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NEW YORK, SATURDAY, FEBRUARY 8, 1902.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

LESSONS OF THE MURRAY HILL EXPLOSION.

The recent dynamite explosion at Murray Hill, in this city, is one of those unfortunate accidents which, judging from their frequency, seem to be inseparable, at least under existing conditions, from the carrying out of municipal improvements that involve extensive blasting operations in the heart of a busy city. It is certain that accidents due to blasting operations are altogether too frequent, and it is probable that this disaster, like the collision which occurred only a few days earlier in the New York Central tunnel, will lead to a revision of the rules which have been laid down for the protection of life and property, as far as they are affected by this class of work. High explosives, because of their enormous latent energy, are inherently dangerous; for, although by taking the proper precautions, the risk of premature explosion may be reduced to a very low margin, when a disaster does occur, it is liable to be of positively appalling magnitude. On the other hand, unless we are satisfied to see the march of improvement arrested, unless we are prepared, especially on Manhattan Island, to cease the erection of tall buildings calling for deep foundations and put an end to our ever-multiplying schemes for rapid transit and improved communication with outlying territories, we shall have to get accustomed to the knowledge of the fact that dynamite is being carted through our streets, and is being temporarily stored in innocent-looking sheds that are, of necessity, in uncomfortable proximity to the moving throngs and surging traffic of a great city. Although, as we have said, there is an enormous potency for disaster, even in the smaller quantities of high explosives, these substances may be handled and used with perfect safety if only proper rules for storage and manipulation are laid down and rigorously carried out. Cases are extremely rare in the present day in which disastrous explosions of the ordinary blasting agents have been due to chemical decomposition of the agents themselves; almost invariably they are traceable to carelessness or accident in the handling. There is, therefore, no cause for panic on the part of the citizens of New York, or of any other municipality where extensive blasting operations have been carried on. The disaster has shown the necessity for more stringent inspection on the part of the city authorities of the methods of storing and handling high explosives. The lesson for the contractors is that only eternal vigilance can ensure New York against future accidents of the kind during the completion of the subway.

FRAILTY OF TORPEDO BOAT DESTROYERS.

Owing to the innumerable disasters that have overtaken several of the torpedo boat destroyers during the past few months, Sir Edward Reed, the former Chief Designer of the British navy, has urged for a Parliamentary return relative to the character of the tests imposed upon torpedo boat destroyers before the Admiralty finally accepted them, and a report upon the efficiency of this type of war vessel. The government in their return give the names of all the torpedo boat destroyers in the British navy, the dates when they were ordered, and the dates when the boats were accepted by the government, or, in the case of unfinished boats, the expected dates of delivery. Particulars are also furnished of the number of preliminary trials the boats of 30 knots or more undergo, and particulars of typical cases wherein those trials have been exceptional in number, and have been extended over considerable periods.

According to this report, in twenty cases the trials were very protracted, and in several instances the government had to forego their demand for a certain speed, since the boats failed to attain it. The "Albatross," for instance, was ordered in April, 1896, and the trials, numbering seventeen, were spread over a period of six months, chiefly in consequence of alterations made to propellers and other parts of the machinery with the object of reaching the contract speed. The vessel tendered for thirty-two knots, but as she failed to accomplish this speed she was finally accepted at thirty-one and a half knots. The "Express," which has not been taken over by the Admiralty, has already been submitted to no fewer than twenty-seven preliminary and ten official trials, but satisfaction has not yet been obtained. In many cases failure to obtain the required speed has been the cause of the extended trials. Of four thirty-knot boats, one was accepted at twenty-nine knots, and three others at twenty-nine and a quarter knots. One destroyer was tested for six months, after which locomotive boilers gave place to water tube, of which a two months' trial was made, but the boat was finally accepted at twenty-six and three-quarter knots instead of thirty knots. All the new orders since 1900 have required thirty-two knots, but only four of these have been accepted. Altogether sixteen destroyers have yet to be delivered.

The Admiralty has also issued a note of warning to the Admirals in command of the British fleets on foreign stations, urging the more careful usage of destroyers. It is specially pointed out that these frail craft are not fit for the rough work to which they have hitherto been submitted. The Naval Department now directs that they should be treated with more consideration for their structure and capabilities than has heretofore been shown.

SUBTERRANEAN TEMPERATURE.

