislation, and was the sole contractor with the Government. The Western Union Telegraph Company afterward assumed the contract, and built the line, under Mr. Sibley's administration as president, ten years in advance of the railroad.

[Illustration: *Hiram Sibley*.]

Not satisfied with this success at home, he sought to unite the two hemispheres by way of Alaska and Siberia, under P. McD. Collins' franchise. On visiting Russia with Mr. Collins in the winter of 1864-5, he was cordially received and entertained by the Czar, who approved the plan. A most favorable impression had preceded him. For when the Russian squadron visited New York in 1863—the year after Russia and Great Britain had declined the overture of the French government for joint mediation in the American conflict—Mr. Sibley and other prominent gentlemen were untiring in efforts to entertain the Russian admiral, Lusoffski, in a becoming mariner. Mr. Sibley was among the foremost in the arrangements of the committee of reception. So marked were his personal kindnesses that when the admiral returned he mentioned Mr. Sibley by name to the Emperor Alexander, and thus unexpectedly prepared the way for the friendship of that generous monarch. During Mr. Sibley's stay in St. Petersburg, he was honored in a manner only accorded to those who enjoy the special favor of royalty. Just before his arrival the Czar had returned from the burial of his son at Nice; and, in accordance with a long honored custom when the head of the empire goes abroad and returns, he held the ceremony of "counting the emperor's

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jewels;" which means an invitation to those whom his majesty desires to compliment as his friends, without regard to court etiquette or the formalities of official rank. At this grand reception in the palace at Tsarskozela, seventeen miles from St. Petersburg, Mr. Sibley was the second on the list, the French ambassador being the first, and Prince Gortchakoff, the Prime Minister, the third. This order was observed also in the procession of 250 court carriages with outriders, Mr. Sibley's carriage being the second in the line. On this occasion Prince Gortchakoff turning to Mr. Sibley, said: "Sir, if I remember rightly, in the course of a very pleasant conversation had with you a few days since, at the State department, you expressed your surprise at the pomp and circumstance attending upon all court ceremony. Now, sir, when you take precedence of the Prime Minister, I trust you are more reconciled to the usage attendant upon royalty, which was so repugnant to your democratic ideas." Such an honor was greatly appreciated by Mr. Sibley; for it meant the most sincere respect of the "Autocrat of all the Russias" for the people of the United States, and a recognition of the courtesies conferred upon his fleet when in American waters.

Mr. Sibley was duly complimented by the members of the royal family and others present, including the ambassadors of the great powers. Mr. Collins, his colleague in the telegraph enterprise, shared in these attentions. Mr. Sibley was recorded in the official blue book of the State department of St. Petersburg as "the distinguished American," by which title he was generally known. Of this book he has a copy as a souvenir of his Russian experience. His intercourse with the Russian authorities was also facilitated by a very complimentary letter from Secretary Seward to Prince Gortchakoff. The Russian government agreed to build the line from Irkootsk to the mouth of the Amoor River. After 1,500 miles of wire had been put up, the final success of the Atlantic cable caused the abandonment of the line, at a loss of $3,000,000. This was a loss in the midst of success, for Mr. Sibley had demonstrated the feasibility of putting a telegraphic girdle round the earth. In railway enterprises the accomplishments of his energy and management have been no less signal than in the establishment of the telegraph. One of these was the important line of the Southern Michigan and Northern Indiana Railway. His principal efforts in this direction have been in the Southern States. After the war, prompted more by the desire of restoring amicable relations than by the prospect of gain, he made large and varied investments at the South, and did much to promote renewed business activity. At Saginaw. Mich., he became a large lumber and salt manufacturer. He bought much property in Michigan, and at one time owned vast tracts in the Lake Superior region, where the most valuable mines have since been worked. While he has been interested

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in bank and manufacturing stocks, his larger investments have been in land. Much of his pleasure has been in reclaiming waste territory and unproductive investments, which have been abandoned by others as hopeless. The satisfying aim of his ambition incites him to difficult undertakings, that add to the wealth and happiness of the community, from which others have shrunk, or in which others have made shipwreck. Besides his stupendous achievements in telegraph and railway extension, he is unrivaled as a farmer and seed grower, and he has placed the stamp of his genius on these occupations, in which many have been content to work in the well-worn ruts of their predecessors.

The seed business was commenced in Rochester thirty years ago. Later, Mr. Sibley undertook to supply seeds of his own importation and raising and others' growth, under a personal knowledge of their vitality and comparative value. He instituted many experiments for the improvements of plants, with reference to their seed-bearing qualities, and has built up a business as unique in its character as it is unprecedented in amount. He cultivates the largest farm in the State, occupying Howland Island, of 3,500 acres, in Cayuga County, near the Erie Canal and the New York Central Railroad, which is largely devoted to seed culture; a portion is used for cereals, and 500 head of cattle are kept. On the Fox Ridge farm, through which the New York Central Railroad passes, where many seeds and bulbs are grown, he has reclaimed a swamp of six hundred acres, making of great value what was worthless in other hands, a kind of operation which affords him much delight. His ownership embraces fourteen other farms in this State, and also large estates in Michigan and Illinois.

The seed business is conducted under the firm name of Hiram Sibley & Co., at Rochester and Chicago, where huge structures afford accommodations for the storage and handling of seeds on the most extensive scale. An efficient means for the improvement of the seeds is their cultivation in different climates. In addition to widely separated seed farms in this country, the firm has growing under its directions several thousands of acres in Canada, England, France, Germany, Holland, and Italy. Experimental grounds and greenhouses are attached to the Rochester and Chicago establishments, where a sample of every parcel of seed is tested, and experiments conducted with new varieties. One department of the business is for the sale of horticultural and agricultural implements of all kinds. A new department supplies ornamental grasses, immortelles, and similar plants used by florists for decorating and for funeral emblems. Plants for these purposes are imported from Germany, France, the Cape of Good Hope, and other countries, and dyed and colored by the best artists here. As an illustration of their methods of business, it may be mentioned that the firm has distributed gratuitously, the past year, $5,000 in seeds and prizes for essays on gardening in the Southern States, designed to foster the interests of horticulture in that section.

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The largest farm owned by Mr. Sibley, and the largest cultivated farm in the world, deserves a special description. This is the “Sullivant Farm,” as formerly designated, but now known as the “Burr Oaks Farm,” originally 40,000 acres, situated about 100 miles south of Chicago, on both sides of the Wabash, St. Louis, and Pacific Railroad. The property passed into the hands of an assignee, and, on Mr. Sullivant’s death in 1879, came into the possession of Mr. Sibley. His first step was to change the whole plan of cultivation. Convinced that so large a territory could not be worked profitably by hired labor, he divided it into small tracts, until there are now many hundreds of such farms; 146 of these are occupied by tenants working on shares, consisting of about equal proportions of Americans, Germans, Swedes, and Frenchmen. A house and a barn have been erected on each tract, and implements and agricultural machines provided. At the center, on the railway, is a four-story warehouse, having a storage capacity of 20,000 bushels, used as a depot for the seeds grown on the farm, from which they are shipped as wanted to the establishments in Chicago and Rochester. The largest elevator on the line of the railway has been built, at a cost of over $20,000; its capacity is 50,000 bushels, and it has a mill capable of shelling and loading twenty-five cars of corn a day. Near by is a flax mill, also run by steam, for converting flax straw into stock for bagging and upholstery. Another engine is used for grinding feed. Within four years there has sprung up on the property a village containing one hundred buildings, called Sibley by the people, which is supplied with schools, churches, a newspaper, telegraph office, and the largest hotel on the route between Chicago and St. Louis. A fine station house is to be erected by the railway company.

Mr. Sibley is the president and largest stockholder of the Bank of Monroe, at Rochester, and is connected with various institutions. He has not acquired wealth simply to hoard it. The Sibley College of Mechanic Arts of Cornell University, at Ithaca, which he founded, and endowed at a cost of $100,000, has afforded a practical education to many hundreds of students. Sibley Hall, costing more than $100,000, is his contribution for a public library, and for the use of the University of Rochester for its library and cabinets; it is a magnificent fire-proof structure of brownstone trimmed with white, and enriched with appropriate statuary. Mrs. Sibley has also made large donations to the hospitals and other charitable institutions in Rochester and elsewhere. She erected, at a cost of $25,000, St. John’s Episcopal Church, in North Adams, Mass., her native village. Mr. Sibley has one son and one daughter living—Hiram W. Sibley, who married the only child of Fletcher Harper, Jr., and resides in New York, and Emily Sibley Averell, who resides in Rochester. He has lost two children—Louise Sibley Atkinson and Giles B. Sibley.

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A quotation from Mr. Sibley's address to the students of Sibley College, during a recent visit to Ithaca, is illustrative of his practical thought and expression, and a fitting close to this brief sketch of his practical life: "There are two most valuable possessions which no search warrant can get at, which no execution can take away, and which no reverse of fortune can destroy; they are what a man puts into his head—*knowledge*; and in to his hands—*skill*."—*Encyclopaedia of Contemporary Biography*.

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Hydrastis in dyspepsia.—Several correspondents in *The Lancet* have lauded hydrastis as a most useful drug in dyspepsia.

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THE ETHICS OF ENGINEERING PRACTICE.

At the Pittsburg meeting of the American Institute of Mining Engineers, held from the 16th to the 19th of February, Mr. James C. Bayles, the President, delivered the following address:

Gentlemen of the Institute: Having availed myself somewhat liberally during the past two years of the latitude which is accorded the president in the selection of the topics presented in addresses from the chair, I do not need to plead safe precedent as my warrant for devoting the address which marks the conclusion of my service in the dignified and honorable office to which, through your unmerited favor, I have been twice chosen, to the consideration of some of the questions in casuistry the answers to which will be found to furnish a basis for a code of professional ethics. It is not asking too much of the engineer that his professional morality shall conform to higher standards than those which govern men who buy and sell with no other object than the getting of gain. The professional man stands in a more confidential relation to his client than is supposed to exist between buyer and seller in trade. He is necessarily more trusted, and has larger opportunities of betraying the confidence reposed in him than is offered the merchant or the business agent. For the reason that he cannot be held to the same strict accountability which law and usage establish in mercantile business, he is under a moral obligation to fix his own rules of conduct by high standards and conform to them under all circumstances. Whatever the measure of his professional success—whether wealth and reputation crown his career, or disappointment and poverty be his constant and unwelcome companions—no taint of suspicion should attach to any professional act or utterance. Not only should we be able to write above the wreck of bright hopes, "Honor alone remains," but upon our great and successful achievements should it be possible for others to inscribe the legend, "In honor wrought; with honor crowned."

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It is frequently and confidently asserted that at no time in the history of the world were the standards of business honor so high as now. The prevalence of dishonesty, in one form or another, is held to show that there is a great deal of moral weakness which is unequal to the strain to which principle is subjected in the keenness of business competition, and in the presence of the almost unlimited confidence which apparently characterizes commercial intercourse. The enormous volume of the daily transactions on 'change, where a verbal agreement or a sign made and recognized in the midst of indescribable confusion has all the binding force of a formal contract; the real-estate and merchandise transactions effected on unwitnessed and unrecorded understandings; the certification of checks on the promise of deposits or collaterals, and a hundred other evidences of confidence, are cited as proof that the accepted standards of business honor are high, and are kept so by public opinion. All of this is true, in a certain limited sense; but the confidence which is the basis of all business creates opportunities for dishonesty which changes its shape with more than Protean facility when detected and denounced. The keenness of competition in all departments of professional and business enterprise presents a constant temptation to seize every advantage, fair or unfair, which promises immediate profit. It is unfortunately true that the successful cleverness which sacrifices honor to gain is more easily condoned by public opinion than honest dullness which is caught in the snares laid for it by the cunning manipulators of speculation. The man who fails to deliver what he has bought, to meet his paper at maturity and make good the certifications of his banker, loses at once his business standing, and is practically excluded from business competition; but if he keeps his engagements and is successful, the public is kindly blind to the agencies he may employ to depreciate what he wants to buy or impart a fictitious value to what he wants to sell. Viewed from this standpoint, it may be questioned whether the accepted standards of business morality are not, after all, those fixed by the revised statutes.

In so far as the engineer is brought in contact with the activities of trade, he cannot fail to be conscious of the fact that serious temptations surround him. Such reputation as he has gained is assumed to have a market value, and the price is held out to him on every side. It should not be difficult for the conscientious engineer, jealous of his professional honor, to decide what is right and what is not. He does not need to be reminded that he cannot sell his independence nor make merchandise of his good name. But as delicate problems in casuistry may mislead or confuse him, it is to be regretted that so little effort has been made to formulate a code of professional ethics which would help to right decisions those who cannot reach them unaided.

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Standing in the presence of so many of those who have dignified the profession of engineering, I should hesitate to express my views on this subject did I not believe that many earnest and right-minded young men in our active and associate membership will be glad to know what rules of conduct govern those whose example they would willingly follow, and how one not a practicing engineer, but with good opportunities of observation and judgment, would characterize practices which have been to some extent sanctioned by custom. To those who have yet to win the gilded spurs of professional knighthood, but who cherish a high and honorable ambition, my suggestions are chiefly addressed.

An ever present stumbling block in the path of the young engineer is what is lightly spoken of as the “customary commission”—a percentage paid him on the price of machinery and supplies purchased or recommended by him. That manufacturers expect to pay commissions to engineers who are instrumental in effecting the sale of their products is a striking proof that the standards of business morality are quite as low as I have assumed them to be; that engineers do not unite in indignant protest against the custom, and denounce as bribe-givers and bribe-takers those who thus exchange services, shows that the iron has entered the souls of many who may be disposed to resent such plain terms as those in which I decree it my duty to describe transactions of this kind.

The young man who is tendered a commission will naturally ask himself whether he can accept and retain it, and may, perhaps, reason somewhat in this way: “My professional advice was given without expectation of personal profit other than that earned in my fee, and it expressed my best judgment. The price at which the goods were purchased was that which every consumer must pay, and was not increased for my advantage. The transaction was satisfactory to buyer and seller, and was concluded when payment was made. I am now tendered a commission which I am at liberty to accept or to decline. If I decline it, I lose something, my client gains nothing, and the remaining profit to the seller is greater than he expected by that amount. If I accept it, I do my client no wrong. If it is the custom of manufacturers to pay commissions, it must be the custom of engineers to receive them; and there is no reason why I should be supersensitive on a point long since decided by usage.” This is false reasoning, based upon erroneous assumptions. Why do manufacturers pay commissions? Is it probable they make it a part of their business policy to give something for nothing? Is it not certain that they expect an equivalent for every dollar thus disbursed, and that in paying the engineer a commission they are seeking to establish relations with him which shall warp his judgment and make him their agent? It may be urged in the case of reputable manufacturers that they yield to this custom because other manufacturers

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have established it, and that in following the pernicious example they have no other object than to equalize the influences tending to the formation of professional judgment. This reasoning does not change in the least the moral aspects of the question from the manufacturer's standpoint, but what engineer with a delicate sense of professional honor could offer or hear such an explanation without feeling the hot blush of shame suffuse his cheeks? The plain truth about the commission is that the manufacturer or dealer adds it to the selling price of his goods, and the buyer unconsciously pays the bribe designed to corrupt his own agent. Can an engineer receive and retain for his own use a commission thus collected from his client without a surrender of his independence, and having surrendered that, can he conscientiously serve the client who seeks disinterested advice and assistance in the planning and construction of work?

It is possible, perhaps, for a man to dissociate his preferences from his interests; so, also, is it possible for one to walk through fire and not scorch his garments but how few are able to do it! The young man in professional life who begins by accepting commissions will soon find himself expecting and demanding them, and from that moment his professional judgment is as much for sale as pork in the shambles. I counsel the young man thus tempted to ask himself, Am I entitled to pay from the manufacturer who offers it? If so, for what? If not, will my self-respect permit me to become his debtor for a gratuity to which I have no claim? Does not this money belong to my client, as an overcharge unconsciously paid by him for my benefit? If I refuse it, can I not with propriety demand in future that the percentage which this commission represents shall be deducted in advance from the manufacturer's price, that my client may have the benefit of it? If this is denied, can I resist the conclusion that it is a bribe to command future services at my hands? Is not the smile of incredulity with which the dealer receives my assurance that I can only take it for my client and hand it over to him, an insult to the profession, which, as a man of honor, I am bound to resent?

Gentlemen, it is not true that custom sanctions the acceptance of commissions by the engineer. That it is much too general I will not deny, but there are very few men of recognized professional standing who would confess that they have yielded to the temptation and retained for their own benefit the commissions received by them. I do not hesitate to give it as my opinion that the acceptance and retention of a commission is incompatible with a standard of professional honor to which every self-respecting engineer should seek to conform. Those who defend it as proper and right, and plead the sanction of usage, are not the ones to whom the young engineer can safely go for counsel and advice. The most dangerous and least reputable of all the competition he will encounter in an attempt to make an honest living in the practice of his profession is that of the engineer who charges little for professional services and expects to be paid by those whose goods are purchased on his recommendation.

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With equal emphasis would I characterize as unprofessional the framing of specifications calling for patented or controlled specialties when, to deceive the client, bids are invited. I am well aware that it is easier to procure drawings and specifications from manufacturers than to make them. Many manufacturers are very willing to furnish them, but those who do are careful to so frame the specifications that they can secure the contracts at prices to include the cost of the professional work for which the engineer is also paid. There is nothing unprofessional in recommending a patented article or process if it be, in the judgment of the engineer, the best for the purpose to be accomplished, but he will do it openly and with the courage of his convictions. The young engineer should, I think, have no difficulty in recognizing the important difference which inheres in the methods by which a given result is accomplished.

In the relations of engineers to contractors there is many a snare and pitfall for the unwary feet of the beginner. In superintending the construction of work the engineer may err on the side of unreasonable strictness or on that of improper leniency. If so disposed, he can involve any contractor in loss and do him great wrong, but it more often happens that the engineer is forced to assume a defensive attitude and to resist influences too strong for a man of average courage and strength of will, especially if his experience in charge of work is limited. He should enter upon the discharge of his delicate and responsible duties with a desire to do impartial justice between client and contractor. He is warranted in assuming that his judgment and discretion are his chief qualifications for the position of supervising engineer, and that all specifications are designed to be in some measure elastic, since the conditions to be encountered in carrying them out cannot possibly be known in advance. He should not impose unnecessary and unreasonable requirements upon the contractor, even if empowered to do so by the letter of the specifications. The danger, however, is principally in the opposite direction. Frequently the engineer has all he can do to hold the contractor to a faithful performance of the spirit of his agreement. He is bullied, misled, deceived, and sometimes openly defied. He must constantly defend himself against charges impeaching his personal integrity and his professional intelligence. The contractor can usually succeed in making it appear that he is the victim of persecution, and especially in public work he is likely to have more influence than the engineer with those for whom the work is done. It often happens that the engineer, defeated and discouraged, gives up the unequal battle. From that moment he is of no further use as an engineer, and if he remains for an hour in responsible charge of work he cannot control, he rates his fee as more desirable than a reputation unsullied by the stain

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of dishonor. He has a right to decline a conflict for which he feels unequal, but he has no right to consent to a sacrifice of the interests of his client while he is paid to protect them. The questions of professional ethics arising out of the relations between the engineer and the contractor are much too complex to be decided by an inflexible rule of professional conduct, but the engineer cannot make a mistake in refusing to remain in responsible charge of work when, by remaining, he must give consent to that which his judgment tells him involves a wrong to his client. With equal confidence may it be asserted that the engineer who secretly participates in the profits of the contractor, whatever the arrangement by which such participation is brought about, sacrifices his professional standing.

In making reports for contingent fees or fees of contingent value, the young engineer needs to exercise great discretion. This may be done without impropriety if done openly; but it is safe to assume that few opportunities will come to the young man with a reputation still to make in which he can do clean and creditable work on any such basis. The engineer called upon to make a report for a fee in stock which depends for its value upon the effect of his report in creating confidence in the public mind, takes a fearful risk. However honest he may be, he places himself in a position in which the danger is obvious and the advantage uncertain. If, having a contingent interest in the result of his work, he is afraid to say so in his report, he may safely consider his position unprofessional and unsafe. Contingent fees are a delusion and a snare, and in making it a rule to refuse them the young engineer will be likely to gain more than he loses.

Reports intended to influence the public upon subjects concerning which the engineer knows himself unqualified to speak with authority are to be classed with other forms of charlatanry. No man can claim infallibility of judgment, nor is this expected of the engineer, whatever his position; but those who pay for professional services have a right to demand that the man who assumes to speak as an expert shall have the special knowledge which will command for his opinion the respect of those who are well informed. I consider it unprofessional for the engineer to enter upon the discharge of any duties for which he knows he is not qualified, if for the satisfactory discharge of those duties he must assume a knowledge he does not possess. There has been an immense amount of unprofessional work done in the field of reporting, and many reputations have been blasted by a failure to draw nice distinctions in questions of professional honor. The young engineer cannot be too careful in this matter, and he will be fortunate if, with all the prudence he can exercise, he is able to avoid disaster. Of a professional reputation dependent upon the accuracy as well as the honesty of reports ordered and used for speculative purposes, one may say as a marine underwriter lately said of an unseaworthy steamer, that he “would not insure her against sinking, from Castle Garden to Sandy Hook, with a cargo of shavings.”

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In the matter of expert service in the courts I am disposed to speak guardedly. I see no reason why an engineer should not willingly go upon the witness stand to give expert testimony if he has made proper preparation and has an honest conviction that his testimony can be given with a conscientious regard for the obligations of his oath as a witness. It is his duty and his privilege to defend his opinions, for the man without opinions which he is prepared to defend is worthless as a witness and cannot properly be called an expert. But the conscientious engineer has no right to appear as a partisan of anything except what he believes to be the truth. If he finds himself parrying the questions of the cross-examination with a view to concealing the truth, if he realizes that he is a partisan of the side which retains him, and feels a temptation to earn his fee by falsehood, concealment, or evasion, he can be sure that he is in a position in which no man of honor has a right to be. The abuses of expert testimony in civil and criminal suits are many and grave; its uses are perhaps exaggerated, and the witness stand is not an inviting field for the young engineer seeking a satisfactory career.