The driving of the great Simplon tunnel through the Alps is affording some interesting data on the subject of subterranean temperature. The work has progressed in the north heading over 21,000 feet, and in the south heading over 17,000 feet. Temperature observations have been taken both of the rock and the atmosphere. The temperatures of the rock show a steady increase with the depth of penetration in both headings. Thus at 1,640 feet from the portal of the north heading the rock showed a temperature of 54.3 deg. Fah., while in the south heading at the same distance from the portal the temperature was 56.2 degs. At 6,560 feet the temperature in the north heading was 63.6 degs., and in the south heading 69.7 degs. At 12,920 feet from the north heading the temperature was 76.3 degs.; at 15,090 feet it had risen to 86.3 degs., and at 16,400 feet penetration the temperature of the rock was 89.1 degs. The highest temperature recorded previous to September last was 92.2 degs. Fah. Early in October a heavy stream of water was encountered, which temporarily drove the gangs of workmen from the heading and necessitated temporary suspension of work in the main tunnel. The heaviest flow of water recorded at that time was about 200 gallons per second; and while it has been productive of considerable inconvenience in the tunnel work, it brought with it the advantage that it produced a very marked decrease in the temperature of the rock. The temperatures of the air are not given, for the reason that they vary with the amount of ventilation. During the summer it was found necessary to deliver to the northern end of the tunnel 39,000 cubic feet of air, and 66,000 cubic feet to the south end.

THE EAST RIVER BRIDGE FROM THE STANDPOINT OF ART.

Considered from the æsthetic standpoint, the new East River Bridge is destined always to suffer by comparison with its near neighbor, the present New York and Brooklyn suspension bridge. Whatever criticism has been made against the constructive features of the latter structure, it has always been conceded to be an extremely graceful and well-balanced design. It is possible that, were it not in existence, we would not hear so many strictures upon the manifest want of beauty in the later and larger East River Bridge, which is destined to be popular more on account of its size and usefulness than for its graceful lines. As a matter of fact, the East River Bridge is an engineer's bridge pure and simple. The eye may range from anchorage to anchorage, and from pier to finial of the towers, without finding a single detail which suggests any controlling motive, either in its design or fashioning, other than that of bald utility. The bridge is a strain sheet translated most literally into metal. For simple strains of tension or compression the most favorable distribution of metal in the framed portions of a bridge occurs when its members are strictly rectilinear. Speaking in a general way, curved forms, both in the details and in the general sweep of the outline of the bridge (saving, of course, the one great exception of the main cables), while they conduce to the grace and elegance of the structure, almost invariably add to the cost, and. weight for weight, diminish the strength of the structure. Hence, pound for pound of material, a bridge which follows most nearly the simple straight lines of the strain sheet will be the most economical in construction. It will also be the most scientific, the most easy to construct, both as regards shopwork and erection, and, in all probability, the most ugly.

Mr. Gustave Lindenthal, the new Commissioner of Bridges for New York city, and a bridge engineer whose designs are invariably of architectural merit, is stated to have said at a recent meeting of the Municipal Art Society that the towers of the new East River Bridge were the "ugliest possible." While we are scarcely prepared to go so far in condemnation as this, we must confess that we have always regarded these towers as unshapely. The most serious defect, from the architectural standpoint, is the very abrupt angle in the towers at the level of the roadway. The two halves of the tower are vertical to about the level of the roadway, and then incline inwardly at a decided angle, making an awkward and irregular outline which is entirely out of harmony with the curves of the main cable, or the unbroken vertical lines of the approach and the main trusses of the roadway. Mr. Lindenthal would doubtless have designed these towers with symmetrical curves, such as he adopted on his very artistic design of the Hudson River Bridge. Such towers might have been slightly more expensive to build, but the extra cost would have been a small price to pay for the added beauty which would have been given to the whole conception. This is not by any means the first time, as we have already suggested, that the East River Bridge has been criticised for its lack of æsthetic beauty. Some two or three years ago the Hon. Salem H. Wales, at that time a member of the East River Bridge Commission, gave warning that the designers of the bridge were disregarding the æsthetic elements of the problem, and urged that steps should be taken to beautify the towers. It will be a pleasure to some of our older readers to recall the fact that many years ago Mr. Wales was one of the editors and proprietors of the SCIENTIFIC AMERICAN.

RAILWAY WORKMEN AND DISBURSEMENTS.