How far an engineer can properly use for his own advantage information gained in the discharge of duties of a confidential nature, is a question at once delicate and difficult. He cannot help knowing what he has learned, and his knowledge is his capital. He must be governed in this matter by the considerations which influence men of honor in the ordinary relations of life. Stock and real estate operations, on confidential information which belongs to one’s principals, are usually in violation of the simplest rules of professional honor. The manager who advises his brokers by telegraph and his principals by mail cannot, I think, claim to have a very delicate sense of right and wrong. He can judge his own conduct by the standard he would apply in judging like infidelity on the part of those employed by him.

In professional criticism of professional work, it is easy to fall into ways which are wrong, morally and professionally. Criticism which is designed merely to advertise the critic serves no good purpose, and savors of charlatanry or something worse. Only a small proportion of the current critical literature of engineering serves any good or useful purpose, since it has no other or higher object than to help the critics to climb into notoriety on the shoulders of the older and wiser men with whom they are brought into competition. I regard as unprofessional every effort to discredit honest and intelligent work, and every form of disguised advertising designed to give an engineer a greater prominence than he has earned by successful and creditable work, or is entitled to claim by virtue of fitness for more than average professional achievements.

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It is neither possible nor desirable to catalogue the unprofessional practices which in one way or another come to the notice of those observant of current happenings in the several departments of engineering. It is the contention of some that right and wrong are relative terms, applying to no action or line of conduct save as it is considered in relation to coincident and contingent circumstances. I will not deny that this may be true of all professional acts, but the impossibility of an arbitrary classification under the heads right and wrong, honorable and dishonorable, need not make it difficult for a man to formulate a code of professional ethics by which his own conduct shall be governed. There are certain broad ethical principles which never change. One is that a man cannot serve two masters having conflicting interests, and be faithful to each. Another is that, however skillfully one may juggle words to conceal meanings or evade responsibility, if the intent to deceive is there, he lies. Professional ethics are no different from the ethics of the Decalogue; they are specific applications of the rules of conduct which have governed enlightened and honorable men in all ages and in all walks of life. It is only when the moral sense is blunted or temptation presents itself in some new and unrecognized form that it is difficult to draw the line between right and wrong. I am aware that a delicate sense of honor often comes between a man and his opportunities of profit, and that a fine sensitiveness is rarely appreciated at its value by those who employ professional service. I know that in this busy world men of affairs do not always stop to weigh motives, and that confident assurance always commands respect, while modest merit is distrusted. But I do not know that a man can sell his honor for a price, and retain thereafter the right to stand erect in the presence of his fellows. I do not know that any engineer can make for himself a creditable and satisfactory career of whom it cannot be said that, whatever his mistakes or successes, his failures or triumphs, he has held his professional honor above suspicion.

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LIFTING A FORTY INCH WATER MAIN.

[Illustration: *Raising* A *forty inch main on the Boston water works*.]

The sketch below, reproduced from a photograph, shows the general method adopted for lifting a 40 inch water main on Brookline Avenue, in Boston, Mass. *Engineering News* says:

The work, which was commenced in June, 1884, included the raising of 1,000 feet of this main from to 18 feet to adjust it to a new grade in the avenue. The plan pursued by the Boston Water Department was about as follows:

After the pipe was uncovered, piles were driven in pairs on each side, 5 feet 6 inches apart, and in bents 12 feet apart; the pile-heads were then tenoned, and a cap made of two pieces of 4 by 12 in. stuff was bolted on as shown, and the bents stayed longitudinally. The lifting was done with the pipe empty, by screws 8 feet long, working in square nuts resting on a broad iron plate on the cap pieces. After all preparatory work was completed, the lifting of the pipe to its new position was accomplished in about nine hours.

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After the pipe was raised, two more 4 by 12 inch pieces were bolted to the piles just under the pipe, and the bottoms of the piles were cross-braced. Stringers made of two 6 by 12 inch timbers were then placed on the caps, and a track of standard gauge put into place, upon which the dump cars used in filling the avenue were run out.

The engineer in charge was Mr. Dexter Brackett, and we understand from him that a 48 inch main is to be raised in a somewhat similar manner during the present year.

* * * * *

THE INTEROCEANIC CANAL QUESTION.

Mr. J. Foster Crowell lately read a paper before the Engineers' Club of Philadelphia upon the Present Situation of the Inter-oceanic Canal Question, presenting the subject from a general standpoint. He sketched the history of the various past attempts to establish communication through the American Isthmus, and traced the developments in the different directions of effort, which finally concentrated the problem upon the three projects now before the world, summarizing the progress in each case, and stating the following propositions:

I. That Panama is the only possible site for a Sea Level Canal, and that such treatment is the only feasible method at that place.

II. That Nicaragua is the only practicable site for a Slack Water system (for a canal with locks), and that it is pre-eminently adapted by nature for such a use; that there are no obstacles in an engineering sense, and no physical drawbacks that need deter the undertaking.

III. That the Ship Railway, as a mechanical contrivance, has the indorsement of the best authorities, and may be admitted to be the *ne plus ultra* as a means of taking ships from their natural element and transporting them over the land.

IV. That none of these plans has as yet advanced sufficiently to warrant our considering its completion as beyond doubt.

V. That, as the *additional* sum now asked for by De Lesseps (*even if sufficient*) to complete the Panama Canal is *greater* than the estimated cost of either Nicaragua Canal or the Ship Railway, it would be economical to abandon the Panama Canal, and the money sunk in it, to date, unless its location and form possess paramount advantages; and we therefore may profitably consider the relative merits of the three lines without regard to the past, from four standpoints, *viz*.:

1. Geographical convenience of location.

2. Adaptiveness to all marine requirements, present and future.

3. Political security.

4. Economy of construction and operation.

He then discussed the comparative claims to excellence. In the first consideration, after classifying the several grand divisions of future ocean traffic, and noting especially the needs of the United States, he claimed that while there was little to choose, in this respect, between Nicaragua and Tehuantepec, either was far superior to Panama.

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In the second particular he maintained that owing to the characteristics of the Panama Canal and the practical impossibility of enlarging it hereafter, excepting at stupendous cost, it could not serve the purposes of the future, although it might, if completed, supply present need. He praised the ingenuity of the plans for the Ship Railway, but emphasized the fact that it will be the *movement of the traffic*, not merely the lifting and supporting of ships in transit, that will test the system, and suggested that even the beautiful application of mechanical force which had been contrived might be powerless to insure the high grade of service which is an absolute necessity. In this connection the general features of the Nicaragua Canal, in its latest form, were referred to, and the opinion expressed that even were all difficulties in the way of the Ship Railway eliminated, it could not be superior to the canal in respect of adaptiveness.

In point of political security he claimed that both Tehuantepec and Nicaragua were reasonably free from doubts, with the advantage in favor of the latter, while at Panama no security, for United States interests at least, could be counted on, without the liability of a military expenditure far exceeding the cost of the canal itself.

The matter of comparative cost of construction and operation was discussed generally, and in conclusion the author stated that “this all-important question is still an open one, of which the future needs of our country justify and demand at this time a most searching scrutiny, and moreover our interest and the interest of mankind require that before this century closes, the best possible pathway between the Atlantic and the Pacific shall be open to the navies of the world.”

The paper was illustrated with maps and diagrams.

* * * * *

THE MERSEY TUNNEL.

The Mersey Tunnel was lately opened by the Prince of Wales, and, as the London *Standard* says, after an infancy of troubles and failures, and a ten years’ middle age of inaction, the Mersey Tunnel emerges into notoriety under the hands of Mr. James Brunlees and Mr. C.D. Fox, and of Mr. Waddell, the contractor, as a triumph of engineering skill. The tunnel is 1,250 yards in length. It is driven through solid, but porous, red sandstone, through which the water has percolated in volumes during construction, at a level of about 30 feet below the bed of the river. It is lined throughout with blue bricks, the brickwork of the invert being 3 feet in thickness. Its transverse section is a depressed oval 26 feet in width and 21 feet in height, and it contains two lines of railway. At a depth of about 18 feet below the main tunnel there is a continuous drainage culvert 7 feet in diameter, entered at intervals by staple shafts. There are two capacious underground terminal stations 400 feet long, 50 feet broad, and 38 feet

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high, and gigantic lifts for raising 240 passengers in forty seconds, from more than three times the depth of the Metropolitan Railway to the busy streets above. These splendid lifts, the finest in the world, are now, through the engineering skill of Messrs. Easton & Anderson, like the tunnel, accomplished facts; and their construction and working were tested and reported on in high terms of favor by the Government Inspector, General Hutchinson, a few weeks ago. At the Liverpool end the direct descent to the underground platform of the Mersey Railway is about 90 feet; at the Birkenhead end the depth is something more.

The description of the Liverpool lifts will well suffice also for the Birkenhead lifts. The former are under James Street, where above ground, rising in lofty stateliness, is a fine tower for the hydraulic power, the water being intended to be stored in a circular tank near its summit, the dimensions of which will be 15 feet in diameter and its internal depth 9 feet. From the level of the rails of the Mersey Railway to the bottom of this water-tank the vertical distance is 198 feet. At the western side of the subterranean railway there is, above the arrival platform, a “lower booking-hall,” or, more properly, a large waiting room, 32 feet square and 29 feet high, the access to which on this side is by a broad flight of steps rising 12 feet, and to and from which all passengers on the departure platform have communication by a lattice bridge 16 feet above the line of rails. From the western side of this hall the passengers will have access to the three lifts, and will thence ascend in large ascending rooms or cages, capable of containing one hundred persons each, to the upper booking-hall on the ground level of James Street. Intermediate in height between the lower and upper halls the engine-room for the pumps is located. From the lower hall also there is provided, independent of the lifts, an inclined subway, leading up toward the Exchange. In this lower subterranean chamber there are four doorways, 5 feet wide, three of them being fitted with ticket gateways, and leading to the three lift-shafts, excavated in the rock, and lined, where needed, with brick. In each of these shafts, which are 21 feet by 19 feet in sectional area, a handsome ascending wood-paneled room, or cage, formed of teak and American oak, is fitted, its dimensions in plan being 20 feet by 17 feet, and its general internal height 8 feet; but in the central portion the roof rises into a flat lantern 10 feet high, the sides of which are lined with mirrors that reflect into the ascending-room the rays of a powerful gas-lamp. The foundation of this room is a very stiff structure, consisting of two wrought-iron special-form girders crossing beneath it, the cross, 14 inches deep, connecting them being of steel, and forged from a single ingot. The central boss of the cross is 22 inches in diameter, and in this is bored out a central cavity, into which

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the head of the steel ram, 18 inches in diameter, is fitted; the ram itself being built up of steel cylinders or tubes, 11 feet 3 inches in length, which are connected together by internal screws. There is also a central rod within the ram, as an additional security. The ram descends into a very strong cast-iron cylinder, 21 inches internal diameter, which is suspended in a boring 40 inches internal diameter, and carried down to a depth of over 100 feet in the rock. The two iron girders under the frame of the ascending-room or cage cross the entire lift space, and then at their outer ends are attached to four chains which rise over pulleys fixed about 12 feet above the floor of the upper booking-office. These chains thence descend to suspend two heavy counterweights, so arranged as to work in guides and to pass the ascending-room in the 12 inch interspace between the cage and the side walls of the shaft. These chains are of 1-1/8 inch bar iron, and have each been tested with a load of over 15 tons. The maximum load which can ever come as a strain upon any chain is about three tons. Two chains are attached to each counter-weight, and special attention has been paid to the attachments of these chains to the cage girders. The stroke of each hydraulic lift is 96 feet 7 inches. In the engine-room there are three marine boilers, each 6 feet 6 inches diameter and 11 feet 6 inches long, and three pairs of pumping engines of patented type, each capable of raising thirty thousand gallons of water per hour from the waste tanks below the engine-room to the top tank of the tower above ground. There are three suction and three delivery mains, and these are connected direct to the lifts by a series of change sluices, admirably, neatly, and handily arranged in the engine-room by Mr. Rich, and in such a way that any engine, any lift, or any supply main can be disconnected without interference with the rest of the system. When the tower tank is completed, it alone, under any circumstances, would be able to supply the lifts if every pumping engine were stopped. But if any or all the engines were working, they would automatically assist the top tank, for nominally they will keep the top tank exactly full, and will then stop of themselves. The tower, as we have indicated, is not yet completed, and the pumping engines are consequently doing all the work of the lifts. The ascent and descent of the cages is effected by the attendant who accompanies the passengers, by means of a rope arrangement.

Each cage or room is intended ordinarily to take a maximum freight of 100 passengers, calculated at about 15,000 lb. The hydraulic ram weighs about 11,000 lb., the iron frame and cross of the cage about 6,500 lb., and the cage itself about 13,200 lb., the total being about 30,700 lb. The mass in motion when a cage is fully loaded is estimated at 63,000 lb. dead weight. The journey of elevation will ordinarily be made within one minute, but in the experimental

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trials which have been made the full journey has actually been accomplished in 32 seconds. In the Board of Trade tests under General Hutchinson, weights to the extent of 15,000 lb. were variously shifted, and in certain cases concentrated in trying localities, but the cage stood the trials without any appreciable change of form, and in neither the cage nor the chains were any objectionable features developed. The three lifts can be worked singly or combined, so that the accommodation is always ready for from 100 to 300 persons. Further railway connections between the Mersey Subaqueous Railway and the surrounding land lines than those which yet exist are in contemplation.

All the booking-halls, waiting-rooms, *etc*., *etc*., in connection with the four stations have been laid with Lowe's patent wood-block flooring. The blocks are only 1-1/2 inches thick, but, being made of hard wood and securely fastened to the concrete bed with Lowe's patent preservative composition, they cannot become loose, and will wear for a long series of years, until, in fact, the wood is made too thin by incessant traffic.

The engineer, Mr. Fox, and the architect, Mr. Grayson, are much pleased with the work, especially as it is so noiseless and warm to the feet. These floors ought to be adopted more frequently by railway companies in connection with their station buildings, as "dry rot" and "dampness" are effectually prevented, and a durable and noiseless floor secured.

* * * * *

IMPROVED REVOLVER.

The Kynoch revolver, manufactured by the Kynoch Gun Factory, at Aston, Birmingham, is the invention of Mr. Henry Schlund. It may be regarded as the most simple in respect of lock mechanism of any existing revolver, whether single or double action. It extracts the cartridges automatically, and combines with this important feature strength and safety in the closing of the breech. Certainty of aim when firing is obtained by means of a double trigger, which serves many purposes. This secures quick repeating as in the double-action revolvers, and at the same time the revolver is not pulled out of the line of sight, as the trigger is pulled off by the forefinger, independently of the cocking motion, the cocking trigger being longer than the ordinary double-action triggers. The cocking trigger further serves to tighten the grasp, and so enables the power of the first recoil, which affects the shooting of all revolvers, to be held in check. The light pull-off enables a steady shooter to make surpassingly fine diagrams.

[Illustration: THE KYNOCH REVOLVER.]

The upper side of the barrel is perfectly free from obstruction, so that the sighting can be done with the greatest ease, and the entire weapon is flush and without projections which can catch surrounding objects, with the exception of the cocking trigger, which seems to require a second guard to render it secure when thrusting the pistol hastily into a holster. At the same time, it should be remembered that the cocking trigger does not effect the firing. It puts the hammer to full cock and rotates the cylinder, and these operations may be performed time after time with safety.

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Turning to the mechanical details, it is noticeable that no tools are required to take the weapon to pieces and to put it together. By removing a milled headed screw seen to the left of the general view, every individual part of the lock action comes apart, and can be cleaned and put together again in a few minutes. This screw is numbered 24 in Fig. 4. To load the pistol the thumb piece (marked 2 in Fig. 4 and shown separately in Fig. 3) is drawn back, and thus withdraws the sliding bolt, 3, from the barrel, 20. The barrel and cylinder are then tilted on the pin, 15—a shake will effect this if only one hand be available—and as the chamber rises, the extractor is forced back by the lifter, 15, and the empty shells are thrown out. When the barrel has moved about 80 deg., the spring, 14, which works the lifter, 15, is tripped, and the spring 13 carries the extractor home ready for the fresh cartridge to be inserted. When these are in place, the barrel and cylinder are returned to the position shown in Fig. 1, and are automatically locked by the bolt, 3. All is then ready for firing. The middle finger is placed on the cocking lever, and the forefinger within the trigger guard. The cocking trigger is drawn back, taking with it the firing trigger for the greater part of its stroke. At the same time the lifter, 8, which is pivoted to the cocking lever, engages with a ratchet wheel (seen in Fig. 2) attached to the cylinder, and rotates it through one-sixth of a revolution. To insure the exact amount of rotation, a heel on the trigger, not to be seen in the engravings, engages in one of the six slots (Figs. 1 and 2) formed round the barrel. The end of the slot is square, and comes up against the heel, which tightly grips the cylinder, and holds it steady while firing. A toe-piece, just over the figure 4, in Fig. 3, holds the cylinder when the cocking trigger is in its normal position. The cocking lever also compresses the main spring, 7, and holds it in this state until the firing trigger, 12, is pressed by the forefinger against the sear, 9, and the hammer, 5, is driven forward against the cartridge. If the pistol be not fired, the release of the cocking trigger takes the pressure off the spring, and there is thus no danger of accidental discharge.

It will thus be seen, says *Engineering*, that the weapon presents many advantages. It can be loaded on horseback when one hand is engaged with the reins; there is nothing to obstruct the aim, and the act of firing does not throw up the muzzle, for the two operations of cocking and shooting are separate, and consequently the latter needs only a very light pressure of the finger to effect it. The breech is well protected, so that the flash from a burst cartridge cannot reach the face of the user. The mechanism is as nearly dust proof as possible, and can be entirely taken to pieces and cleaned in a few moments, and the whole forms as handy a weapon as can be desired, where rapid and accurate shooting is required.

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[JOURNAL OF THE SOCIETY or ARTS.]

MOTORS FOR STREET RAILWAYS.

RESULTS OF EXPERIMENTS ON MECHANICAL MOTORS FOR TRAMWAYS MADE BY THE
JURY ON RAILWAY APPLIANCES AT THE ANTWERP EXHIBITION.

By Captain DOUGLAS GALTON, D.C.L., O.B., F.R.S.

An interesting feature of the International Exhibition at Antwerp was the competition which was invited between different forms of mechanical motors on tramways for use in towns, and between different forms of engines for use on light railways in country districts, or as these are termed, “Chemins de Fer Vicinaux.”

These latter have obtained a considerable development in Belgium, Italy, and other Continental states; and are found to be most valuable as a means of cheapening the cost of transit in thinly peopled districts. But owing to the fact that the Board of Trade regulations in this country have not recognized a different standard of construction for this class of railway from that adopted on main lines, there has been no opportunity for the construction of such lines in England.

There has, however, been a great development of tramway lines in England, which in populous districts supply a want which railways never could fully respond to; and although hitherto mechanical traction has not attained any very considerable extension, it is quite evident that if tramways are to fullfil their object satisfactorily, it must be by means of mechanical traction.

It is also certain that the mechanical motor which shall be found to be most universally adaptable, that is to say, most pliant in accommodating itself to the various lines and to the varying work of the traffic, will be the form of motor which will eventually carry the day.

The competition between different forms of motors at the Antwerp Exhibition, which was carefully superintended, and which was arranged to be carried on for a reasonable time, so as to enable the qualities and defects of the different motors to be ascertained, affords a starting point from which it will be possible to carry on future investigations.

I have, therefore, thought it advantageous to the interests of the community in this country to bring the results arrived at before this Society; and as the “Chemins de Fer Vicinaux,” to which one part of the competition was devoted, have no counterpart in this country, it is proposed to limit the present paper to an account of the experiments made on the motors for tramways.

Certain conditions were laid down in the programme published at the opening of the Exhibition, to regulate the competition, in order that the competitors might understand the points which would be taken into account by the judges in awarding the prizes.

The experiments were made upon a line of tramway laid down for the purpose in the city of Antwerp, carried along the boulevards from near the main entrance of the exhibition to the vicinity of the principal railway station, a distance of 2,292 meters.

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The line ended in a triangle of 505 meters, in order that those motors which required to run always in the same direction should be enabled to do so.

Out of the whole length of the line, *viz*., 2,797 meters, 2,295 meters were in a straight line, 189 meters in curves of 13/4 chains radius, and 313 meters in curves of 1 chain radius. There were on the line four passing places, besides a passing place at the terminus; these were joined to the main line by curves of 13/4 chains radius.

The line was practically level, the steepest incline being 1 in 1,000; this circumstance is somewhat to be regretted, but the city of Antwerp afforded no convenient locality where a line with steep gradients could have been obtained. The motors were kept in sheds close to the commencement of the line of tramway near the exhibition, where all necessary cleaning and such minor repairs as were required could take place.

A regular service was established, according to a fixed time-table, to which each motor was required to conform. Each journey was reckoned as starting from the end near the exhibition, proceeding to the beginning of the triangle, and returning to the starting point. An hour was allowed between the commencement of each journey, fourteen minutes were allowed for a stoppage at the end near the exhibition, and eighteen minutes at the other end—thus allowing twenty-eight minutes for traveling 2 miles 1,500 yards, or a traveling speed of about 6 miles an hour. The motors were required to work four days out of six, and on one of the four days to draw a supplementary carriage.

An official, assisted by a storekeeper, was appointed to keep a detailed record—

1. Of the work done by each of the motors.
2. Of any delays occurring on the journey, and of the causes of delay.
3. Of the consumption of fuel, both for lighting the fires and for working.
4. Of the consumption of grease.
5. Of the consumption of water.
6. Of all repairs of whatever nature.
7. Of the frequency of cleaning and other necessary operations required for the efficient service of the motor.

The experiments lasted about four months. Five competitors offered themselves, which may be classed as follows: Three were propelled by the direct action of steam, and two were propelled by stored-up force supplied from fixed engines.

Propelled by the direct action of the steam.
1. The Krauss locomotive engine, separate from the carriage.
2. The Wilkinson locomotive engine (i.e., Black and

Hawthorn), also separate from the carriage.
3. The Rowan engine and carriage combined.

Propelled by stored-up force.

4. The Beaumont compressed-air engine.
5. The electric carriage.

It is somewhat to be regretted in the public interest that other forms of mechanical motors, such as the Mekarski compressed-air engine, or the engine worked with superheated water, or cable tramways, or electrical tramways, were not also presented for competition.

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1. The Krauss locomotive is of the general type of a tramway locomotive, but with certain specialties of construction. It has coupled wheels. The weight is suspended on three points. The water-tanks form part of the framing on each side; a covering conceals all except the dome of the boiler. Above the roof is a surface condenser, consisting of 108 copper tubes placed transversely, each of which has an external diameter of 1.45 inches. The boiler is similar to that of an ordinary locomotive; its axis is 3 feet 101/2 inches above the road. The body of the engine is 9 feet 11 inches long, and 7 feet 21/2 inches wide. The axles are 4 feet 11 inches from center to center. The platform extends along each side of the boiler; the door of the fire-box is in the axis of the road. The engine driver stands on the right-hand side, in the middle of the motor, where he has command of all the appliances for regulating the movements of the engine as well as of the brake.

The Wilkinson (Black and Hawthorn) engine had a vertical boiler and machinery. The cylinders were on the opposite side of the boiler from the door of the fire box, and mounted independently; the motion of the piston was communicated by means of a crank shaft and toothed wheels to the driving axle. The wheels were coupled. A regulator, injector, and a hand-brake were placed at each end, so that the engine driver could always stand in the front, whichever was the direction in which the engine moved; and there was a platform of communication between the two ends, carried along one side of the boiler.

The boiler was constructed with “Field” tubes, the horizontal tube plate having a flue in the middle which carried the heated gases into the chimney.

The visible escape of the steam is prevented by superheating. To effect this, the steam, as it leaves the cylinder, passes into a cast iron chamber adjacent to the boiler, which is intended to retain the water carried off with the steam. From thence the steam passes into a second chamber, suspended at a small height above the grate in the axis of the boiler and of the flue which conveys the heated gases into the chimney, and thence into a sort of pocket inclosed in the last-mentioned chamber, which is open at the bottom, and the upper part of which terminates in a tube passing into the open air. This method of dissipating the steam avoids the necessity of a condenser; but if it be admitted that the steam in escaping has a minimum temperature of 572 deg. Fahr., it will carry away 12 per cent. more caloric than would have been required to raise it to a pressure of 150 lb. per square inch.

The steam escaping through the safety valve is passed through the same apparatus.

The toothed wheel on the driving axle is arranged to act upon another toothed wheel on a shaft connected with the regulator, so as to control its speed automatically.

The length of the engine is 10 ft. 10 in., its width 5 ft. 9 in., and the distance from center to center of the wheels 5 ft. 2 in.

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The Rowan tram-car consists of a body 31 feet long and 7 feet wide, resting on a two-wheeled bogie behind and on a four-wheeled bogie in front, this front bogie being the motor, and the whole has the appearance of a long railway carriage, somewhat in the form of an omnibus with a platform at each end, of which the front platform is occupied by the engine. It requires, therefore, either a turntable or a triangle at the end of the line, so as to enable it to reverse its direction.

This motor is a steam engine of light and simple form, supplied with steam from a water tube boiler with very perfect combustion, so that no smoke escapes. The boiler is somewhat on the principle of a Shand and Mason boiler; it is so built that It can easily be opened and every part of the interior examined and cleaned.

The peculiarity of the Rowan motor is the simplicity of the attachment of the engine to the carriage, and the facility with which it can be detached when required for cleaning or repair, *viz*., in five or six minutes.

The steam can be got up in the engine with great rapidity if a change of engine is required. When, however, the engine is detached, the carriage loses its support in front, and is therefore not serviceable. When necessary, the combined motor can draw a second ordinary carriage.

The motor by itself occupies a length of 9 ft. 8 in. It has two horizontal cylinders; the four wheels of the bogie are coupled, and between the wheels the sides of the framing are rounded to allow two vertical boilers to stand. These boilers have vertical tubes for the water, which are joined together at the top by a horizontal cylinder. Each boiler, with its covering, is 1 ft. 9 in. in diameter. The boilers stand 1 ft. 9 in. apart, thus affording space between them for the motive machinery, including the pump. The crank axle is behind the boilers. The levers, the injector, the access to the fire-box, a pedal for working the engine brake as well as a screw brake for the carriage, are all in front. The brakes act on all six wheels, are worked by the driver, and the whole weight of the engine, car, and passengers being carried on these wheels, the car can be stopped almost instantaneously; and as over two-thirds of the entire weight of the car and passengers rests on the four driving wheels; there is always sufficient adhesion on all reasonable inclines, and the adhesion is augmented as the number of passengers carried increases. Hence this car is adapted for lines with heavy grades.

A small water tank is attached to the framing; two small boxes for coal or coke, with a cubic capacity of about 31/2 feet, are attached to the plate in front of the bogie. The covering of the boilers is in two parts, which are put on from each side horizontally, and screwed together in the center. The removal of the upper part enables the tubes to be examined and cleaned. The draught is natural; the base of the chimney is 3 ft. 2 in, from the grate; the height of the chimney is 5 ft. 2 in.

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The steam from the cylinders passes directly into a condenser placed on the top of the carriage. The condenser is made of corrigated copper sheets millimeter thick. Two sheets, about 15 to 18 inches wide and 15 feet long, are laid together and firmly soldered, forming a chamber. Twenty of these chambers are placed side by side on the top of the carriage, connected with a tube at each end, so as to allow the steam to pass freely through them. The lower corrugations in the several chambers are connected together, and thence a pipe with a siphon to stop the steam is carried to a water tank under the carriage, which thus receives the condensed water. This arrangement afforded a condensing surface of about 800 square feet. It should be mentioned that with larger engines Mr. Rowan employs as much as 1,600 feet of condensing surface. The nearness of the chambers to each other tends no doubt to diminish the power of condensing the steam, but this is somewhat compensated by the artificial circulation of air produced by the movement of the carriage. But in any case, if there is surplus steam, the pipe from the condenser causes it to pass under the grate, whence it rises superheated and invisible through the fire and up the chimney.

Under the carriage attached to the framing are four reservoirs, holding about three and a half cubic feet of water, of which water space one-half acts as a reservoir for cold feed water, and half for the condensed water. A tube from the small reservoir on the engine communicates through valves with the reservoirs of hot and cold water on the carriage.

The consumption of cold water measured during two days was 2.86 lb. per kilometer; assuming that the boiler evaporated 6.5 lb. of water per pound of coal, the cold water formed one-fifth of the total feed water required.

The carriage, i. e., the part occupied by passengers, is 21 ft. 8 in. in length. It holds seats for forty-five passengers, besides those who would stand on the gangway and platform. The seats are placed transversely on each side of a central corridor, each seat holding two people. The platform of the carriage is about 2 ft. 6 in. above the rails. Passengers have access to the interior from behind by means of the end platform, and in front near the engine from the two sides. As already mentioned, the hind part of the carriage rests upon two wheels, the front part being, as already mentioned, supported on the engine bogie. To effect this support, the hinder part of the framing of the engine is formed in a half circle, with a broad groove, in which the ends of two springs are arranged to slide. The centers of the springs form the support of the framing of the carriage.

The framing of the engine bogie is attached to the hind bogie truck of the carriage by two diagonal drawbars. The coupling is effected by bolts close to the engine, and the car is drawn entirely by means of the bogie pin of the hind bogie. The trucks are 16.5 ft. apart.

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Table I. above shows the dimensions of different parts of these three steam motors, as well as their weights.

The Beaumont engine, worked by compressed air, may be generally said to be similar to that described in a paper read before the Society of Arts on the 16th March, 1881, to which, however, some improvements have been since introduced.

The apparatus for compressing the air was placed in the shed. The air was compressed to 63 atmospheres by a pump worked by a steam engine, and stored in cylindrical reservoirs of wrought iron without rivets. A pipe led the air from the reservoirs to the head of the tramway, where the cylinder placed on the motor for storing the air during the journey could be conveniently charged.

The air was compressed by means of four pumps, placed two and two in a water-box, and worked by the direct action of a compound engine, with cylinders, placed in juxtaposition, of 8 in. and 14 in. diameter respectively, with an equal length of stroke of 13 in.

TABLE I.

	Krauss.	Wilkinson.	Rowan.
Diameter of cylinder.........d	5.5 in.	6.5 in.	5.1 in.
Length of stroke.............l	11.8 in.	9 in.	9.8 in.
Diameter of wheels..........D	31.5 in.	27.5 in.	29.5 in.
Pressure at which boiler is worked..........P	220 lb.	147 lb.	191 lb.
$(p(d^{2})l)/(2D)$.............E	1,210 lb.	1,509 lb.	805 lb.
Total heating surface........S	105 sq. ft.	105 sq. ft.	64 sq. ft.
Grate surface................G	2.7 sq. ft.	5.4 sq. ft.	3.1 sq. ft.
Surface of condenser.........C	274.482 s. ft.	None.	861.120 s. ft.
Weight in running order (motor only)...............P’	15,400 lb.	15,400 lb.	9,020 lb.
Weight in running order (total)....................P”	-	-	15,400 lb.
Contents of water tank.......-	28.24 cub. ft.	13 cub. ft.	4.2 cub. ft.
Contents of coal bunks.......-	14.12 cub. ft.	12.5 cub. ft.	8.5 cub. ft.
P’*E*	*12.7 lb.*	*10.2 lb.*	*11.2 lb.*
P"E	—	—	19.125 lb.
P’*S*	*146*	*147*	*140*
P’G	5,722	2,855	2,889
C/S	2.6	—	13.4
C/G	102	—	275

The air, after being forced through the first pump cylinder, passed successively through the other three, the diameters of which were of proportionately decreasing sizes, *viz*., 8.2 in., 5 in., 3.5 in., and 2 in., and the air on leaving each cylinder passed on its way to the next cylinder through a coiled pipe immersed in flowing water to remove the heat generated. This cooling surface amounted to nearly 54 sq. ft.

The cooling of the air was very efficient. In an experiment made on this question, the temperature of the compressor did not vary to the extent of 9 deg. F. in charging the reservoir from 40 to 63 atmospheres, occupying an hour and a half, the consumption of water during the time being about 1,400 gallons.

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The fixed reservoirs were of about 240 cubic feet capacity.

The motor formed part of a compound vehicle, which may be said to have consisted of two parts joined together by an articulated corridor, the whole being covered by a roof which was approached from the platform behind by an easy staircase. On this roof were seats for outside passengers.

The front part of the compound vehicle contained the motor, as well as a compartment for six inside passengers, with roof space for twenty passengers, and weighed about 15,400 lb. when empty; the hind part contained accommodation inside for twelve passengers, and outside for fourteen passengers, and weighed 6,600 lb.

The combined vehicle was entered from the platform in the rear, which could hold four passengers, and from thence, as already mentioned, the staircase led on to the roof. The total number of passengers this vehicle could accommodate was thus eighteen inside, thirty-four on the roof, four on the platform, or fifty-six in all.

The total length of the carriage was 29 ft. 7 in., the width 7 ft. The distance between the axes of the bogies was 16 ft. 9 in. The distances apart of the centers of the wheels were in the case of the hind bogie 3 ft. 9 in., and in the case of the front bogie 4 ft. 4.6 in.

The motor is a compound engine, the diameters of the cylinders being 4.9 in. and 1.9 in., with a 12 in. stroke. The diameter of the wheels was 2 ft. 4 in. A small boiler is placed on one side, in front, for creating steam, which passes into a steam-jacket, inclosing the pipe of communication from the reservoir to the cylinders, as well as the cylinders themselves, so that the air was warmed before it escaped. The reservoirs on the motor contained 71 cubic feet.

In an experiment made on charging the reservoir in the motor, the pressure in the fixed reservoirs, at the time of charging the reservoirs on the motor, was 63.8 atmospheres, at a temperature of 68 deg. F. One atmosphere was lost by letting the air into the pipe laid between the shed and the tramway where the motor stood; when the reservoir on the motor was charged, the pressure fell to 42.6 atmospheres in the fixed reservoirs, at a temperature of 55 deg. F.

The pressure in the reservoir on the motor, when ready to start, was 42.6 atmospheres, at a temperature of 84 deg. F. On its return, at the end of forty-six minutes, after a journey as above mentioned of about three and a quarter miles including the triangle, the pressure had fallen to 20.9 atmospheres, and the temperature to 71 deg. F. The weight of air used during the journey was thus about 110 lb., or, say, 34 lb. per mile. The coal consumed by the stationary engine to compress the air amounted to 39 lb. per mile, in addition to 3 lb. of coke per mile for warming the exhaust.

While the motor was performing its journey, the stationary steam-engine was employed in raising the pressure in the fixed cylinders to 63 atmospheres, and worked, on an average, during fifty minutes in each hour; during the rest of the journey it remained idle. It was thus always employed in doing work in excess of the pressure which could be utilized on the car, and the work was, under the circumstances of the case, necessarily intermittent. This was a very unfavorable condition of working.

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In the electric tram-car the haulage was effected by means of accumulators. The car was of the ordinary type with two platforms. It was said to have been running as an ordinary tram-car since 1876. It had been altered in 1884 by raising the body about six inches, so as to lift it clear of the wheels, in order to allow the space under the seats to be available for receiving the accumulators, which consisted of Faure batteries of a modified construction. The accumulators employed were of an improved kind, devised by M. Julien, the under manager of the Compagnie l'Electrique, which undertook the work.

The principal modification consists in the substitution, for the lead core of the plates, of one composed of a new unalterable metal. By this change the resistance is considerably diminished, the electromotive force rises to 2.40 volts, the return is greater, the output more constant, and the weight is considerably reduced. The plates being no longer subject to deformation have the prospect of lasting indefinitely. The accumulators used were constructed in August, 1884.

The car, as altered, had been running as an electric tram-car on the Brussels tramways since October, 1884, till it was transferred to the experimental tramway at Antwerp. The accumulators had been in use upon the car during the whole of this period, and they were in good order at the end of the experiments, that is to say, when the exhibition closed at the end of October, 1885.

The accumulator had forty elements, divided into four series, each series communicating, by means of wires fixed to the floor of the car, with commutators which connected them with the dynamo used as a motor.

There were two sets of these batteries or accumulators, one of which was being charged in the shed while the other was in use. The exchange required ten minutes, including the time for the car to go off the tramway into the shed and return to the tramway. This exchange took place after every seven journeys. Therefore, the two batteries would have sufficed for working the car over a distance of about forty-two miles during sixteen hours.

It may be observed that the first service in the morning would be performed by means of the accumulators charged during the afternoon and evening of the previous day.

Each element of a battery was composed of nineteen plates, of which nine were positive, four millimeters thick, and ten negative, three millimeters thick. Each positive plate weighed 1.44 lb., of which about twenty-five per cent. consisted of active material. Each negative plate weighed nearly 1 lb., of which one-third consisted of active matter. The weight of the metallic part of the battery amounted, therefore, to 1,846 lb.; and the whole battery, including the case and the liquid, amounted to 2,464 lb., which contained 499 lb. of active matter, or about 20.25 per cent. The four cases in which the battery was contained were so arranged as to divide the weight equally between the wheels.

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Two commutators inclosed in a box were placed on the platforms at the two ends of the carriage, so as to be available for moving in either direction.

The accumulators were divided into four series of ten double elements, which, by means of the commutators, could be united under four combinations, *viz*.:

1st. 4 series in quantity—1 in tension. 2d. 2 " " " 2 " 3d. 3 " 4th. 4 "

Finally, a fifth movement united the four series in quantity, coupling them on each other, and putting the dynamo out of circuit, thus restoring equilibrium. When in a state of repose, the handle was so arranged as to keep this latter switch turned on. The accumulators were arranged for charging in two series united in quantity, each containing twenty double elements. The charge was effected by a Gramme machine, worked by a portable engine. Each of these series received its charge during seven hours for the ordinary service of the car, and during nine hours for the accelerated service.

The accumulators on the car actuated a Siemens dynamo, acting as a motor, such as is used for lighting, having a normal speed of 1,000 revolutions, fixed on the frame of the carriage. The motion was conveyed from the pulley on the dynamo by means of a belt passing round a shaft fixed on movable bearings to regulate its tension, and thence to the axles by means of a flat chain of phosphor bronze. The chain was adopted as the means of moving the axle, on account of its simplicity and facility of repair by unskilled labor.

The speed was fixed at 4 meters per second (which corresponds with a speed of nearly 9 miles per hour) for 1,000 revolutions of the dynamo; and it was regulated by cutting a certain number of the accumulators out of circuit, instead of by the device of inserting resistances, which cause a waste of energy. By breaking the circuit entirely the motive power ceased, and the vehicle might either be stopped by the brakes or allowed to run forward by gravity, if the road were sufficiently inclined. The reversal of the motor was effected by means of a lever which reversed the position of the brushes of the dynamo.

The dynamo could be set in motion, and the carriage worked from either end, as desired. The handle to effect this was movable, and as there was only one handle, and this one was in charge of the conductor, he used it at either end as required.

It should be mentioned that the car was lighted at night by two incandescent lamps, which absorbed 1.5 amperes each; and the brakes also were worked by the accumulators.

The weight of the tram-car was 5,654 lb.; the weight of the accumulators was 2,460 lb.; the weight of the machinery, including dynamo, 1,232 lb. The car contained room for

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fourteen persons inside and twenty outside. Under the conditions of the competition the car was required to draw a second car occasionally.

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The jury made special observations upon the work required to move the car between the 20th September and 15th October, 1885. Seals were attached to the accumulators. Moreover, from the 27th of September, after each charge, seals were placed on the belts from the steam-engine to prevent any movement of the Gramme machine, so that there could be no charges put into the accumulators beyond those measured by the jury.

The instruments used for measuring were Ayrton's amperemeter and Deprez's voltmeter, which had been tested in the exhibition by the Commission for Experiments on Electrical Instruments, under the presidency of Professor Rousseau. Besides this, Siemens' electro-dynamometer and Ayrton's voltmeter were used to check the results; but there was no practical difference discovered. During the period of charging the accumulators, the intensity of the current and the electromotive force was measured every quarter of an hour, and thence the energy stored up in the battery was deduced. It may be mentioned that the charge in the accumulators, when the experiments were commenced, was equal in amount to that at their termination.

An experiment was made on 21st October to ascertain, as a practical question, what was the work absorbed by the Gramme machine in charging the accumulators. The work transmitted from the steam-engine was measured every quarter of an hour by a Siemens dynamometer; at the same time the intensity of the electromotive force given out by the machine, as well as the number of the revolutions it was making, was noted. It resulted that for a mean development of 4 mechanical horse power, the dynamometer gave into the accumulators to be stored up 2.28 electrical horse power, or 57 per cent. The intensity varied between 25.03 and 23.51 amperes during the whole time of charging. Of this amount stored up in the accumulators a further loss took place in working the motor; so that from 30 to 40 per cent. of the work originally given out by the steam-engine must be taken as the utmost useful effect on the rail.

It was estimated that to draw the carriage on the level 0.714 horse power was required, or if a second carriage was attached, 0.848 horse power would draw the two together. This would mean that, say, 2 horse power on the fixed engine would be employed to create the electricity for producing the energy required to draw the carriage on the level.

The electric tram-car was quite equal in speed to those driven by steam or compressed air, and was characterized by its noiselessness and by the care with which it was manipulated.

Assuming the car, by itself, cost the same as an ordinary tram-car, the extra cost relatively to other systems was stated as being according to the following figures, *viz*.: the Gramme machine cost L48, the motor L208, and the accumulators 2.25 francs per kilogramme (10d. per pound). To these must be added the cost of erection, and of switches for manipulating the current; as well as the proportion of the cost of a fixed engine to create the electricity.

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Having thus given a general description of the various motors which were presented for competition, I will now give a brief summary of some of the principal particulars obtained during the competition. In the first place, it may be mentioned that the jury consisted of the following:

President.—M. Hubert, Ingenieur en Chef, Inspecteur de Direction a l'administration des chemins de fer de l'Etat Belge.

Vice-President.—M. Beliard, Ingenieur des Arts et Manufactures, delegue par le Gouvernenent Francais.

Members.—MM. Douglas Galton, Capitaine du Genie, delegue par le Gouvernement Anglais; Gunther, Ingenieur, Commissaire General de la Section allemande a l'Exposition d'Anvers; Huberti, Ingenieur a l'administration des chemins de fer de l'Etat Belge, Professeur a l'Universite de Bruxelles; Dery, Ingenieur Chef de service a l'administration des chemins de fer de l'Etat Belge.

Secretary.—M. Dupuich, Ingenieur Chef du service du material et de la traction a la Societe Generale des chemins de fer economiques.

Reporter.—M. Belleroche, Ingenieur en Chef, a la traction et au material des chemins de fer du Grand Central.

Members added by the Jury.—MM. Vincotte, Ingenieur, Directeur de l'Association pour la surveillance des machines a vapeur; Laurent, Ingenieur des mines et de l'Institut electro-technique de l'Universite de Liege.

The original programme of the conditions which were laid down in the invitation to competitors, as those upon which the adjudication of merit would be awarded, contained twenty heads, to each of which a certain value was to be attached; and, in addition to these special heads, there were also to be weighed the following general considerations, *viz*.:

a. The defects or inconveniences established in the course of the trials.

b. The necessity or otherwise of turning the motor, or the carriage with motor, at the termini.

c. Whether one or two men would be required for the management of the engine.