The growth of our railroads in recent years has been so rapid that they exert an influence on the whole national life scarcely comprehended by outsiders, and politically, financially, and socially they form in the aggregate a factor of far-reaching importance. No other business, except that of agriculture, employs so many men, nor does any other single industry begin to distribute such an amount of money in wages and interest and dividends as the railroads. The combined number of employés of the railroads of the United States is roughly estimated at a million, with some five millions directly dependent upon them. This army of employés includes officials, clerks, engineers, firemen, trainmen, and mechanics and workmen in the shops, stations and general offices, representing the widest range of work. The railroads thus touch upon a dozen different technical and industrial fields, with workmen graded from the unskilled day laborers on the tracks up to the engineers and officers, with their highly technical knowledge and training.

Last year the gross earnings of the railroads of the United States amounted to $1,487,000,000. This enormous amount puts all other industrial corporations or combinations of corporations in the shade. Of this sum, $577,000,000 went to pay for labor that appeared regularly on the pay rolls. The stockholders received as their portion some $118,000,000, while the balance, or some $910,000,000, was needed for rentals, interest, taxes, supplies and material.

In view of these figures collected for 1900, it is interesting to note the disbursing power of this gigantic industry. Over a billion dollars are annually distributed throughout the whole of the country by the railroads in the form of wages, rentals, taxes, interest, and payment for supplies and raw material. A good deal of this money is paid for rolling stock and steel rails, which in turn becomes wages for employés in the mills and shops which turn out these necessary articles of railroad building. In other words, according to a recent authority on railroad matters, the gross earnings of the railroads are distributed as follows: Of every $100 earned by the corporations, $39 go directly to the employés of the road in the form of wages and salaries, $27 for supplies and the labor required to produce them, $23 for interest and rentals, $3 for general taxes, and $8 to the stockholders. The general distribution of the vast gross earnings of the roads is thus so general and over such a wide area that the railroads might well be considered the greatest combined agency for equalizing the general circulation of money in the world.

The disbursement of $577,000,000 a year among the direct and regular employés of the railroads represent a weekly pay roll of about $10,000,000. This would give to each employé, if divided equally, about $11 per week, or $570 per year, for his services. To carry this disbursement further, it will be seen that according to our population, there would be about $75 a year for every person in the country.

The distribution of the money thus collected and earned by the railroads is further shown by the payment of the $910,000,000 for material, supplies, rental, interests and taxes. These supplies include the rolling stock, steel rails, offices, buildings, and innumerable other necessities of a railroad plant. The construction of cars employs skilled labor in a score of different branches, and also the manufacturing of steel rails, telegraph wire, and other articles of use. Millions of dollars are thus directly distributed annually in manufacturing lines which are entirely dependent upon the railroads for their existence. The materials used for operating a great railroad are so many and different that it would require a small volume to attempt their classification, and their manufacture is directly responsible to the growth and expansion of the railroads.

Both in respect to their capitalization and the number of men employed, the railroads stand pre-eminently first among our national industries, and it is natural that the highest standard of efficiency and training should have been developed here. The engineers, firemen, mechanics, and trainmen of the railroads of the United States have developed and broadened with the companies they serve. In no other industry is there a better trained class of men. Merit and efficiency have always been the qualities that have led to promotion and financial reward in this department. In self-protection the railroad companies have had to encourage in the men an ambition to serve in the highest and most satisfactory manner. The work of engineers, firemen, switchmen, dispatchers, and operators, as well as that of the directing officers, is of such a character that the gravest responsibilities rest upon them. In no business is the effect of mistakes, carelessness or ignorance of more serious concern. Keeness of mind and intellect, sobriety, and watchfulness are constantly demanded of these employés.

The railroad companies have stimulated their employés to save money and to observe temperance and sobriety. Drinking is almost prohibited in the railroad service. No man who drinks while on duty or just before going on duty could retain his position. An engineer, dispatcher or switchman accustomed to drinking could not long conceal his weakness and be retained. The companies do not lay down prohibitive rules for the sake of the temperance cause, but as a matter of self-protection.