As regards these preliminary special points, the compressed air motor, as well as the Rowan engine, required to be turned for the return journey, whereas the other motors could run in either direction.

In regard to this, the electric car was peculiarly manageable, as it moved in either direction, and the handle by which it was managed was always in front, close to the brake. This carriage was the only one which was entirely free from the necessity of attending to the fire during the progress of the journey, for even the compressed air engine had its small furnace and boiler for heating the air.

Each of the motors under trial was managed by one man.

The several conditions of the programme may be conveniently classified in three groups, under the letters A, B, C. Under the letter A have been classed accessory considerations, such as those of safety and of police. These are of special importance in towns. But their relative importance varies somewhat with the habits of the people as well as with the requirements of the authorities; for instance, in one locality or country conditions are not objected to which, in another locality, are considered entirely prohibitory.

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The conditions under this head are:
1. Absence of steam.
2. Absence of smoke and cinders.
3. Absence, more or less complete, of noise.
4. Elegance of aspect.
5. The facility with which the motor can be separated from the carriage itself.
6. Capacity of the brake for acting upon the greatest possible number of wheels of the vehicle or vehicles.
7. The degree to which the outside covering of the motor conceals the machinery from the public, while allowing it to be visible and accessible in all parts to the engineer.
8. Facility of communication between the engineer and the conductor of the train.

In deciding upon the relative merits of the several motors, so far as the eight points included under this heading are concerned, it is clear that, except possibly as regards absence of noise, the electrical car surpassed all the others.

The compressed air car followed, in its superiority in respect of the first three points, *viz*., absence of steam, absence of smoke, and absence of noise; but the Rowan was considered superior in respect of the other points included in this class.

Under the letter B have been classed considerations of maintenance and construction.

9. Protection, more or less complete, of the machinery against the action of dust and mud.
10. Regularity and smoothness of motion.
11. Capacity for passing over curves of small radius.
12. The simplest and most rational construction.
13. Facility for inspecting and cleaning the interior of the boilers.
14. Dead weight of the train compared with the number of places.
15. Effective power of traction when the carriages are completely full.
16. Rapidity with which the motor can be taken out of the shed and made ready for running.
17. The longest daily service without stops other than those compatible with the requirements of the service.
18. Cost of maintenance per kilometer. (It was assumed, for the purposes of this sub-heading, that the motor or carriage which gave the best results under the conditions relating to paragraphs 9, 10, 12, and 13 would be least costly for repairs.)

As regards the first of these, *viz*., protection of the machinery against dirt, the machinery of the electrical car had no protection. It was not found in the experiments at Antwerp that inconvenience resulted from this; but it is a question whether in very dusty localities, and especially in a locality where there is metallic dust, the absence of protection might not entail serious difficulties, and even cause the destruction of parts of the machinery.

In respect to the smoothness of motion and facility of passing curves, the cars did not present vary material differences, except that the cars in which the motor formed part of the car had the preference.

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In the case of simplicity of construction, it is evident that the simplest and most rational construction is that of a car which depends on itself for its movement, which can move in either direction with equal facility, which can be applied to any existing tramway without expense for altering the road, and the use of which will not throw out of employment vehicles already used on the lines; the electric car fulfilled this condition best, as also the condition numbered 13, as it possessed no boiler.

In respect to No. 14, *viz*., the ratio of the dead weight of the train to passengers, if we assume 154 lb. as the average weight per passenger, the following is the result in respect of the three cars in which the power formed part of the car:

```
9,350 lb.
Electric car.      --------- =  1.78
154 x 34

15,950 lb.
Rowan.            ---------- =  2.30
154 x 45

22,000 lb.
Compressed air.   ---------- =  2.55
154 x 56
```

The detached engines gave, of course, less favorable results under this head.

Under head No. 15 the tractive power of all the motors was sufficient during the trials, but the line was practically level, therefore this question could only be resolved theoretically, so far as these trials were concerned, and the table before given affords all the necessary data for the theoretical calculation.

As regards the rapidity with which the motors could be brought into use from standing empty in the shed, the electric car could receive its accumulators more rapidly than could the boiler for heating the exhaust of the compressed-air car be brought into use.

As regards the steam motors, the following were the results from the time of lighting the fires:

The Rowan—
  In 34 minutes 3 atmospheres.
   " 36 " 4 "

At this pressure the vehicle could move—

In 40 minutes 8 atmospheres.

The Wilkinson—
In 35 minutes 2 atmospheres.
" 40 " 4 "
" 44 " 6 "
" 47 " 8 "

The Krauss machine required two hours to give 6 atmospheres, which was the lowest pressure at which it could be worked.

The results under No. 17, *viz*., the fewest interruptions to the daily service, class the motors in the following order: Krauss, electric, Rowan, Wilkinson, compressed air. The chief cause of injury to the compressed air motor arose from the carelessness of the drivers, who allowed the steam boiler to be burnt out. Unfortunately, these drivers were new to the work.

Under the letter C are classed considerations of economy in the consumption of materials used for generating the power necessary for working.

19. Minimum consumption of fuel (either coke or coal),
in proportion to the number of kilometers run, and
to the number of places, assuming for the seats a
width of at least sixteen inches for each person seated.

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It must be borne in mind that the conditions of the competition required that a second car should be periodically drawn by the motor, and that the calculations which follow include the total number of miles run, the total amount of fuel, *etc*., consumed, and the total number of passengers which could be conveyed by each motor, during the total time that the experiments were being carried on.

TABLE II.

Description of motor.	Total number of train miles run.	Total Consumption of fuel.	No. of lb. per train mile.
		lb.	
Electric.	2,358.9	14 786	6.16
Rowan.	2,616.9	14,498	5.42
Wilkinson.	2,473.3	22,000	8.82
Krauss.	2,457.8	22,726	9.10
Compressed air.	2,259.1	90,420	39.48

TABLE III.

Description of motor.	No. of places indicated on the cars, per mile run.	Consumption of fuel.	No. of lb. of fuel consumed per places indicated per mile run.
		lb.	
Electric	80,203.5	14,786	0.18
Rowan	148,399.6	14,498	0.09
Wilkinson	119,085.1	22,000	0.18
Krauss	108,983.9	22,726	0.20
Compressed air	128,189.3	90,420	0.69

TABLE IV.

Description of motor.	No. of seats per mile run.	Consumption of fuel.	No, of lb. of fuel consumed per seat per mile run.
		lb.	
Electric	61,591.2	14,786	0.23
Rowan	135,928.8	14,498	0.10
Wilkinson	93,965.6	22,000	0.23

Krauss 86,039.9 22,726 0.25
Compressed air 132,732.7 90,420 0.66

As regards the figures in these tables, it is to be observed that the consumption of fuel for the electric car is, to a certain extent, an estimate; because the engine which furnished the electricity to the motor also supplied electricity for electric lights, as well as for an experimental electric motor which was running on the lines of tramway, but was not brought into competition.

20. Minimum consumption of oil, of grease, tallow, *etc*. (the same conditions as in No. 19).

TABLE V.

Description of motor.	Total number of miles run.	Total consumption of oil, tallow, *etc*.	Consumption of oil, tallow, *etc*., per train mile run.
lb.			
Electric	2,358.9	99.0	0.038

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Rowan, steam	2,616.9	106.7	0.038
Krauss, steam	2,457.8	188.5	0.073
Wilkinson, steam	2,473.3	255.4	0.101
Compressed air	2,259.1	585.2	0.255

In addition to these considerations, it was thought useful to investigate the quantity of water consumed in the case of those engines which used steam. The experiments made on this point showed as the consumption of water:

	Gallons per mile.
Rowan	0.75
Compressed air	1.06
Wilkinson	5.89
Krauss	6.52

Thus, owing to the large proportion of water returned from the condenser to the tanks, the Rowan actually used less water than the compressed air engine.

CONCLUSION.

The general conclusion to which these experiments bring us is that, undoubtedly, if it could certainly be relied upon, the electric car would be the preferable form of tramway motor in towns, because it is simply a self-contained ordinary tram-car, and in a town the service requires a number of separate cars, occupying as small a space each as is compatible with accommodating the passengers, and which follow each other at rapid intervals.

But the practicability and the economy of a system of electric tram-cars has yet to be proved; for the experiments at Antwerp, while they show the perfection of the electric car as a means of conveyance, have not yet finally determined all the questions which arise in the consideration of the subject. For instance, with regard to economy, the engine employed to generate the electricity was not in thoroughly good order, and from its being used to do other work than charging the accumulators of the tram-car, the consumption of fuel had to be to some extent estimated. In the next place, the durability of the accumulators is still to be ascertained; upon this much of the economy would depend. And in addition to this question, there is also that of the durability of parts of the machinery if exposed to dust and mud.

After the electric car, there is no question but that at the Antwerp Exhibition the most taking of the tramway motors was the Rowan, which was very economical in fuel, quite free from the appearance of steam, and very convenient and manageable.

The economy of the Rowan motor arises in a large degree from the extent of its condensing power, by means of which a considerable supply of warm water is constantly supplied for use in the boiler, and consequently the quantity of water which has to be carried is lessened, and the fuel is economized.

Independently, however, of its convenience as a motor for tramways in towns, the Rowan machine has been adapted on the Continent to the conveyance of goods as well as passenger traffic on light branch railways, and fitted to pass over curves of 50 feet radius, and up gradients of 1:10.

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In England, with our depressed trade and agriculture, there is a great want in many parts of the country of a cheap means of conveyance from the railway stations into the surrounding districts; such a means of conveyance might be afforded by light railways along or near the road-side, the cost of which would be comparatively small, provided that the expensive methods of construction, of signaling, and of working which have been required for main lines, and which are perfectly unnecessary for such light railways, were dispensed with.

It is certain that this question will acquire prominence as soon as a system of local government has been adopted, in which the wants of the several communities have full opportunity of asserting themselves, and in which each local authority shall have power to decide on those measures which are essential to the development of the resources of its own district, without interference from a centralized bureaucracy.

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ON THE THEORY OF THE ELECTRO-MAGNETIC TELEPHONE TRANSMITTER.

By E. MERCADIER.

[Footnote: Note presented to the Academy of Sciences, Oct. 19, 1885.]

The first point to be studied in this theory is the *role* performed by the iron or steel diaphragm of the telephone, both as regards the nature of the movements that it effects through elasticity and the conversion of mechanical into magnetic energy as a result of its motions.

I. When we produce simple or complex vibratory motions in the air in front of the diaphragm, like those that result from articulate speech, either the fundamental and harmonic sounds of the diaphragm are not produced, or else they play but a secondary *role*.

(1.) In fact, diaphragms are never set in vibration, as is supposed, when we desire to determine the series of harmonics and nodal lines, since we do not leave them to themselves until they have been set in motion, and we do not allow a free play to the action of elastic forces; in a word, the vibrations that they are capable of effecting are constantly *forced* ones.

(2.) When a disk is set into a groove, and its edges are fixed, theory indicates that the first harmonics of the free disk should only rise a little. Let us take steel disks 4 inches in diameter and but 0.08 inch in thickness, and of which the fundamental sound in a free state is about *ut*{5}_, and which the setting only further increases. It is impossible to see how this fundamental and the harmonics can be set in play when a continuous series of sounds or accords below *ut*{5}_, are produced before the disk; and yet these sounds are produced perfectly (with feeble intensity, it is true, in an ordinary telephone) with their pitch and quality. They produce, then, in the transmitting diaphragm other motions than those of the fundamental sound and of its peculiar harmonics.

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(3.) It is true that in practice the edges of the telephone diaphragm are in nowise fixed, but merely set into a groove, or rather clamped between wooden or metallic rings, whose mass is comparable to their own; and they are, therefore, as regards elasticity, in an ill ascertained state. Yet a diaphragm of the usual diameter (from 2 to 4 inches), and very thin (from 0.001 to 0.02 inch), clamped in this way by its edges, is capable of vibrating when a continuous series of sounds are produced near it, by means, for example, of a series of organ pipes. But the series of sounds that it clearly re-enforces, in exhibiting a kind of complex nodal lines, is plainly *discontinuous*; and how, therefore, would the existence of such series suffice to explain the production of a *continuous* scale of isolated or superposed sounds, the chief property of the telephone?

(4.) The interposition of a plate of any substance whatever between the diaphragm and the source of the vibratory motions in nowise alters the telephonic qualities of the diaphragm, and consequently the *nature* of the motions that it effects—a fact that would be very astonishing if the motions were those that corresponded to the peculiar sounds of the diaphragm. This fact is already known, and I have verified it with mica, glass, zinc, copper, cork, wood, paper, cotton, a feather, soft wax, sand, and water, even in taking thicknesses of from 5 to 8 inches of these substances.

(5.) We can put a diaphragm manifestly out of condition to effect its peculiar scale of harmonics by placing small, unequal, and irregularly distributed bodies upon its surface, by cutting it out in the form of a wheel, and by punching a sufficient number of holes in it to reduce it half in bulk. None of these modifications removes its telephonic qualities.

(6.) We can go still further, and employ diaphragms of scarcely any stiffness and elasticity without altering their essential telephonic properties, the reproduction of a continuous series of sounds, accords, and timbres. Such is the case with a sheet iron diaphragm. It is very difficult, then, to imagine a fundamental sound and its harmonics.

The conclusion from all this appears to me to be that the mechanism by virtue of which telephone diaphragms perform their motions is at least analogous to, if not identical with, that through which solid bodies of any form whatever (a wall, for example) transmit to all of their surfaces all the simple or complex successive or simultaneous vibratory motions, of periods varying in a continuous or discontinuous manner, that are produced in the air in contact with the other surface. In a word, we have here a phenomenon of *resonance*. In diaphragms of sufficient thickness this kind of motion would exist alone. In thin diaphragms the motions that correspond to their special sounds might become superposed upon the preceding, and this would be prejudicial rather than useful, since, in such a case, if there resulted a re-enforcement of the effects produced, it would be at the expense of the reproduction of the timbre, the harmonics of the diaphragm being capable of coinciding only through the merest accident with those of the sounds that were setting in play the fundamental sound of the diaphragm. This is what experiment clearly demonstrates.

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II. Let us now pass to the *magnetic role* of the telephone diaphragm. Such *role* can be clearly enough defined by the following facts:

(1.) The presence of the magnetic field of the telephone in nowise changes the preceding conclusions.

(2.) Upon farther and farther diminishing the stiffness and elasticity of the diaphragm, I have succeeded in suppressing it entirely. In fact, it is only necessary to substitute for it, in any telephone whatever, a few grains of iron filings, thrown upon the pole of the magnet, covered with a bit of paper or cardboard, in order to render it possible to reproduce all sounds, and articulate speech with its characteristic quality, although, it is true, with very feeble intensity.

(3.) In order to increase the intensity of the effect produced, it suffices to substitute for the iron diaphragm a thin disk of any sort of slightly flexible substance, metallic or otherwise, cardboard, for example, and through the aperture of the usual cover of the instrument to scatter over it from 11/2 to 3 grains of iron filings. In this way we obtain an iron filings telephone. By properly increasing the intensity of the magnetic field, I have been able to form telephones of this kind that produced in an ordinary receiver as intense effects as those given by the usual transmitters with stiff disks, and which, too, were reversible. But for a field of given intensity, there is a weight of iron filings that produces a maximum of effect.

We thus see that the advantage of the iron diaphragm over filings is truly reduced to the presentation of a much larger number of magnetic molecules to the action of the field and to external actions, within the same volume. It increases the *intensity* of the telephonic effects, although for *the production* of the latter with all their variety, fineness, and perfection it is nowise indispensable. It suffices, after a manner, to materialize the lines of force with iron filings, and to act mechanically upon them, and consequently upon the field itself.

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ON THE THEORY OF THE RECEIVER OF THE ELECTRO-MAGNETIC TELEPHONE.

By E. MERCADIER.

[Footnote: Note presented to the Academy of Sciences, November 16, 1885.]

On a former occasion I described some experiments that had led me to a theory of the telephone transmitter; a few words will suffice to expose that of the receiver.

Such theory gave rise during the first years succeeding the invention of the telephone to a considerable number of investigations, the principal results of which may be summed up in the two following points:

1. All the parts of a telephone receiver—core, helix, disk, handle, *etc*.—vibrate simultaneously (Boudet, Laborde, Breguet, Ader, Du Moncel, and others). But there is no doubt that by far the most energetic effects are those of the disk. It has been possible to put the vibrations of the core and helix beyond a doubt only by employing very energetic transmitter currents, or very simplified and special arrangements of the receiver (Ader, Du Moncel, and others).

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2. In telephone receivers we may employ disks or diaphragms of any thickness up to six inches (Bell, Breguet, and others).

From the first point it had already resulted that the diaphragm was no more indispensable in the receiver than it was in the transmitter, as I have already shown (*Comptes Rendus*, t. ci., p. 944); and, from the second point, that there were other effects in a receiver than those that could result from the transverse vibrations corresponding to the fundamental sound and to the harmonics of the diaphragm.

So Du Moncel, basing a theory upon these two categories of facts, asserted that the effects of the telephone receiver were principally due to the molecular vibrations of the core of the electro-magnet (analogous to those that had been studied by Page, De la Rive, Wetheim, Reis, and others), super-excited and re-enforced by the iron diaphragm operating as an armature.

This theory has certainly truth for a basis; but it is incomplete, in that the molecular vibrations of the core are but a very feeble accessory phenomenon, and not a prominent one. At all events, I believe that we can, in a few words, and very simply, present the theory of the telephone receiver by going back to the facts that served me as a basis for the theory of the transmitter, and that result from studies made with telephones of ordinary forms.

In fact, it is enough to remark that the iron filings telephone transmitter described in a preceding article (*1. c.*) is reversible and capable of serving as a receiver—not a very intense one, it is true, but here it is a question of the *nature* of the phenomena, and not of their intensity. It at once results that in receivers, as in transmitters, the rigidity of the iron diaphragm is in nowise indispensable for telephonic effects, such as the production of continuous series of successive or simultaneous sounds and of articulate speech.

The diaphragm serves but to increase the intensity of these effects, as in the transmitter, by concentrating the lines of force of the field, and by presenting a greater surface to the air—the necessary vehicle of sound. When it is thick, the internal motions that it takes on in consequence of variations in the field, and which are transmitted to the surrounding air and the ear, are solely those of resonance. When it is very thin, the peculiar motions resulting from its geometric form and its structure may become superposed upon the preceding, because it may then happen that the corresponding sounds remain within the limits of the pitch wherein the human voice usually moves (from ut_{2} to ut_{5}); but then, also, as the harmonics of the voice in nowise coincide with the proper sounds of the diaphragm, the intensity of the effects is obtained at the expense of a good reproduction of the timbre. This is certainly one of the causes of the nasal timbre of most thin-diaphragmed telephones. By diminishing their thickness, we lose in quality what we gain in intensity.

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But even in this latter respect there is a maximum for receivers, as I have already pointed out that there is for iron filings transmitters. For a magnetic field of given intensity, there is, all things equal, a diaphragm thickness that gives a maximum telephonic result. Such result, which is analogous to those that occur in other electro-magnetic phenomena, may explain the want of success of many tentatives made somewhat at haphazard, with a view to increasing the intensity of telephonic effects.

* * * * *

DECOMPOSITION AND FERMENTATION OF MILK.

Dr. F. Hueppe, who has paid great attention to this subject, describes five distinct organisms which he finds to be invariable accompaniments of lactic fermentation. One of these he isolated on nutrient gelatine in the form of white, shining, flat, minute beads. This organism has the power of transforming milk sugar and other saccharoses into lactic acid, with evolution of carbonic acid gas. It is rarely found in the saliva or mucilage of the teeth. In these are two micrococci, both of which cause the production of lactic acid, but which manifest differences in their development under cultivation. There are also two pigment forming bacteria, *Micrococcus prodigiosus,* which produces intensely red spots, and the yellow micrococcus of osteomyelitis. These five bacteria are so different and so constant in their properties that they must, in Dr. Hueppe's opinion, be regarded as distinct species. In addition to them there is in milk an organism resembling *Mycoderma aceti*, which transforms milk sugar into gluconic acid.

* * * * *

THE NEW "BURGTHEATER" IN VIENNA.

At last the new "Burgtheater" in Vienna is completed. We say "at last," for work was begun on this new theater more than ten years ago. One after another, monumental architectural works have been erected, which are no less grand and beautiful than this. They were finished long ago, and given over to their respective uses—the Parliament buildings, the "Rathhaus," the University; but Baron Hasenauer, who had charge of the construction of this building, as well as of many others, could not bring himself to the quicker *tempo* of Messrs Hansen, Schmid, and Ferstel. The citizens of Vienna were naturally impatient to see their beautiful "Ringstrasse" completed, and only the Hasenauer buildings were needed to make it perfect.

[Illustration: THE NEW IMPERIAL PALACE THEATRE, VIENNA. ORIGINAL DESIGN BY J.J. KIRCHNER.]

The building was built according to the plans of Semper and Hasenauer; for, as in the other great buildings erected by Hasenauer, the new palace and the museums, Semper’s plans served as a foundation. All the modern improvements in the architecture of theaters have been embodied in the new theater, for the terrible catastrophe at the Ringtheater taught a lesson which has not been forgotten, and the greatest care has been taken to guard against fire.

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The new “Burgtheater” stands directly opposite the imposing “Rathhaus” (senate-house), and is separated from the same by a charming park; to the right stands the University, and to the left the Houses of Parliament. In order to be worthy of such company, and not be overshadowed by these buildings, it was necessary that the theater should be very grand. The most important requirements have been perfectly fulfilled; beauty, elegance, appropriateness, and security against fire, nothing has been neglected.

The principal part of the building stands out strongly, and is flanked on either side by a pavilion-like wing. The audience room will accommodate about two thousand people.

The public and the actors alike rejoice in the new Burgtheater, for which they have waited so long.

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THE NEW GERMAN BOOKDEALERS’ EXCHANGE IN LEIPZIG.

It seems strange that book-printing and the book trade in general should have developed so slowly in the busy city of Leipzig, where a university was established as early as the beginning of the fifteenth century. The first honorable mention of the printing of Leipzig was made during the first decade of the sixteenth century, but it was not until the end of the seventeenth century that the printing and publishing of books received a notable impulse, which was given it by Messrs. J.F. Gleditsch and Thomas Fritsche and Profs. Carpzov and Mericke, who published many works of great typographical beauty.

From 1682 to 1700 ninety-one papers and periodicals appeared in Leipzig, of which the *Acta eruditorum* was the oldest, being the first German scientific paper. At this time there were seventeen printing establishments in Leipzig, and the seventy presses in use printed, on an average, 2,000 bales of paper yearly.

One of the leading bookdealers, Philipp Emanuel Reich, won the approbation of his fellow citizens by establishing the first Bookdealers’ Association at the time of the Easter Fair in Leipzig, in 1764, and it was through his efforts that the Book Exchange or Fair was founded, which has placed Leipzig at the head of the book trade; but several years passed before this private undertaking become a public association. About 1834 a building was erected specially for a book exchange or bourse, but this building was soon outgrown, and it was decided to build a new one which should be adequate to the requirements of the institution.

A competition for designs for the new building was opened, and five designs were presented, from which the plan of Messrs. Kayser and Von. Grossheim, of Berlin, was selected. This design, which is shown in the accompanying cut, taken from the *Illustrirte Zeitung,* presents a picturesque grouping of the different parts of the building, the main building being on one street and the adjoining building on another street. The roof, which forms a beautiful sky-line, is ornamented with dormer-windows and little towers, there being a large tower on the main building.

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[Illustration: PRIZE PLAN FOR THE NEW BOOK EXCHANGE IN LEIPZIG, BY MESSRS. KAYSER AND VON GROSSHEIM, ARCHITECTS.]

To the left of the principal hall in the main building, which has three large ornamental windows, there is a little hall, the central office, and committee rooms, while the restaurant and the assembly rooms are on the right. In the smaller building, through which there is a central corridor, are the order rooms, assorting rooms, editorial sanctum of the *Borsenblat* (Bourse journal), and the post office, with telegraph offices.

A low building runs almost the entire length of the main building, to which it is joined at the right and left by side wings, thus inclosing an open court. In this low building the exhibition rooms are arranged, and in the middle is a vestibule through which these exhibition rooms, the wardrobes, and the great hall can be reached. Over the vestibule is a cupola.

The arrangements for lighting, heating, and ventilation are excellent. Steam heat is used, and the large hall is ventilated by the pulsation system.

The building, which is of red brick and sandstone, is worthy of holding a place among the numerous beautiful buildings which have been erected in Leipzig during the last few years. The cost of the building was limited to 700,000 M., or about $160,000.

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A correspondent has transmitted to the editor of *L'Union Pharmaceutique* the prospectus of an oyster dealer who, besides dealing in the ordinary bivalves, advertises specialties in medicinal oysters, such as “huitres ferrugineuses” and “huitres au goudron.” The “huitres ferrugineuses” are recommended to anaemic persons, and the “huitres au goudron” are said to replace with advantage all other means of administering tar, while of both it is alleged that analyses made by “distinguished *savants*” leave no doubt as to their valuable qualities.

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ALIZARINE DYES.

Notwithstanding the unprecedented progress of the coal-tar dyestuff industry during the past few decades, the time-honored indigo, logwood, fustic, *etc*., have been only partly displaced by the coal-tar products in wool dyeing. The cause is that, though the dyer handled many aniline dyestuffs which dyed as fast against light as logwood or fustic, the dye proved unsatisfactory for fulling goods, because it bled in the treatment with soap and soda, and often more or less changed its tone. We intend to render a service to our readers by calling their special attention to some products of the coal-tar industry which are free from these defects of aniline dyestuffs, and for which it is claimed that they far surpass logwood, fustic, cudbear, *etc*., as to fastness against light, and excellently stand fulling. We allude to the alizarine dyestuffs, which have long since been introduced and are largely employed in cotton dyeing and printing.

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Alizarine, which has been extensively discussed in various articles in our journal, is the coloring matter contained in the madder root. In 1869, two German chemists, Graebe and Liebermann, succeeded in artificially producing this dyestuff from anthracene, a component of coal-tar. The artificial dyestuff being perfectly pure and free from those contaminations which render the use of madder difficult, it soon was preferred to the latter, which it has at present nearly completely displaced.

The discovery of alizarine red was soon followed by those of alizarine orange, galleine, coeruleine, and, in 1878, of alizarine blue.

The slow adoption of these dyestuffs in the wool-dyeing industry is principally attributable to the deep-rooted distrust of wool dyers against any innovation. This resistance, however, is speedily disappearing, as every manufacturer and dyer trying the new dyestuffs invariably finds that they are in no respect inferior to his fastest dyes produced with indigo and madder, but are simpler to apply and more advantageous for wool.

The alizarine colors are dyed after an old method which is known to every wool dyer. The wool is first boiled for 11/2 hours with chromate of potash and tartar, then dyed upon a fresh bath by 21/2 to 3 hours' boiling. All alizarine colors (such as those of the Badische Anilin und Soda Fabrik, of Ludwigshafen and Stuttgart; Wm. Pickhardt & Kuttroff, New York, Boston, and Philadelphia, *viz*.):

Alizarine orange W, for brown orange,
Alizarine red WR, for yellow touch ponceau or scarlet,
Alizarine red WB, for blue touch yellow or scarlet,
Alizarine blue WX and SW, for bright blue,
Alizarine blue WR SRW, for dark reddish blue,
Coeruleine W and SW, for green, and
Galleine W, for dahlia,

are dyed after the same method, which offers the great advantage that all these colors can be dyed upon one bath, and that by their mixture numerous fast colors can be produced. On the ground of numerous careful experiments, the writer recommends the following method, which gives well developed and well fixed colors, *viz*.:

For 100 kil.—The scoured and washed wool is mordanted by boiling for 11/2 hours in a bath containing 3 kil. chromate of potash and 21/2 kil. tartar, and lightly rinsed; when it can immediately be dyed. For 1,000 lit. water, 1 lit. acetic acid of about 7 deg. Be. is added to the bath. If the water is very hard, double the quantity of acetic acid, which is indispensable, is added. Then the required quantity of dyestuff is added, well stirred, the wool entered, and the temperature raised to boiling, which is continued for 21/2 to 3 hours, that is, until a sample taken does no longer surrender any color to a hot solution of soap. Loose wool and worsted slubbing can be entered at 60 deg. C. (140 deg. F.).

In dyeing yarn and piece-goods, however, it is advisable to enter the bath cold, work for about

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1/4 hour in the cold, and then slowly to raise the temperature in about one hour to the boiling point. With this precaution, level and thoroughly dyed goods are always obtained. If the wool is entered in a hot bath, or if it is rapidly brought to a boil, the dyestuff is too rapidly fixed by the mordant and is liable to run up unevenly, and, with piece-goods, more superficially. For the same reason the goods must always be well wetted out before entering the bath.

We add some special recipes for the various colors, the mordant for all of them being of 3 per cent. chromate of potash and 21/2 per cent. tartar for 100 by weight of dry wool.

1. *Orange, Brown Touch*. 20 kil. wool, mordant with 600 grm. chromate of potash and 500 grm. tartar, dye with 3 kil. alizarine orange W.

2. *Ponceau, Yellow Touch*.

20 kil. wool, mordant as for No. 1, dye with 2 kil. alizarine red WR 20 per cent.

3. *Ponceau, Blue Touch*.

20 kil. wool, mordant like No. 1, dye with 2 kil. alizarine red WB 20 per cent.

4. *Dahlia*.

20 kil. wool, mordant like No. 1, dye with 5 kil. galleine W.

5. *Green*.

20 kil. wool, mordant like No. 1, dye with 6 kil. coeruleine W.

For Piece-goods.

20 kil cloth, mordant the same, dye with 1 kil. 200 grm. coeruleine SW.

6. *Blue, Bright*.

20 kil. wool, mordant the same, dye with 6 kil. alizarine blue WX.

For Piece-goods.

20 kil. cloth, mordant the same, dye with 1 kil. 200 grm. alizarine blue SW.

7. *Blue, Dark and Red Touch*.

20 kil. wool, mordant like No. 1, dye with 6 kil. alizarine blue WR.

For Piece-goods.

20 kil. cloth, mordant the same, dye with 1 kil. 200 grm. alizarine blue SRW.

Particular stress is to be laid upon the great fastness of the alizarine dyes against light and fulling. Besides, these dyestuffs contain nothing whatever injurious to the wool fiber. Sanders, which very much tenders the wool, as every dyer knows, can in all cases be replaced by alizarine red and alizarine orange, making an end to the spinners' frequent complaints about too much waste.

Alizarine blue in particular seems to be destined to replace indigo in the majority of its applications, having at least the same power of resisting light and acids, and relieving the dyer of the troublesome, protracted rinsings required for indigo dyed goods. Every piece-dyer knows that the medium and dark indigo blue goods still rub off, even after eight hours' rinsing; but alizarine blue pieces are perfectly dyed through and clean after one hour of rinsing. Another advantage of alizarine blue and the other alizarine dyestuffs is that they unite with all wood colors, as well as with indigo carmine and all aniline dyestuffs. A fine and cheap dark blue, for instance, is obtained by mordanting the wool as above stated and dyeing (20 kil.) in the second bath with 6 kil. alizarine WX and 2 kil. logwood chips; the wood is added to the bath together with the alizarine blue WX, and the best method is to put it into a bag which is hung in the bath.—*D. Woll.-Gew.; Tex. Colorist.*

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Papier mache has come of late to be largely used in the manufacture of theatrical properties, and nearly all the magnificent vases, the handsome plaques, the graceful statues, and the superb gold and silver plate seen to-day on the stage are made of that material.

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CEMENT PAVING.

The streets of "Old London" at the recent Inventions Exhibition at South Kensington were paved with a material in imitation of old, worn bowlder stones and red, herring-boned brickwork, all in one piece from one side of the street to the other. The composition is made by Wilkes' Metallic Flooring Company, out of a mixture consisting chiefly of iron slag and Portland cement, a compound possessing properties which won the only gold medal given for paving at that Exhibition. At the present time the colonnade in Pall Mall, near Her Majesty's Theater, is being laid with this paving, which is also being extensively used in London and the provinces for roads, tramways, and flooring; the composition is likewise sometimes cast into artistic forms for the ornamentation of buildings, or into slabs for roofing, facing, and other purposes. The subway from the Exhibition to the District Railway is laid with the same material.

The works of the Wilkes Metallic Flooring Company are in the goods yard of the Midland Railway Company at West Kensington. The Portland cement, before it is accepted at the works, is tested by means of an Aidie's machine. The general strain the set cement is required to bear is 750 lb. to the square inch. All samples which will not bear a strain of 500 lb. are rejected. The various iron slags are carefully selected, and rejected when too soft, and at the works a small percentage of black slag, rich in iron, is mixed in with them. The lumps of slag are first crushed in a Mason & Co.'s stone breaker, and then sifted through 1/8 in., 1/4 in., and 1/16 in. wire meshes into these three sizes for mixing. Next the granulated substance is thoroughly well washed with water to remove soluble matter and impalpable dust, and afterward placed where it is protected from the access of dust and dirt. The washing waters carry off some sulphides, as well as mechanical impurities. The Portland cement is not used just as it, comes from the works, but is exposed to the air in a drying room for about fourteen days, and turned over two or three times during that period. The slag is also turned over three times dry and three times wet, and mixed with the Portland cement by means of water containing 5 per cent. of "Reekie" cement to make the whole mass set quickly. The mixture is then turned over twice and put into moulds; each mould is first half filled, and the mixture then hammered down with iron beaters. The rest of the composition is then poured in, beaten down, and the whole mould violently jolted

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by machinery to shake down the mixture and to get rid of air holes. While it is still wet the casting is taken out of the mould, its edges are cleaned, and after the lapse of one day it is placed in a bath, of silicate of soda. Should the casting be allowed to get dry before it is placed in this bath, no good results would be obtained; it is left in the bath for seven days. When delicate stone carvings have to be copied, the moulds are of a compound of gelatine, from the flexible nature of which material designs much undercut can be reproduced. For the foregoing particulars we are indebted to Mr. William Millar, the working manager at West Kensington. Sometimes the composition is cast in large, heavy slabs, moulded on the top to resemble the surface of roads of granite blocks. A feature of the invention is the rapidity with which the composition sets. For instance, the manager states that a roadway was finished at the Inventions Exhibition at seven o’clock one night, and at six o’clock next morning four or five tons of paper in vans passed over it into the building, without doing any harm to the new road. In laying down roads, much of the preparation of the material is done on the spot, and the composition after being put down unsilicated in a large layer has the required design stamped upon its wet surface by means of wooden or gutta-percha moulds. As regards the durability of the composition, Mr. T. Grover, one of the directors, says that the company guarantees its paving work for ten years, and that the paving, the whole of the ornamental tracings, and some of the other work at Upton Church, Forest Gate, Essex, were executed by means of Wilkes’ metallic cement three years ago, and will now bear examination as to its resistance to the action of weather. Some of this paving has been down in Oxford Street, London, for more than six years. Mr. A.R. Robinson, C.E., London agent of the company, states that the North Metropolitan Tramway Company has about 25,000 yards of it in use at the present time, and that the paving is largely used by the War Office for cavalry stables. The latter is a good test, for paving for stables must be non-slippery and have good power of resisting chemical action.

In the Wm. Millar and Christian Fair Nichols patent for “Improvements in the means of accelerating the setting and hardening of cements,” they take advantage of the hydraulicity of certain of the salts of magnesia, by which the cements set hard and quickly while wet. For accelerating the setting of cements they use carbonate of soda, alum, and carbonate of ammonia; for indurating or increasing the hardening properties of cements they use chloride of calcium, oxide of magnesia, and chloride of magnesia or bittern water; for obtaining an intense hardness they use oxychloride of magnesia. The inventors do not bind themselves to any fixed proportions, but give the following as the best within their knowledge. For colored concretes for casts or other purposes they use Carbonate

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of soda, 8.41; carbonate of ammonia, 1.12; chloride of magnesia, 0.28; borax, 0.56; water, 89.63; total, 100.00. For gray concrete for any purpose they use: Alum, 8.46; caustic soda, 0.28; whitening or chalk, 0.56; borax, 0.56; water, 90.14; total, 100.00. For floors or slabs *in situ* they add to cement, well mixed and incorporated with any required proportion of agglomerate for a base, liquid composition of the following proportions: Oxide of magnesia, 0.29; chloride of magnesia, 0.29; carbonate of soda or alum, 4.74; water, 94.68; total, 100.00. Articles manufactured by the invention are afterward wetted with chloride of calcium and placed in a bath containing a solution of silicate of soda or chloride of calcium. The strength of the chloride of calcium is equal to about 20 deg. specific gravity.

C.A. Wilkes and William Millar's improved "metallic compound for flooring, paving, and other purposes," has for its object to provide a paving compound which is not slippery or liable to soften in hot weather, which sets rapidly, and is durable. To three parts of blast furnace slag are added one part of hydraulic cement and enough water to give the proper consistency. To each gallon of water used is added one part of bittern water—-the dregs from the manufacture of sea salt—or one part of brine, or about 5 per cent. of carbonate of soda, and 21/2 per cent. of carbonate of ammonia. In the compound they sometimes use potash in the proportion of about 5 per cent. of the carbonate of ammonia and carbonate of soda, and when potash is used with bittern water or brine, the proportion of the latter is correspondingly reduced. The compound is of a blue gray color; but when a more striking color is desired, red or yellow oxide of iron may be added. When more speedy induration is necessary, they add about 1 oz. of copperas to every gallon of compound used. The claim is the admixture of bittern water, carbonate of soda, and carbonate of ammonia with the washed slag and cement.

Another improvement, by C.A. Wilkes, relates, in laying *in situ* any metallic or other materials for street roadways, to completing the convenience thereof by roughening or grooving the surfaces. The concrete is laid in a plastic condition upon a bed of hard core, broken stone, or preferably rough concrete. For footpaths the material may be laid in convenient sections, say 4 ft. to 8 ft. square and 2 in. to 4 in. thick; and in order to allow for the expansion of the material during the setting of the sections or subsequent variations in temperature, he packs the joints between the sections with a layer of felting cloth or other compressible material, thus forming expansion joints. Sometimes he slightly roughens the surface of the material, to give better foothold to pedestrians. Sometimes the grooving is made in imitation of ordinary granite paving sets. In tramway pavement there are grooves to give a grip to the horses' feet, and a slight camber between the rails. He states that a great advantage in laying a pavement by the method is that, when any repairs are necessary, a piece of the exact size can be manufactured at the works, and stamped to the same pattern as the adjoining pavement, then placed at once in position on the removal of the worn portion, thus saving the time necessary for the setting of the concrete on the spot.—*The Engineer*.

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A NEW BLEACHING PROCESS.

In the spring of 1883 a Mr. J.B. Thompson, of New Cross, London, patented a new process of bleaching, the main feature of which consisted in the use of carbonic acid gas in a closed vessel to decompose the chloride of lime. The “chemicking” and “souring” operations he performed at the same time. The reactions which took place in his bleaching keir were stated by the inventor as follows:

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     Cl.\
1.  Ca ) + CO_{2} = CaCO_{3} + Cl_{2}.
    OCl./
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2. $OH_{2} + Cl_{2} = (ClH)_{2} + O$.

3. $CaCO_{3} + (ClH)_{2} = CaCl_{2} + CO_{2} + H_{2}O$.

That is, in 1 chloride of lime and carbonic acid react upon each other, producing chalk and nascent chlorine; in 2 the nascent chlorine reacts upon the water of the solution and decomposes it, producing hydrochloric acid and nascent oxygen, which bleaches; in 3 the hydrochloric acid just formed reacts upon chalk formed in 1, and produces calcium chloride and one equivalent of water, and at the same time frees the carbonic acid to be used again in the process of decomposing the chloride of lime.

When the process was first brought to the notice of the Lancashire bleachers, it met with an amount of opposition. Some bleaching chemists declared the process was not patentable, as fully half a century ago carbonic acid was known to decompose chloride of lime. The patentee’s answer was emphatic, that carbonic acid gas had never been applied in bleaching before. After some delay one of the largest English cotton bleachers, Messrs. Ainsworth, Son & Co., Halliwell, Bolton, threw open their works for a fair test of the Thompson process on a commercial scale.

The result of trial was so satisfactory that a company was formed to work the patent. Soon after this the well-known authorities on the oxidation of cellulose, Messrs. Cross & Bevan and Mr. Mather, the principal partner in the engineering firm of Mather & Platt, of Salford, Lancashire, joined the company. For the last twelve months these gentlemen have devoted considerable attention to improving the original contrivance of Thompson, and a few weeks since they handed over to Messrs. Ainsworth the machinery and instructions for what they considered the most complete and best process of bleaching that has ever been introduced.

Recently a “demonstration” of the “Mather-Thompson” process of bleaching took place at Halliwell, and to which were invited numerous chemists and practical bleachers.

Having been favored with an invitation, I propose to lay before your readers a concise report of the proceedings.

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It is usual in this country to give a short preliminary boil to the cloth before it is brought in contact with the alkali, the object being to well scour the cloth from the loose impurities present in the raw fiber and also the added sizing materials. In the new process the waste or spent alkaline liquors of the succeeding process are employed, with the result that the bleaching proper is much facilitated. The economy effected by this change is considerable, but in the next operation, that of saponification, the new process differs even more widely from those generally in use. In England, “market” or “white” bleaching requires a number of operations. There is first the alkaline treatment divided into the two stages or processes of lime stewing and bowking in soda-ash, which only imperfectly breaks down the motes. There is consequently a second round given to the goods, consisting of a bowk in soda-ash, followed by the second and usually final chemicking. There is, therefore, much handling of the cloth, with the consequent increase of time and therefore expense.

Now, in the saponification process, the Mather-Thompson Company claim to have achieved a complete triumph. They use a “steamer keir,” the invention of Mr. Mather. This keir is so constructed that it will allow of two wire wagons being run in and the door securely fastened. At the top of the keir is fixed a mechanical appliance for steaming the cloth. The steamer keir process consists essentially in:

1. The application of the alkali in solution and in its most effective form, *viz*., as caustic alkali, to each portion of fiber in such quantity as to produce the complete result upon that portion.

2. The immediate and sustained action of heat in the most effective form of steam.

Before the cloth is run into the steamer keir on the wire wagons, it is saturated with about twice its weight of a dilute solution of caustic soda (2 deg. to 4 deg. Twaddell = 0.5 to 1% $Na_{2}O$) at a boiling-temperature, when in the steamer keir it is exposed to an atmosphere of steam at four pounds pressure for five hours. This part of the process is entirely new. The advantage of using caustic soda alone in the one operation, such as I describe, has been long recognized, but hitherto no one has been able to effect this improvement. It will be observed that the Mather-Thompson process does away entirely with the use of lime and soda-ash in at least two boilings and the accessory souring operation. In the space of the five hours necessary for the steamer keir process the goods are thoroughly bottomed and all the motes removed, no matter what be the texture or weight of the cloth. After the cloth is washed in hot water it is removed from the steamer keir, then follows a rinse in cold water, and the goods are ready for the bleaching process.

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In passing to the bleaching and whitening process, it may be necessary to say that thus far the original Thompson process has been entirely altered. Now we come to that part of the bleaching operation where the essential feature in Thompson's patent is utilized. The patentee has apparently thoroughly grasped the fact that carbonic acid has great affinity for lime and that it liberates, in its gaseous condition, the hypochlorous acid, which bleaches. The most perfect contact is realized between the *nascent* hypochlorous acid resulting from its action and the fiber constituent in the exposure of the cloth treated with the bleaching solution to the action of the gas. The order of treatment is as follows:

(1) Saturation with weak chemic (1 deg. Tw.), squeeze, and passage to gas chamber.
(2) Wash (running).
(3) Soda scald.
(4) Wash.
(5) Repetition of 1, but with weaker chemic (1/2 deg. Tw.).
(6) Wash.
(7) Scouring.

The whole of the above operations are carried out on a continuous plan, the machinery being the invention of Mr. Mather. The cloth travels along at the rate of sixty or eighty yards a minute, and comes out a splendid white bleach. The company consider, however, that it is necessary in the case of some cloth to give a second treatment with chemic and gas, each of thirty seconds duration, with an intermediate scald in a boiling very dilute alkaline solution. Mr. Thompson originally claimed that the use of carbonic acid gas rendered the employment of a mineral acid for souring unnecessary. It is considered now to be advisable to employ it, and the souring is included, as will be observed, in the continuous operation.

The new process for treating cloth differs materially from that originally proposed by Mr. Thompson. His plan was to use an air-tight keir in conjunction with a gas-holder. It is obvious that the "continuous" process would not answer for yarns; Thompson's keir is, therefore, employed for these and all heavy piece-goods.

Thus far I have given a concise outline of the Mather-Thompson process of bleaching, which, it cannot be denied, differs materially from any system hitherto recommended to the trade. Beyond doubt the goods are as perfectly bleached by this process as by any now in use. The question arises, What pecuniary advantage does it offer? Mr. Manby, the manager of Messrs. Ainsworth, has informed me that he has bleached as much as ten miles of cloth by the new process, and is, therefore, entitled to be heard on the subject of cost. In regard to the consumption of chemicals, he estimates the saving to amount to (in money value) one-fourth; steam (coal), one-half; labor, one-half; water, four-fifths; time, two-thirds.

It might be well to contrast the process formerly employed by Messrs. Ainsworth with that they have recently adopted:

“MATHER-THOMPSON” SYSTEM.

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Alkali. Bleach Acid Machine
(chemic). Washes.
/ Saturate.
(1) <
\ Steam.
/ (2) Continuous
| (chemic)
| machine
| (or keir if
(2) < for yarns,
| *etc*.).
| (2a) Machine or
\ pit sour.
(3) Wash up for

finishing.

ORDINARY SYSTEM.

Alkali. Bleach. Acid Machine

Washes.

(1) Lime stew. (1) Wash.
(2) Sour. (2) "
(3) Gray bowk (3) "
(soda ash).
(4)I Chemic. (4) "
(5) Sour. (5) "
(6) White bowk. (6) "
(7)II Chemic. (7) "
(8) Sour. (8) "

It will be understood that 2 and 2a are merged into a single process by using the “continuous” machine. Of course, it will be understood that the cloth has in each case to be cleansed from size and loose impurities. The “Mather-Thompson” Company claim that their system takes twelve hours in the case of “market” or “white” bleaching. They reckon eight hours for the steaming process and four for bleaching and washing. This has to be compared with the old system, which generally takes forty hours, made up as follows: 8 treatments with reagents and the necessary washings, the former taking four hours and the latter one hour each.

The “Mather-Thompson” system has created considerable commotion in English bleaching circles. It is generally considered that the bleachers throughout the whole country will be compelled to adopt it, so great is the saving in time and cost. In commencing a bleachery, the cost of plant by this system is, I understand, less than by the old processes.—*Textile Colorist*.

* * * * *

INSTRUMENTS FOR DRAWING CURVES.

By Prof. C.W. MacCord, Sc.D.

I. THE HYPERBOLA.

We are free to express the opinion at the outset, that for various reasons the draughtsman is likely to gain very little advantage by the use of mechanical devices for describing mathematical curves by continuous motion. Such instruments are as a rule not only complicated and expensive, but cumbersome and difficult of adjustment. It may be suggested, *per contra*, that these objections do not apply to the familiar combination of two pins and a string, for tracing the “gardener’s ellipse.” But we question the propriety of classing a string among strictly mechanical devices; it has its uses, to be sure, but in respect to perfect flexibility and inextensibility it cannot be relied on when rigid accuracy is required in drawing any of the conic sections.

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[Illustration: FIG. 1.]

Nevertheless, the construction of such apparatus affords a study which to some is fascinating, and even in the abstract is not devoid of utility. In each case a definite object is presented, and usually a choice of methods of attaining it; success requires a thorough knowledge of the properties of the curve in hand, while ingenuity is stimulated, and familiarity with expedients is cultivated, by the effort to select the most available of those properties, and to arrange parts whose motions shall be in accordance with them. Such exercise of the inventive faculties, then, is good training for the mechanician. And it must not be forgotten that a mechanical movement thus devised for one purpose very frequently is either itself applicable to a different one, or proves to be the germ from which are developed new movements which can be made so; the solution of one problem sometimes furnishing a hint or clew of great value in dealing with another.

[Illustration: FIG. 2.]

We proceed, then, to describe a few instruments of this kind, which we believe to be new, in the hope that in the manner just pointed out they may render a greater service than that for which they are directly intended.

The first of these, shown in Fig. 1, is for the purpose of describing the hyperbola. The properties of the curve, upon which the action of the instrument depends, are illustrated in Fig. 2, where MM, NN, are the two branches of an hyperbola; C the center; AB the major axis; F and F’ the foci. If now a tangent TT be drawn at any point as P of either branch, and a perpendicular let fall upon it from the nearer focus F be produced to cut at G a line drawn from P to the farther focus F’, then this perpendicular will cut the tangent at a point I upon the circumference of a circle described about C upon AB as a diameter, and also the distance F’G will be equal to AB.

In Fig. 1, then, we have a crank CI, whose radius is equal to CB, half the major axis, turning about a fixed center C. Upon the crank-pin I is hung, so as to turn freely, a rigid cross composed of a long slotted piece TT, in which slides a block, and two cylindrical arms at right angles to it and in line with each other, the axis EE passing through I. The arm on the right slides through a socket pivoted at the focus F; the one on the left slides through a similar socket, which is pivoted at G to a third socket longer than the others, which again is pivoted at the focus F’; the distance F’G being equal to AB. Through this long socket slides a rod KP, the end P being formed into an eye, by which this rod is pivoted to the block which slides in the long slot, and thus controls the motion of the block; and the pivot at P is centrally drilled to carry the pencil. It is thus apparent that the center line of the slot TT must in all positions be tangent to the hyperbola PBR, which will be traced by the pencil, whose motions are so restricted as always to satisfy the conditions explained in connection with Fig. 2.

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The apparatus as thus represented does not at first sight appear unduly complicated. But in order to render it adjustable, so that hyperbolas of varying eccentricities and on different scales may be drawn with it, several parts not here shown must be added. A frame must be provided, in which to arrange supports for the pivots at F and F', and these supports connected by a right and left handed screw, or equivalent means of altering the distance between the foci; the crank CI and the socket F'G must be of variable length, and these in each case would require to be carefully adjusted. So that, as we stated in the beginning, it is questionable whether a draughtsman of ordinary skill could draw the curve any more readily by the aid of such a piece of mechanism than he could without it; but it may claim a passing notice as a novel device, and the first one, we believe, for describing the hyperbola by a combination of rigid parts.

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EXPERIMENTS WITH FIBERS.

By Dr. THOMAS TAYLOR.

As Microscopist of the United States Department of Agriculture, I am frequently called upon to make investigations as to the character of textile fibers and fabrics, not only for the public generally, but also for several departments of the Government.

Textile fibers are presented both in the raw and as articles of manufacture. In the latter case they may have been dyed, stained, or painted. It is obvious that under these conditions the fibers should be subjected to chemical reaction to bring them as nearly as possible to their normal condition.

Considering how well the structures of the common textile fibers of commerce—cotton, flax, ramie, hemp, jute, Manila hemp, silk, and wool—have been investigated and minutely described by able and exact microscopists, I will in this paper confine myself chiefly to such experiments as I have personally made with textile fibers, treating them with chemical agents while under the objective.

While I am aware that this method is not wholly new, I am satisfied that comparatively little work has been done in this direction, and that a wide field is still open for future research.

As microscopists, we have to fortify ourselves in every way that will sustain, by truthful work, the value of the microscope as a means of research, sometimes conducting our experiments under the most trying circumstances. Fibers may be so treated by experts as to make it difficult to determine how their changed appearance has been effected, and it may happen in this age of experiment and of fraud that important decisions in commercial transactions and in criminal cases may depend on our observations.

DETECTION OF A FRAUD.

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A case in point will illustrate this. While Dr. Dyrenforth was chief of the chemical division of the U.S. Patent Office, a person applied for a patent on what he called “cottonized silk,” inclosing specimens. He claimed that he had discovered a mode of covering cotton fiber with a solution of silk which could be woven into goods of various kinds; in order to satisfy the public of the reality of his invention, he placed on exhibition, in various localities, specimens of silk-like goods in the form of ribbons in the web and skeins of thread, representing them to be “cottonized silk.”

Dr. Dyrenforth was not satisfied that the so-called discovery was an accomplished fact, and he forwarded a few fibers of the material to the division of which I have charge for investigation. I subjected them to my usual tests, and found them to consist of pure silk, and I so reported to Dr. Dyrenforth, who rejected the application for a patent. The microscope was thus usefully employed to protect capitalists from imposition.

METHODS EMPLOYED.

It may be well to state briefly the methods I employed in detecting the real character of the material. The fibers were first viewed under plain transmitted light, secondly, polarized light and selenite plate. Since silk and cotton are polarizing bodies, “cottonized silk,” if such could be made as described, would give, in this case, the prismatic colors of both fibers, and the complementary colors would differ greatly because of the great disparity of their respective polarizing and refractive powers.

The fact will be observed that a cotton fiber presents the appearance of a twisted ribbon when viewed by the microscope, while silk, owing to its cylindrical form, cannot twist on itself. It should also be considered that the diameter of “cottonized silk,” so called, would be greater than that of a fiber of silk, because the silk solution would have to be applied to an actual thread of cotton, and not to a single cotton fiber, by reason of the shortness of the original hairs of the latter. Were a single fiber of such a combination put under a suitable objective, and a drop of nitric acid brought in contact with the fiber, it would be seen that the acid would destroy the silk and leave the fibers of cotton untouched, the latter being insoluble in cold nitric acid. The action of muriatic acid is similar in this respect. Were a fiber of cotton present and a drop of pure sulphuric acid placed on it, followed quickly by a drop of a transparent solution of the tincture of iodine, a peculiar change in the fiber would take place, provided the right proportion of acid be used. Cotton fiber, and especially flax fiber, under such conditions, forms into disks or beads of a beautiful blue color.

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Fig. 1 represents a cotton fiber, and 2, 3, 4, 5 those of flax, as they appear under the acid treatment. Every textile amylaceous fiber is convertible into these forms, more or less, by strong sulphuric acid. The fibers of cotton, flax, and ramie are examples of amylaceous cellulose, that is to say, these fibers are converted into starchy matter by treatment with the last-named acid. Therefore combinations of these fibers in any composition of non-amylaceous fiber (ligneous or woody fiber) will be dissolved, leaving the latter unharmed; the woody fibers remaining will prove suitable objects for examination under the microscope.

COTTON MIXED WITH LINEN.

Again, it might be important to know whether a certain pulp or composition contained flax in combination with cotton. The composition might be of such a well-digested character as to destroy all appearance of normal form, that is to say, the “twisted ribbon” character of cotton, as well as that of the cylindrical and jointed characteristic of flax, might be lost to ordinary view. In this case make a watery solution of the pulp, spread it out thinly on a glass slide 3 inches by one, draw off any superfluous water, then add one or two drops of a strong solution of chromic acid to the preparation, and place over it a glass cover; when viewed by the microscope, any portion of the flax joints present will appear of a dark brown color; a solution of iodine has a similar effect. The brown portions of the joints are nitrogenous in character; cotton fibers are devoid of nitrogen.

[Illustration: Figs. 1, 2, 3, 4, 5.]

EXPERIMENTS WITH FLAX.

A chemist of the Department of Agriculture had once occasion to make experiments with flax fibers, his object being to make them chemically pure; and to this end he treated them with excess of bleaching agents, thus rendering them of a beautiful white, silky appearance, to the naked eye; but when I examined them under the microscope, I found the brown nitrogenous matter of the joints still present, and on using the chromic acid test, they became deeply stained. A chemical solution of flax therefore would prove for some purposes undesirable, owing to the presence of this ligneous matter. A chemical solution of cotton which is destitute of ligneous matter will give a chemically pure solution. Cotton is therefore better adapted than flax for collodion compounds.

WOOL TESTED WITH ACID.

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It is known that when wool is treated with the sulphuric acid of commerce or in strong dilute sulphuric acid, the surface scales of the fiber are liberated at one end, and appear, under a low power, as hairs proceeding from the body of the fibers. Wool may remain thus saturated in the acid for several hours, without appearing to undergo any further change, as far as is revealed by the microscope. When treated in mass in a bath of sulphuric acid, strength 60 deg. B., for several minutes, and afterward quickly washed in a weak solution of soda, and finally in pure water and dried, it feels rough to the fingers, owing to the separation of the scales. I have preserved a small quantity of wool thus treated for the last twelve years, my object being to ascertain whether the chemical action to which it was exposed would impair its strength. As far as I can observe, without the aid of the proper tests, it seems to have retained its original tenacity. Wool thus treated seems to possess the property of resisting the ravages of the larvae of the moth. This specimen, although openly exposed for the period named, suffered no injury from them. Under the microscope, the lubrications appear to have resumed their natural position, and appear finer.

From these experiments it would seem not improbable that a new article of commerce might be produced from wool thus treated, considering that it seems to be moth-proof.

I find in practice that when sable brushes are washed in a weak solution of pure phenic alcohol and afterward in warm water, the moth worm will not eat them. In this way I preserve sable brushes. I mention this chemical fact because it shows that a change of this material is brought about by the phenol as to its edibility, and this may explain why wool treated with sulphuric acid is rendered moth-proof.

I find that when brain matter has been subjected to a solution of weak phenic alcohol, weak alkaline solutions afterward applied fail to separate its nerve-cells on the process of maceration. (This is probably owing to its albuminoids being coagulated by the action of the phenol.) When brain matter is subjected to a weak solution of soda alone, the nerve-cells are easily separated by maceration, and well adapted for microscopic use.

TESTS OF DYED BLACK SILK.

The fibers of dyed black silk may be viewed with interest under the microscope. If a few threads of its warp are placed on a glass slide, and one or two drops of concentrated nitric acid placed in contact with them, the black color changes first to green, then to blue; a life-like motion is observed in all the fibers; they appear marked crosswise like the rings of an earthworm; the surface of each fiber appears loaded with particles of dyestuff; finally the fibers wholly dissolve in the acid. If we now treat a few threads of the weft in the same manner, a similar change of color takes place. When the fibers assume

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the blue color, a dark line is observed in the center of each, running longitudinally the whole length; this dark line is doubtless the dividing line of the two original normal threads formed directly by the two spinnerets; the dark air line or shadow finally breaks up, and in the course of a few minutes the silk is wholly dissolved. Were ramie, cotton, flax, or hemp present, they would be observed, as all their fibers remain unchanged under this treatment. If wool be present, rapid decomposition will follow, giving off copious fumes of nitrous acid, allowing, however, sufficient time to observe the separation of the scales of the fibers and to demonstrate by observation under the microscope that the fibers are those of wool.

In making these experiments it is not necessary to use a glass disk over the treated fibers. If a disk or cover is pressed on them while undergoing this treatment, the life-like motion of the silk will not be so apparent.

* * * * *

IMPROVED PYROMETER.

Mr. John Frew, Langloan Iron Works, Coatbridge, has been successful in perfecting a most ingenious pyrometer, an instrument which is capable of continuously indicating every variation of temperature with a remarkable degree of correctness. This instrument, which we here illustrate, has already become known to a number of proprietors and managers of blast furnaces; and on the occasion of the members of the Iron and Steel Institute visiting Coatbridge, in connection with the meeting of that body which was held in Glasgow last autumn, many persons became interested in its construction and in the practical determination of blast temperatures by its readings. Furthermore, Sir William Thomson has expressed himself as being highly delighted with it on account of the manner in which its use illustrates various beautiful scientific principles.

The leading principle on which the construction of this pyrometer has been based is the well-known law of the expansion of gases. Referring to our engraving, it will be seen that at A is a pipe through which air from the cold blast main is admitted into another and larger pipe, B, which reaches nearly to the bottom of a water cistern, C. By means of the inlet and outlet pipes, D and E, the height of the water in the cistern is maintained at a uniform level. In this way there is provided a head of water which retains within the pipe, B, a constant pressure of air, equivalent to the head of water between the open end of that pipe and the overflow at E. Any excess of pressure is prevented by means of the open-ended pipe, which permits the air to escape by the central tube. This latter prevents the agitation caused by the upward rushing air from disturbing the level of the water in the cistern; and in order further to assist this, the central tube is filled loosely in its upper part with lead bullets or other suitable materials supported on a perforated plate. The water level in the cistern is indicated by means of a glass gauge, which is represented at G. To the upper end of the pipe, B, another pipe, H, is attached. This is required for conveying the cold air to the pyrometer proper, for the piece of apparatus above described is simply an arrangement for securing a flow or current of air at constant pressure.

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At any point where it is desired to fix a pyrometer, a connection is made with the pipe last spoken of, by means of a small pipe such as is indicated at J, into which is fixed a platinum or other metallic nozzle of small bore, as shown at K. To this same pipe there is attached a solid-drawn copper spiral heater or worm, L, which is fixed into the place or the material the temperature of which it is desired to indicate. Into the outlet of this worm another similar but larger nozzle, M, is fixed. At N is shown a small pipe which is connected with the pipe, J, at any convenient point between the inlet nozzle, K, and the spiral heater, L. The other end of this pipe passes through the India rubber stopper of a small cistern or bottle, O, which, when in use, is about two-thirds filled with a colored liquid. It will be seen that the tube, N, only passes through the stopper, so that it may convey pressure to the surface of the liquid. At P is a glass tube which also passes through the stopper and then to the bottom of the colored liquid; and as its upper end is open, any variation of pressure in the spiral heater is directly transmitted to the indicating column of colored liquid.

[Illustration: FREW’S PYROMETER.]

The operation of the instrument is as follows: As the cold blast used in the apparatus would be useless for the working of the pyrometer if taken direct from the cold blast main, owing to its irregularity of pressure, the regulator that has been described is employed, and by its means an absolutely steady flow of cold blast air at an unvarying pressure is secured. The diameters of the inlet and outlet nozzles are so nicely adjusted that, so long as both are at the same temperature, the outlet nozzle, which is open to the atmosphere, will pass all the air that the inlet nozzle can deliver without disturbing the pressure in the cistern, O; but if heat be applied to the circulating air through the walls of the spiral heater, the air expands in volume, and is unable to pass through the outlet nozzle in its heated condition as rapidly as it is delivered cold by the inlet nozzle. The consequence is that an increase of pressure takes place in the apparatus between the two nozzles, and it is this pressure that indicates the amount of heat that the air has taken up from the hot blast pipe, in which the spiral heater is fixed. Then, again, as this pressure is directly transmitted to the indicating liquid in the cistern and the vertical tube immersed in it, a rise takes place in the column which is in exact proportion to the expansion of the current of blast passing through the spiral heater.

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The method of graduating the indicator scales of the Frew pyrometer is worthy of special notice. When the apparatus is fitted up, and before it is permanently fixed in position, the spiral heater is placed in cold water of known temperature, and the point noted at which the colored liquid stands in the indicator tube. The water is then boiled, and the rise in the liquid in the tube is again noted. Suppose, in the first instance, the cold water temperature to be 62 deg. Fahr., and that, from this point up to 212 deg. Fahr., the liquid to have risen 21/4 in. in the tube; this is equal to 11/2 in. per 100 deg. Fahr., and from these data a scale is constructed, the correctness of which is easily verified by transferring the spiral heater into an air bath or oil of high boiling point, and then comparing the readings of the pyrometer scale with those of a mercurial thermometer placed alongside of the spiral heater. By this means it can be clearly demonstrated that, up to the highest point to which it is safe to use a mercurial thermometer, the readings of the pyrometer scale and that of the thermometer are identical.

While this pyrometer is particularly valuable for indicating the temperature of hot blast stoves of every description, there are doubtless many uses that will suggest themselves to persons engaged in various industrial arts and manufactures. The apparatus is neat and substantial in its parts, while it occupies very little space, is not at all liable to derangement, and is entirely automatic in its action. A number of the instruments have been in continuous use at the Langloan Iron Works, with the most satisfactory results, for about eight months. The temperatures they are graduated for vary according to the furnaces with which they are connected and the kind of work to which these are applied. —*Engineering*.

* * * * *

An exchange gives the following very simple way of avoiding the disagreeable smoke and gas which always pours into the room when a fire is lit in a stove, heater, or fireplace on a damp day: Put in the wood and coal as usual; but before lighting them, ignite a handful of paper or shavings placed on top of the coal. This produces a current of hot air in the chimney, which draws up the smoke and gas at once.

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[FROM PHOTOGRAPHISCHE CORRESPONDENZ.]

ORTHOCHROMATIC PLATES.

By CH SCOLIK.

Since the emulsion process has taken root, no improvement has awakened such a lively, steadily increasing interest as photography of colored objects in their correct tone proportions; a process which makes it possible to reproduce the warmer color-tones, particularly yellow, orange-red, and yellow-green, in their correct light value as they appear to the eye.

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In professional circles, as also among the public, the value of this invention cannot possibly be underestimated; an invention with which a new epoch in photography may begin, and by which the handsomest results, particularly in reproductions of oil paintings, can be attained. But in portraiture, as well as in landscape photography, recourse must also be had to orthochromatic plates to obtain effective pictures, particularly as plates can now be produced in which the relative sensitiveness closely resembles that of the ordinary emulsion plate. Although a good deal has been written about this subject, none of these sometimes excellent treatises contains a complete and generally comprehensive formula for the production of color-sensitive plates, and this circumstance causes me to publish my own experiences.

The following coloring matters are particularly recommended in the several publications as preferable:

Eosine yellow and eosine blue shade, iodine cyanin, erythrosine, methyl violet, aniline violet, iodine green, azalein, Hoffmann’s violet, acid green, methyl green, rose bengal, pyrosine, chlorophyl, saffrosine, coralline, saffranine, *etc*.

Particularly important is the correct concentration. The most excellent color matters make the plates oftentimes quite useless by an incorrect proportion of concentration. If this should be too strong, the total sensitiveness will sink (decrease); but when too weak, the color sensitiveness is much reduced.

This fault, particularly, cannot be corrected during washing, but I have mentioned, at the end, how such overcolored emulsion can be made of use before wetting (flowing).

By the addition of some coloring matter to the emulsion, the light sensitiveness of the film toward some individual colored rays is increased, but the sensitiveness for the stronger refractive rays is, as a rule, generally reduced. The result is a loss of the total sensitiveness for white light. Color-sensitive plates are therefore less sensitive to light than ordinary plates of the same origin.

The action of the coloring matter depends also very essentially upon the emulsion. If the emulsion contains iodide of silver, it has a greater sensitiveness for light blue and blue-green light. At all events, the iodide combination must not amount to more than one or two per cent., a small quantity of iodine acting much better upon the total sensitiveness of the plates than can be obtained by pure bromide of silver emulsion.

Methyl violet, rose bengal, and azalein act perceptibly in 1/10000 per cent. upon yellow sensitiveness. Eosine and its varieties, eosine yellow shade, or eosine J, pyrosine J, erythrosine yellowish, may all be noted as very good sensitizers for green, yellow-green, and eventually for yellow. The bluish shades of eosine colors, on the contrary, have an absorption band further in the yellow. This is also the case with the blue shade eosine

(eosine B) and the most bluish of all eosines, the bengal rosa. Of both eosines, yellow shade and blue shade, the latter gives a little more intensity.

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Although the eosine permits a large limit in the quantity, it will reduce the sensitiveness greatly in larger quantity.

If eosine solution is mixed with bromide of silver emulsion, which is entirely free from nitrate of silver, no eosine silver can form; it acts, therefore, only as an optical sensitizer.

Of the several kinds of cyanin, chlorosulphate, nitrate, and iodide, the latter acts best, as stated by Eder.

Schumann has already said that one drop of cyanin solution, 1 to 2,500 to 61/2 c. c. emulsion, already acted as sensitizing in orange; five to ten drops cyanin. 1 to 1,500 to 15 c. c. emulsion, even gave red action.

There are two ways to color the gelatine film with a suitable coloring matter: by mixing the latter directly before filtering into the ready made emulsion, to produce at once colored plates; or to bathe dry emulsion plates for one to five minutes in a solution containing the sensitizing coloring matter. The plates have previously to be soaked for a few minutes, whereupon they are bathed in an aqueous alcoholic solution (with eosine yellow shade and eosine blue shade, in a solution of 1 to 3,000; but with cyanin in a diluted solution of 1 to 5,000). A mixture of 1/10 cyanin and 9/10 eosine yellow shade (of above concentration) acts as a very favorable sensitizer. Lohse recommended bathing of the gelatine plates in a solution of 0.03 eosine and 10 c. c. ammonia in 100 parts of water. He found that very diluted eosine solutions, 1 to 20,000, acted as a yellow sensitizer.

After washing, the plates have to be rinsed and dried—colored plates, as long as they remain moist, being less sensitive than dry ones, and very seldom the reverse.

This bathing of the ready made plates may give good results, but pure and faultless plates are very seldom obtained, wherefore the first mentioned manner (direct addition of color to the emulsion) is to be preferred.

After the experiments made by me, eosine mixtures acted equally in the yellow and blue shade; likewise mixtures of cyanin 1/10 and eosine yellow shade 9/10 were the most favorable. The process with eosine underwent first of all a thorough test, of which the following are the results.

The color, solution I made as follows:

I. 0.5 grm. eosine yellow shade in 750 c.c. alcohol (95 per cent.) is dissolved under good shaking.

II. 0.5 grm. eosine blue shade is also dissolved in 750 c.c. alcohol.

(The emulsion preparation I do not repeat, supposing that everybody is conversant with the same.)

To an emulsion after Monckhoven’s method, I add, before filtering, above eosine solutions to 1,000 c.c. emulsion, 15 c.c. each of yellow shade and 15 c.c. of blue shade eosine; mix with a glass stirring-rod, filter, and begin the flowing of the plates. On the contrary, to an emulsion made after Henderson’s method, double the quantity of coloring matter can be added before flowing, without reducing the sensitiveness perceptibly.

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Cyanin and eosine mixtures I give in the following proportions;

III. 0.5 grm. cyanin (iodo-cyanin) dissolved in 1,000 c.c. alcohol under good shaking.

(All coloring matter solutions have to be filtered.)

To 1,000 c.c. Monckhoven emulsion I give:

25 c.c. eosine solution, yellow shade (I.).

5 c.c. cyanine solution (III.).

With Henderson emulsion I increase to double the quantity.

Further experiments taught me that even if 60 to 80 c.c., and more, of these coloring matter solutions were added, and the emulsion was left to coagulate and then laid in alcohol for several days, after which it was washed well, so that hardly any coloration could be observed, it showed, when making a copy of an oil painting, that the color sensitiveness of the emulsion was not reduced, and that it had rather increased in relative sensitiveness.

Anyhow, I put every colored emulsion for eight days in alcohol, having experienced that hereby, after washing, just a sufficient quantity of the coloring matter will remain as is necessary for the color sensitiveness.

For the correctness of what I have said here, the following experiment made by me will speak:

I mixed with an emulsion a quantity of coloring matter five times increased, flowed a plate with same, which I then exposed, but obtained no picture whatever.

The same emulsion I placed for fourteen days in alcohol, washed it well, and flowed a plate again, which latter had not only the full color sensitiveness, but almost equaled an ordinary emulsion plate in total sensitiveness.

From this can be concluded that—as above said—by placing the emulsion in alcohol, all superfluous coloring matter is removed from the same, and that only the quantity necessary for the color sensitiveness remains therein.

Further, it may be mentioned that it might be of advantage to add to all emulsions eosine besides iodide of silver, because this will give to the emulsion clearness and brilliancy besides color sensitiveness, and produce fine lights.

Finally, I express the hope that these communications may be useful to the practical photographer, and it is my intention to report also about other coloring matters at some future time.—*H.D., in Anthony's Bulletin.*

* * * * *

A NEW PHOTOGRAPHIC APPARATUS.

This apparatus consists of a box containing a camera, A, and a frame, C, containing the desired number of plates, each held in a small frame of black Bristol board. The camera contains a mirror, M, which pivots upon an axis and is maneuvered by the extreme bottom, B. This mirror stops at an angle of 45 deg., and sends the image coming from the objective to the horizontal plate, D, at the upper part of the camera. The image thus reflected is righted upon this plate.

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[Illustration: NEW PHOTOGRAPHIC APPARATUS.]

As the objective is of short focus, every object situated beyond a distance of three yards from the apparatus is in focus. In exceptional cases, where the operator might be nearer the object to be photographed, the focusing would be done by means of the rack of the objective. The latter can also slide up and down, so that the apparatus need not be inclined when buildings or high trees are being photographed. The door, E, performs the *role* of a shade. When the apparatus has been fixed upon its tripod and properly directed, all the operator has to do is to close the door, P, and raise the mirror, M, by turning the button, B, and then expose the plate. The sensitized plates are introduced into the apparatus through the door, I, and are always brought automatically to the focus of the objective through the pressure of the springs, R. The shutter of the frame, B, opens through a hook, H, with in the pocket, N. After exposure, each plate is lifted by means of the extractor, K, into the pocket, whence it is taken by hand and introduced through a slit, S, behind the springs, R, and the other plates that the frame contains. All these operations are performed in the interior of the pocket, N, through the impermeable, triple fabric of which no light can enter.

An automatic marker shows the number of plates exposed. When the operations are finished, the objective is put back in the interior of the camera, the doors, P and E, are closed, and the pocket is rolled up. The apparatus is thus hermetically closed, and, containing all the accessories, forms one of the most practical of systems for the itinerant photographer.—*La Nature.*

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METEORITES.

In our SUPPLEMENT No. 529 we gave an abstract of Prof. Dewars recent series of lectures on the above subject at the Royal Institution. We now present an abstract of the last and concluding lecture.

THE DHURMSALA. METEORITE.

After the conclusion of his last lecture, Prof. Dewar distributed among the younger listeners small pieces of a portion of the Dhurmsala meteorite, which had been broken up for presentation to them by Mr. J.R. Gregory, whose collection of rare minerals was recently to some extent described in these pages. The lecturer stated that Sir F. Abel had given him a large piece of a large meteorite, because he thought that the speaker’s piece ought to be bigger than theirs.

Professor Dewar also presented the listeners with a printed detailed account of the fall of the Dhurmsala meteorite, including the report of the occurrence sent to the Punjaub Government, and dated July 28, 1860. The following are the main facts:

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“On the afternoon of Saturday, the 14th of July, 1860, between the hours of 2 and 2:30 P.M., the station of Dhurmsala was startled by a terrific bursting noise, which was supposed at first to proceed from a succession of loud blastings or from the explosion of a mine in the upper part of the station; others, imagining it to be an earthquake or very large landslip, rushed from their houses in the firm belief that they must fall upon them. It soon became apparent that this was not the case. The first report, which was far louder in its discharge than any volley of artillery, was quickly followed by another and another, to the number of fourteen or sixteen. Most of the latter reports grew gradually less and less loud. These were probably but the reverberations of the former, not among the hills, but among the clouds, just as is the case with thunder. It was difficult to say which were the reports and which the echoes. There could certainly not have been fewer than four or five actual reports. During the time that the sound lasted the ground trembled and shook convulsively. From the different accounts of three eyewitnesses there appears to have been observed a flame of fire, described as about 2 ft. in depth and 9 ft. in length, darting in an oblique direction above the station after the first explosion had taken place. The stones as they fell buried themselves from 1 ft. to 11/2 ft. in the ground, sending up a cloud of dust in all directions. Most providentially, no loss of life or property has occurred. Some coolies, passing by where one fell, ran to the spot to pick up the pieces; before they had held them in their hands half a minute they had to drop them, owing to the intensity of the cold, which benumbed their fingers. This, considering the fact that they were apparently but a moment before in a state of ignition, is very remarkable. Each stone that fell bore unmistakable marks of partial fusion.”

Several meteors were seen at Dhurmsala on the evening of the same day.

Dr. C.T. Jackson analyzed a portion of one meteorite weighing 41/2 oz.; the piece was 21/2 in. long, 11/4 in. wide, and 1 in. in average thickness. In the course of his report he stated: “Its specific gravity is 3.456 at 68 deg. Fahr., barom. 29.9. Its structure is imperfectly granular, but not crystallized, and there are small black specks of the size of a pin’s head, and smaller, of malleable meteoric iron, which are readily removed from the crushed stone by the magnet. The color of the mass is ash gray. A portion of the surface is black and is scarified by fusion. Its hardness is not superior to that of olivine or massive chrysolite. Chemical analysis shows that its composition is that of a ferruginous olivine. One gramme of the stone, crushed in an agate mortar, and acted on by a magnet, yielded 0.43 gramme of meteoric iron, which was malleable. After the removal of this a qualitative analysis was made of the residual powder. Another gramme was

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also taken, without picking out the metallic iron, and was tested for chlorine and for phosphoric acid. The results of the qualitative analysis were that the stone contains silica, magnesia, a little alumina, oxide of iron and nickel, a little tin, an alloy of iron and nickel, phosphoric acid, and a trace of chlorine. These ingredients being determined, the plan for a quantitative analysis was laid out, and was duly executed by the usual and approved methods The following are the results of this analysis, per centum:

Silica, with traces of tin 40.000
Magnesia 26.600
Peroxide of iron 27.700
Metallic iron 3.500
Metallic nickel 0.800
Alumina 0.400
Chlorine 0.049
Phosphoric acid not weighed —

99.049"

Messrs. Dewar and Ansdell analyzed the gases in the meteorite, of which it contained three times its volume; the gases were in the following proportions to each other:

Carbonic acid 61.29
Carbonic oxide 7.52
Hydrogen 30.96
Nitrogen 0.23

100.00

* * * * *

TELESCOPIC SEARCH FOR THE TRANS-NEPTUNIAN PLANET.

[Footnote: By David P. Todd, M.A., from the *Proceedings* of the American Academy of Arts and Science.]

In the twentieth volume of the *American Journal of Science*, at page 225, I gave a preliminary account of my search, theoretic and practical, for the trans-Neptunian planet. I say *the* trans-Neptunian planet, because I regard the evidence of its existence as well-founded, and further because, since the time when I was engaged upon this search, nothing has in the least weakened my entire conviction as to its existence in about that part of the sky assigned; while, as is well known, the independent researches in cometary perturbations by Prof. Forbes conducted him to a result identical with my own—a coincidence not to be lightly set aside as pure accident.

That five years have elapsed since this coincidence was remarked, and the planet is still unfound, is not sufficient assurance to me that its existence is merely fanciful. In so far as I am informed, this spot of the sky has received very little scrutiny with telescopes competent to such a search; and most observers finding nothing would, I suspect, prefer not to announce their ineffective search.

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The time has now come when this search can be profitably undertaken by any observer having the rare combination of time, enthusiasm, and the necessary appliances. Strongly marked developments in astronomical photography have been effected since this optical search was conducted; and the capacity of the modern dry-plate for the registry of the light of very faint stars makes the application of this method the shortest and surest way of detecting any such object. Nor is this purely an opinion of my own. But the required apparatus would be costly; and the instrument, together with the services of an astronomer and a photographer, would, for the time being, be necessarily devoted exclusively to the work. While, however, the photographic search might have to be ended with a negative result, in so far as the trans-Neptunian planet is concerned, there would still remain the series of photographic maps of the region explored, and these would be of incalculable service in the astronomy of the future.

In the latter part of the paper alluded to above, I stated the speculative basis upon which I restricted the stellar region to be examined; also the fact that between November of 1877 and March of 1878 I was engaged in a telescopic scrutiny of this region, employing the twenty-six inch refractor of the Naval Observatory. For the purposes contemplated I had no hesitation in adopting the method of search whereby I expected to detect the planet by the contrast of its disk and light with the appearance of an average star of about the thirteenth magnitude. A power of 600 diameters was often employed, but the field of view of this eye-piece was so restricted that a power of 400 diameters had to be used most of the time. I say, too, that, “after the first few nights, I was surprised at the readiness with which my eye detected any variation from the average appearance of a star of a given faint magnitude; as a consequence whereof my observing book contains a large stock of memoranda of suspected objects. My general plan with these was to observe with a sufficient degree of accuracy the position of all suspected objects. On the succeeding night of observation they were re-observed; and, at an interval of several weeks thereafter, the observation was again verified.” Subjoined to the original observations are printed these verifications in heavy-faced type.

In conducting the search, the plans were several times varied in slight detail, generally because experience with the work enabled me to make improvements in method. Usually, I prepared every few days a new zone chart of the region over which I was about to search; and these charts while containing memoranda of all the instrumental data which could be prepared beforehand, were likewise so adjusted with reference to the opposition-time of the planet as to avoid, if possible, its stationary point. The same thing, too, was kept in mind in selecting the times of subsequent observation. Notwithstanding this precaution, however, it would be well if some observer who has a large telescope should now re-examine the positions of these objects.

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Researches in faint nebulae and nebulous stars appearing likely to constitute a separate and interesting branch of the astronomy of the future, it has seemed to me that the astronomers engaged in this work may like to make a careful examination of some of the stars entered in my observing book under the category of “suspected objects.” The method I adopted of insuring re-observation of these objects was by the determination, not of their absolute, but only of their relative, positions, through the agency of the larger “finder” of the great telescope. This has an aperture of five inches, a power of thirty diameters, and a field of view of seventy-eight minutes of arc. Two diagrams were usually drawn in the book for each of these objects, the one showing the relation of adjacent objects in the great telescope, and the other the configuration of the more conspicuous objects in the field of view of the finder. Adjacent to these “finder” diagrams are the settings—to the nearest minute of arc in declination, and of time in right ascension—as read from the large finding-circles, divided in black and white. The field of view of the finder is crossed by two pairs of hairlines, making a square of about twelve minutes on a side by their intersection at the center. The diagrams in all cases represent the objects as seen with an inverting eye-piece. As the adjustment of the finder was occasionally verified, as well as the readings of the large circles, there should be no trouble in identifying any of these objects, notwithstanding the fact that no estimates of absolute magnitude were recorded. The relative magnitudes, while intended to be only approximate, are still shown with sufficient accuracy for the purpose of the research, and the diagrams are, in general, faithful tracings from the original memoranda.

[Mr. Todd transcribes the observing book entire.]

* * * * *

[AMERICAN ANNALS OF THE DEAF AND DUMB.]

NOTES ON MANUAL SPELLING.

The inestimable value of speech-reading and the practicability of its acquisition under favorable conditions is a matter of common experience and observation but justice to the deaf requires a recognition of the fact that speech-reading has its limitations. Certain English words, chiefly short ones, are practically alike to the speech-reader and the context may fail sometimes to give a clew. It is necessary, at times, in communicating with even expert speech-readers, to have recourse to writing or oral spelling to convey the names of persons, places, technical terms, *etc*., not in common use. Moreover, it is convenient to have accurate and rapid means of conversation under unfavorable conditions as to light and distance, or when from any cause the deaf person’s voice cannot be heard.

Writing is slow, inconvenient, and often impossible. Writing upon the palm of the hand was proposed by the Abbe Deschamps in 1778, as utilizing the sense of touch, and was used in darkness by him as a substitute for speech, but it is neither accurate nor rapid. Writing in the air[1] with the finger is also slow and uncertain, while the action is unpleasantly conspicuous.

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[Footnote 1: The brilliant but wily Sicard, whose “show” pupils were accustomed to honoring drafts at sight in appropriate responses to all sorts of questions, acting upon the motto, *Mundus vult decipi, ergo decipiatur*, schooled certain pupils in deciphering writing in the air, and was thus prepared, in emergencies at his public exhibitions, to convey intimations of the answers, while supposed to be using “signs” in putting questions.]

Finger-spelling would appear to be a far more convenient, easy, rapid, and accurate adjunct to speech or substitute for it than writing.

It is a common error to consider the ordinary manual alphabets as deaf-mute alphabets and finger-spelling as the sign-language of the deaf. Finger-spelling is to the deaf a borrowed art. It is used by many of the educated deaf and their friends as a substitute for the sign-language, and it enables them also to supply the deficiencies of the sign-language by incorporating words from written language. Scagliotti, of Turin, devised a system of initial signs[2] which begin with letters of the manual alphabet, and Dr. Isaac Lewis Peet, of New York, has made a similar application of manual letters to signs to suggest words of our written language to the initiated deaf. But it should not be forgotten that practice in finger-spelling is practice in our language.

[Footnote 2: *Quatrieme Circulaire*, Paris, 1836, p. 16. Carton’s *Memoire*, 1845, p. 73.]

The origin of finger-spelling is not known. Barrois, a distinguished orientalist, in his *Dactylologie et Langage primitif*[3], ingeniously traces evidences of finger-spelling, from the Assyrian antiquities down to the fifteenth century upon monuments of art.

[Footnote 3: Barrois: *Dactylologie et langage primitif*, Paris, 1850, Firmin Didot freres.]

The ancient Egyptians, Greeks, and Romans were familiar with manual arithmetic and finger-numeration, as quaint John Bulwer shows by numerous citations in his *Chironomia* (1644). The earliest finger-alphabets extant appear to have been based upon finger-signs for numbers, as, for instance, that given by the Venerable Bede (672-735) in his *De Loguela per Gestum Digitorum sive Indigitatione*, figured in the Ratisbon edition of 1532.[4] Monks and others who had special reason to prize secret and silent modes of communication, beyond doubt invented and used many forms of finger alphabets as well as systems of manual signs.[5] The oldest plates in the library of the National Deaf Mute College are found in the *Thesaurus Artificiosae Memoriae* of frater Cosmas P. Rossellius of Florence, printed in 1579, which gives three forms of one-hand alphabets. Bonet’s work[6] of 1620 gives one form of the one hand Spanish manual alphabet, which contains forms identical with certain letters in the alphabets of 1579. This was introduced into France by Pereire and taught to the Abbe de l’Epee

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by Saboureux de Fontenay, the gifted pupil of Pereire. The good Abbe however continued to use a French[7] two-hand alphabet which, he had learned when a child and which he said all school-children knew. He mentions also a Spanish alphabet in part requiring both hands, and remarks that different nations have different manual alphabets. The Abbe Deschamps, a rival of De l'Epee, made use of a finger alphabet in teaching the deaf to speak, which was not adapted to rapid use. John Bulwer, in his *Chirologia, or the Naturall Language of the Hand*, printed in 1644, figures five manual alphabets for secret communication.

[Footnote 4: The library of the New York Institution contains a copy of this very rare edition, bearing the title *Abacus atque velustissima Latinorum per digitos manusque numerandi (quinetiam loquendi) consuetudo*, *etc*., Ratisbonae, 1532.]

[Footnote 5: For an exhaustive account of the gesture speech in Anglo-Saxon monasteries and of the Cistercian monks, who were under rigid vows of silence, see F. Kluge: *Zur Geschichte der Zeichensprache.—Angelsachsische indicia Monaslerialia,* in *International Zeitschrift fur Allgemeine Sprachwissenschaft,* II. Band, I. Halfte. Leipzig, 1885.]

[Footnote 6: *Reduccion de lasletras y arte para ensenar a hablar los mudos*, 1620. The writer is under obligations to Sr. Santos M. Robledo, of the Ministry of Public Works and Education, for advance sheets of the reprint in beautiful facsimile of this rare work ordered by the Spanish Government in 1881.]

[Footnote 7: The Abbe de l'Epee did not master the Spanish alphabet, and, attaching but little importance to manual spelling, he was unsparing in his criticism of *Messieurs the dactylologists*, but by "the irony of fate" this alphabet occupies a face of the pedestal of one statue to his memory, and in another statue the good Abbe is represented either as receiving this alphabet from the skies or as devoutly using it.]

The first alphabet which appears to have been devised expressly for use in teaching the deaf is that of George Dalgarno, of Aberdeen (1626-1687), given in his remarkable philosophical treatise, *Didascalocophus, or the Deaf and Dumb Man's Tutor*, Oxford, 1680. A facsimile of this alphabet is given in the *Annals*, vol. ix., page 19. Words are spelled by touching with your finger the positions indicated, either upon your hand or upon the hand of your interlocutor. An alphabet of the same character, however, was not unknown at an earlier date. For Bulwer, in 1648, says: "A pregnant example of the officious nature of the Touch in supplying the defect or temporall incapacity of the other senses we have in one Master *Babington* of *Burntwood* in the County of *Essex*, an ingenious gentleman, who through some sicknesse becoming *deaf*, doth notwithstanding feele words, and as if he had an eye in his finger, sees signes

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in the darke; whose Wife discourseth very perfectly with him by a strange way of Arthrologie or Alphabet contrived on the joynts of his Fingers; who taking him by the hand in the night, can so discourse with him very exactly; for he feeling the joynts which she toucheth for letters, by them collected into words, very readily conceives what shee would suggest unto him. By which examples [referring to this case and to that of an abbot who became *deaf, dumb*, and *blind*, who understood writing traced upon his naked arm] you may see how ready upon any invitation of Art, the *Tact* is, to supply the defect, and to officiate for any or all of the other senses, as being the most faithfull sense to man, being both the *Founder*, and *Vicar generall* to all the rest."[8]

[Footnote 8: *Philocophus*: or, THE DEAFE and Dumbe Mans Friend. By I.B. [John Bulwer] sirnamed the *Chorosopher*. London, 1648. Pp. 106,107.]

Dr. Alexander Graham Bell has modified the Dalgarno alphabet, and has made considerable use of it in its modified form as figured in the *Annals*, vol. xxviii., page 133. He esteems it highly for certain purposes, especially as employing touch to assist the sight or to release the sight for other employment, as in reading speech for instance. Here a touch-alphabet may be an efficient aid to the sight, as the touch may fairly keep pace with the rapidity of oral expression in deliberate speech. An objection of Dr. Kitto to the two-hand alphabet so widely know by school-children and others in Great Britain and in this country would seem to apply with greater force to the Dalgarno alphabet: “To hit the right digit on all occasions is by far the most difficult point to learn in the use of the [two-hand] manual alphabet, and it is hard to be sure which fingers have been touched."[9]

[Footnote 9: Dr. Kitto remaks the following common mistakes in reading rapid two-hand spelling: the confounding *i* with *e* or *o*; *d* with *p*; *l* with *t*; *f* with *x*; *r* with *t* and with one form of *j*; *n* with *v*, and adds: “Upon the whole, the system is very defective, and is capable of great improvement.” _—The Lost Senses_, p. 107.]

It is not the purpose of the writer to attempt even a catalogue of the numerous finger alphabets, common, tactile, phonetic, “phonomimic,” “phonodactylologic,” and syllabic, which have been proposed for the special use of the deaf.

The one-hand alphabet used by Ponce and figured by Bonet was common in Spanish almanacs hawked by ballad-mongers upon the streets of Madrid in the days of De l’Epee, and although rejected by him, it was adopted by his pupils. This with slight modifications became the French manual alphabet which was introduced at Hartford by Dr. Thomas Hopkins Gallaudet. This alphabet is known in almost every hamlet in the land. Slight changes in the form of certain letters, or in the position of the hand, in the direction of greater perspicuity and capacity for rapid use, have taken place gradually, though there is no absolute uniformity of usage among instructors or pupils.

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This “American” alphabet, as here presented, through the liberality of Dr. A. Graham Bell, has been drawn and engraved from photographs, and represents typical positions of the fingers, hand and fore-arm from a uniform point of view in front of the person spelling, or as seen in a large mirror by the user himself.[10]

[Footnote 10: See an interesting paper on figured manual alphabets by H.H. Hollister, *Annals*, xv., 88-93.]

This alphabet can be learned in less than an hour, and many have learned it by extraordinary application in ten minutes. It is recommended that the arm be held in an easy position near the body, with the fore-arm as in the plates. Each letter should be mastered before leaving it. Speed will come with use; it should not be attempted nor permitted until the forms of the letters and the appropriate positions of the hand are thoroughly familiar. The forms as given are legible from the distant parts of a public hall. In colloquial use the fingers need not be so closely held nor firmly flexed, as represented, but sprawling should be avoided. It is not necessary to move the arm, but a slight leverage at the elbow is conducive to ease and is permissible, provided the hand delivers the letters steadily within an imaginary immovable ring of, say, ten inches in diameter.

[Illustration: THE ONE-HAND ALPHABET IN GENERAL USE.—FRONT VIEW.]

This adjunct to speech-reading is recommended for its convenience, clearness, rapidity, and ease in colloquial use, as well as for its value as an educational instrument in impressing words, phrases, and sentences in their spelled form upon the mind, in testing the comprehension of children, and in affording by easy steps a substitute for the sign-language.

In the simultaneous instruction of large classes not able to follow speech, finger-spelling “may take the place of signs to a great extent in the definition, explanation, and illustration of single words and phrases, and in questions and answers upon the lessons, and in communications of every kind to which the stock of language already acquired may be adequate."[11]

[Footnote 11: *The Use of the Manual Alphabet*, by S. Porter: Proceedings of the Eighth Convention of American Instructors, pp. 21-30. Copies of the Proceedings which contain this extremely valuable paper may be obtained of R. Mathison, Superintendent of the Ontario Institution, Belleville, Ontario.]

All who have anything to do with the school instruction of the deaf may well bear in mind the matured opinion and wise counsel of Professor Samuel Porter, of the National College, the Nestor of American instructors. In this connection, Professor Porter says:

In short, let the gestural signs come in only as a last resort, or, so far as possible, merely as supplementary to words, re-enforcing them in some instances, or employed as a test of the pupil's knowledge of words, but always, so far as possible, falling behind and taking a subordinate place. And let the pupils be required, in what they have to say to their teachers in the schoolroom or elsewhere, to employ the finger-alphabet instead of natural signs to the utmost possible extent, and this by complete sentences and not in a fragmentary way.

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* * * * *

FRUITS AND SEEDS FOR DRESS-TRIMMING.

The use of natural flowers for decorating the person is instinctive among certain peoples, and a question of fashion among others. It is in Oceanica especially that this taste seems to be nationally developed, and from the narrative of Cook we know that the Tahitian belles use in their toilet the perfumed flowers of the pua and tiare (*Carissa grandis* and *Gardenia Tahitensis*), whose dazzling whiteness renders still more marked the ebony blackness of their wealth of hair.

In Europe this custom is traditional in many countries. Women of fashion scarcely ever appear at a soiree or ball without wearing a camellia or an exotic orchid on their breast or in their head-dress, and so, too, gentlemen of “high life” do not go out without a boutonniere of white violets or Cape jasmine.

But natural flowers, being ephemeral, were once replaced in the toilets of ladies by artificial ones. The artificial flower industry originated in China, and from thence passed into Italy and afterward into France. In course of time people got tired of artificial flowers for decorative purposes, and then imitation fruits made their appearance, and were worn in the toilets of dowagers and mothers of families.

Now that fashion, that tyrant born of dressmakers, milliners, and tailors of renown, obliges us to clothe ourselves according to accepted models, the kaleidoscope no longer suffices to find the most varied designs and most fantastic cuts for garbs or ornament.

In recent years pleasing objects have been borrowed from the animal kingdom, such as small birds and quadrupeds, and insects with brilliant colors and of strange forms. What formerly would have been a repulsive object (such as a great longicorn or beetle) is worn with ease by the belles of our time. The use of such objects of natural history, however, has been about confined to the decoration of head-dresses or the manufacture of jewelry.

[Illustration: FIG. 1.—DRESS TRIMMINGS OF FRUITS AND SEEDS. 1. Seeds of *Casuarina* and fruit of alder. 2. Acorn cup, involcure of beech, and pod of medick. 3. Fruit of *Eucalyptus*, cups of acorns, Job’s tears, and cones of cypress.]

As the need of creating new models is always making itself felt, one ingenious manufacturer, Mr. Collin, has turned toward the vegetable kingdom, and brought out an elegant and original style of dress-trimming made of certain indigenous and exotic fruits and seeds that no one would ever have thought of using for such a purpose. Instead of pendants made of wood and covered with silk or velvet, Mr. Collin uses dry fruits or seeds, which he has previously dyed, gilded, or silvered.

[Illustration: FIG. 2.—DRESS TRIMMINGS OF FRUITS AND SEEDS. 4 and 5. Fruit of alder. 6. Fruit of *Casuarina*. 7. Fruit of *Arbutus*. 8. Fruit of *Casuarina*.]

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In order that the effect may be good, it is necessary that the objects be not uniform. Their surface must be naturally carved and hollowed, and the projecting parts must detach themselves well from each other. The number of species now used is relatively large, but a selection from these will inevitably be made. Some patterns will be better liked than others, and ladies who are to wear these new trimmings this winter will be able to make their choice of them at the fashion stores. When such articles as these make their appearance, they often spread with surprising rapidity. It is now but a few days since the great dressmaker Worth adopted them, and the linen trade already has them in stock. We recently saw at Suzange's some linen aprons and collars ornamented with small groups of fruits and seeds prepared by the Collin process, and which produced a most pleasing effect. The idea has even occurred to apply these trimmings to furniture and upholstery.

In the manufacture of these articles the cones of several species of *Casuarina*, the tags of alder, as well as the naturally carved fruits of certain *Eloeocarpi* of India and Australia, were first used; then came the fruits of the umbelliferous plant, *Oenanthe*, the spiral pods of *Medicago*, the fruit of the water-caltrops, *Melia* and *Zizyphus*, the cups of the acorn, the involucres of the beech, the seeds of *Coix lacryma*, *etc*.

The naturalist ought to be glad to see objects that form the base of his studies taking a direction favorable to the industry of his country.

On another hand, these products themselves cannot fail to arouse the curiosity of ladies who have the instinct of observation. And, who knows? Perhaps a frock or mantle trimmed with these vegetable ornaments may prove a more certain propaganda in favor of botany than the most classic lessons on this gentle, science!—*La Nature*.

* * * * *

DEW.

[Footnote: Abstract of paper read before the Royal Society of Edinburgh on Dec. 21, 1885, by Mr. Aitken, communicated by permission of the Council of the Society.—-*Nature*.]

The first point referred to in this paper is the source of the vapor that condenses to form dew. A short historical sketch is given of the successive theories from time to time advanced on this point, showing how in early times dew was supposed to descend from the heavens, and then afterward it was suggested that it rose from the earth, while Dr. Wells, who has justly been considered the great master of this subject, thought it came neither from above nor from below, but was condensed out of the air near the surface of the earth. He combated Gersten's idea that it rose from the earth, and showed that all the phenomena observed by Gersten and others which were advanced to support this theory could be equally well explained according to the theory that it was simply formed from the vapor present at the time in the air, and which had risen from the ground during the day, and concluded that if any did rise from the ground during night, the quantity must be small, but, with great caution, he adds that "he was not acquainted with any means of determining the proportion of this part to the whole."

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A few observations of the temperature of the ground near the surface, and of the air over it, first raised doubts as to the correctness of the now generally received opinion that dew is formed of vapor existing at the time in the air. These observations, made at night, showed the ground at a short distance below the surface to be always hotter than the air over it, and it was thought that so long as this excess is sufficient to keep the temperature of the surface of the ground above the dew point of the air, it will, if moist, give off vapor, and it will be this rising vapor that will condense on the grass and form dew, and not the vapor that was previously present in the air.

The first question to be determined was whether vapor does, or does not, rise from the ground on dewy nights. One method tried of testing this point was by placing over the grass, in an inverted position, shallow trays made of thin metal and painted. These trays were put over the ground to be tested after sunset and examined at night, and also next morning. It was expected that, if vapor was rising from the ground during dewy nights, it would be trapped inside the trays. The result in all the experiments was that the inside was dewed every night, and the grass inside was wetter than that outside. On some nights there was no dew outside the trays, and on all nights the inside deposit was heavier than the outside one.

An analysis of the action of these trays is given, and it is concluded that they act very much the same as if the air was quite still. Under these conditions vapor will rise from the ground so long as the vapor-tension on the surface of the ground is higher than that at the top of the grass, and much of this rising vapor is, under ordinary conditions, carried away by the passing air, and mixed with a large amount of drier air, whereas the vapor rising under the trays is not so diluted; and hence, though only cooled to the same amount as the air outside, it yields a heavier deposit of dew.

Another method of testing this point was employed, which consisted in weighing a small area of the exposed surface of the ground, as it was evident that if the soil gave off vapor during a dewy night, it must lose weight. A small turf about 6 inches (152 mm.) square was cut out of the lawn, and placed in a small shallow pan of about the same size. The pan with its turf, after being carefully weighed, was put out on the lawn in the place where the turf had been cut. It was exposed for some hours while dew was forming, and on these occasions it was always found to lose weight. It was thus evident that vapor was rising from the ground while dew was forming, and therefore the dew found on the grass was formed of part of the rising vapor, trapped or held back by coming into contact with the cold blades of grass.

The difference between these experiments, in which the exposed bodies *lose* weight, and the well-known ones in which bodies are exposed to radiation, and the amount of dew formed is estimated by the *increase* in their weight, is pointed out. In the former case, the bodies are in good heat-communication with the ground, whereas in the latter little or no heat is received by conduction from the earth.

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Another method employed for determining whether the conditions found in nature were favorable for dew rising from the ground on dewy nights was by observations of the temperatures indicated by two thermometers, one placed on the surface of the grass and the other under the surface, among the stems, but on the top of the soil. The difference in the readings of these two thermometers on dewy nights was found to be very considerable. From 10 deg. to 18 deg. F. was frequently observed. A minimum thermometer placed on, and another under, the grass showed that during the whole night a considerable difference was always maintained. As a result of this difference of temperature, it is evident that vapor will rise from the hotter soil underneath into the colder air above, and some of it will be trapped by coming into contact with the cold grass.

While the experiments were being conducted on grass land, parallel observations were made on bare soil. Over soil the inverted traps collected more dew inside them than those over grass. A small area of soil was spread over a shallow pan, and after being weighed was exposed at the place where the soil had been taken out, to see if bare soil as well as grass lost weight during dewy nights. The result was that on all nights on which the tests were made the soil lost weight, and lost very nearly the same amount as the grass-land.

Another method employed of testing whether vapor is rising from bare soil, or is being condensed upon it, consisted in placing on the soil, and in good contact with it, small pieces of black mirror, or any substance having a surface that shows dewing easily. In this way a small area of the surface of the earth is converted into a hygroscope, and these test surfaces tell us whether the ground is cooled to the dew-point or not. So long as they remain clear and undewed, the surface of the soil is hotter than the dew-point, and vapor is being given off, while if they get dewed, the soil will also be condensing vapor. On all nights observed, these test-surfaces kept clear, and showed the soil to be always giving off vapor.

All these different methods of testing point to the conclusion that during dewy nights, in this climate, vapor is constantly being given off from grass land, and almost always from bare soil; that the tide of vapor almost always sets outward from the earth and but rarely ebbs, save after being condensed to cloud and rain, or on those rarer occasions on which, after the earth has got greatly cooled, a warm moist air blows over it. The results of the experiments are given, showing, from weighings, the amount of vapor lost by the soil at night, and also the heat lost by the surface soil.

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It seems probable that when the radiation is strong, that soil, especially if it is loose and not in good heat-communication with the ground, will get cooled below the dew-point, and have vapor condensed upon it. On some occasions the soil certainly got wetter on the surface, but the question still remains, Whence the vapor? Came it from the air, or from the soil underneath? The latter seems the more probable source; the vapor rising from the hot soil underneath will be trapped by the cold surface-soil, in the same way as it is trapped by grass over grass-land. During frost, opportunities are afforded of studying this point in a satisfactory manner, as the trapped vapor keeps its place where it is condensed. On these occasions the under sides of the clods, at the surface of the soil, are found to be thickly covered with hoar-frost, while there is little on their upper or exposed surfaces, showing that the vapor condensed on the surface-soil has come from below.

The next division of the subject is on dew on roads. It is generally said that dew forms copiously on grass, while none is deposited on roads, because grass is a good radiator and cools quicker, and cools more, than the surface of a road. It is shown that the above statement is wrong, and that dew really does form abundantly on roads, and that the reason it has not been observed is that it has not been sought for at the correct place. We are not entitled to expect to find dew on the surface of roads as on the surface of grass. because stones are good conductors of heat, and, the vapor-tension being higher underneath than above the stones, the result is, the rising vapor gets condensed on the under sides of the stones. If a road is examined on a dewy night, and the gravel turned up, the under sides of the stones are found to be dripping wet.

Another reason why no dew forms on the surface of roads is that the stones, being fair conductors, and in heat communication with the ground, the temperature of the surface of the road is, from observations taken on several occasions, higher than that of the surface of the grass alongside. The air in contact with the stones is, therefore, not cooled so much as that in contact with the grass.

For studying the formation of dew on roads, slates were found to be useful. One slate was placed over a gravelly part of the road, and another over a hard dry part. Examined on dewy nights, the under sides of these slates were always found to be dripping wet, while their upper surfaces, and the ground all round, were quite dry.

The importance of the heat communicated from the ground is illustrated by a simple experiment with two slates or two iron weights, one of them being placed on the ground, either on grass or on bare soil, and the other elevated a few inches above the surface. The one resting on the ground, and in heat-communication with it, is found always to keep dry on dewy nights, whereas the elevated one gets dewed all over.

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The effect of wind in preventing the formation of dew is referred to. It is shown that, in addition to the other ways already known, wind hinders the formation of dew by preventing an accumulation of moist air near the surface of the ground.

An examination of the different forms of vegetation was made on dewy nights. It was soon evident that something else than radiation and condensation was at work to produce the varied appearances then seen on plants. Some kinds of plants were found to be wet, while others of a different kind, and growing close to them, were dry, and even on the same plant some branches were wet, while others were dry. The examination of the leaf of a broccoli plant showed better than any other that the wetting was not what we might expect if it were dew. The surface of the leaf was not wet all over, and the amount of deposit on any part had no relation to its exposure to radiation or access to moist air; but the moisture was collected in little drops, placed at short distances apart, along the very edge of the leaf. Closer examination showed that the position of these drops had a close relation to the structure of the leaf; they were all placed at the points where the veins in the leaf came to the outer edge, at once suggesting that these veins were the channels through which the liquid had been expelled. An examination of grass revealed a similar condition of matters; the moisture was not equally distributed over the blade, but was in drops attached to the tips of some of the blades. These drops, seen on vegetation on dewy nights, are therefore not dew at all, but are an effect of the vitality of the plant.

It is pointed out that the excretion of drops of liquid by plants is no new discovery, as it has been long well known, and the experiments of Dr. Moll on this subject are referred to; but what seems strange is that the relation of it to dew does not seem to have been recognized.

Some experiments were made on this subject in its relation to dew. Leaves of plants that had been seen to be wet on dewy nights were experimented on. They were connected by means of an India-rubber tube with a head of water of about one meter, and the leaf surrounded with saturated air. All were found to exude a watery liquid after being subjected to pressure for some hours, and a broccoli leaf got studded all along its edge with drops, and presented exactly the same appearance it did on dewy nights. A stem of grass was also found to exude at the tips of one or two blades when pressure was applied.

The question as to whether these drops are really exuded by the plant, or are produced in some other way, is considered. The tip of a blade of grass was put under conditions in which it could not extract moisture from the surrounding air, and, as the drop grew as rapidly under these conditions as did those on the unprotected blades, it is concluded that these drops are really exuded by the plant. Grass was found to get “dewed” in air not quite saturated.

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On many nights no true dew is formed, and nothing but these exuded drops appear on the grass; and on all nights when vegetation is active, these drops appear before the true dew; and if the radiation is strong enough and the supply of vapor sufficient, true dew makes its appearance, and now the plants get equally wet all over, in the same manner as dead matter. The difference between true dew on grass and these exuded drops can be detected at a glance. The drops are always exuded at a point near the tip of the blade, and form a drop of some size, while true dew is distributed all over the blade. The exuded liquid forms a large diamond-like drop, while the dew coats the blade with a pearly luster.

Toward the end of the paper the radiating powers of different surfaces at night is considered, and after a reference to some early experiments on this subject, the paper proceeds to describe some experiments made with the radiation thermometer described by the author in a previous paper. When working with this instrument, it is placed in a situation having a clear view of the sky all round, and is fixed at the same height as the ordinary thermometer screen, which is worked along with it, the difference between the thermometer in the screen and the radiation thermometer being observed. This difference in clear nights amounts to from 7 deg. to 10 deg.. By means of the radiation thermometer the radiating powers of different surfaces were observed. Black and white cloths were found to radiate equally well; soil and grass were also almost exactly equal to each other. Lampblack was equal to whitening. Sulphur was about two-thirds of black paint, and polished tin about one-seventh of black paint. Snow in the shade on a bright day was at midday 7 deg. colder than the air, while a black surface at the same time was only 4 deg. colder. This difference diminished as the sun got lower, and at night both radiated almost equally well. In the concluding pages of the paper some less important subjects are considered.

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