All of his training has a direct bearing on the question of distribution of money throughout the country. The railroad men as a rule save more of their wages than any other employés of a similar grade. A part of their wages is invested in relief societies connected with the railroad companies, and another part in paying for pensions which will keep them in comfort when too old to work. This form of co-operation is encouraged and directly abetted by most of the large railroads. The money thus earned by the roads and distributed among their employés is not, as a rule, wasted and lavishly spent, but it is carefully used and invested to keep the men from future want. Long service in the railroads is further encouraged on some roads by systems of pensions which are granted to those who reach the age of seventy. Thus a man is induced to make railroading a life business and not a mere makeshift, and all his abilities and talents are devoted to the industry.

PRACTICAL VALUE OF NERNST LAMPS.

BY ALTON D. ADAMS.

After three years of labor Nernst lamps have been reduced to commercial form. The object here is to inquire to what extent the qualities of the Nernst lamp fit it to displace the arc and incandescent types. The main points to be considered, in a comparison of this latest lamp with the older types, are adaptation for distribution, size and qualities of the service units and efficiency. In distribution of electric lamps the prevailing methods are the series and the multiple. Series distribution is generally applied to street lighting and requires lamps for each of which the ratio of volts to amperes is as small as possible. Multiple distribution is the rule in commercial lighting, and here a lamp is wanted with a large ratio between its required volts and amperes. The smallest Nernst lamp now offered consumes not less than 88 watts, and the sizes that seem best adapted for general use range from this to 517 watts. A lamp for 88 watts may be had at either the 110 or 220 volt pressure, but the larger sizes are only available for 220 volts. The 88 watt lamp at 110 volts, taking 0.8 ampere, has a ratio of required volts to amperes of 137. On a series circuit of 3,000 volts maximum pressure only 27 of these lamps may be operated, giving a total capacity of 2,376 watts. Incandescent lamps for such a circuit may be readily had, each of which requires 6 amperes at 15 volts, or 90 watts, so that the ratio of volts to amperes for each lamp is only 2.5 instead of 137, as in the Nernst lamp. Of these incandescent lamps 200 may be operated on a circuit of 3,000 volts maximum pressure, and the capacity of this circuit will then be 18,000 watts, or almost seven times that of a series circuit of like pressure with Nernst lamps of equal watt consumption. If larger units of illumination are wanted, a Nernst lamp taking 517 watts in the form of 2.35 amperes at 220 volts may be compared with an inclosed arc lamp taking 6 amperes at 85 volts, or 510 watts. For this Nernst lamp the ratio of volts to amperes is 93, and for the arc lamp the like ratio is only 14. On a series circuit of maximum 3,000 volts' pressure 13 of these Nernst lamps may be operated, giving the circuit a capacity of 6,721 watts. The inclosed arc lamps on a similar circuit may number 35 with an aggregate capacity of 17,850 watts. From the foregoing it appears that if 88-watt Nernst lamps are used the number of circuits must be seven times as great as if incandescent lamps using an equal amount of energy each are employed. If resort is had to Nernst lamps of 517 watts each the number of series circuits to distribute a given amount of energy must be 2.6 times as great as where inclosed arc lamps of equal watts are employed. It seems improbable that in street lighting either the advantage of series distribution will be given up or the large increase in the number of circuits just indicated be made for the sake of using Nernst lamps. For multiple distribution it is desirable to have a high ratio of required volts to amperes at each lamp. In this particular Nernst lamps are superior to arcs, but are on a par with the incandescent, since the latter are regularly made for the pressure of 220 volts. Taking the pressure for multiple inclosed arc lamps to be 110 volts, because of the necessary resistance to insure steady operation, it seems that when the Nernst and arc lamps require equal watts the weight of copper necessary to distribute the former at 220 volts is only one-fourth of the like weight for the latter. The great bulk of commercial incandescent lighting is done with 16-candle power lamps, because a lamp of this capacity gives better distribution of illumination for general purposes than larger sizes, and has been found ample for individual use at the work bench or desk. The smallest Nernst lamp offered consumes 88 watts, or 1.76 times as much energy as the 16-candle incandescent lamp using 50 watts. It has generally been found in practice that each workman in the counting room or shop must be supplied with a lamp for his individual use, so that the adoption of Nernst lamps for these purposes must increase the required capacities of dynamos and circuits by 77 per cent. This Nernst lamp using 88 watts yields more than 16-candle power, but incandescent lamps of any candle power up to several hundred have long been available. A large part of electrical distribution at the present time is carried out with direct current, and the important functions of storage batteries furnish strong reasons for continued practice in this direction, as do also the great investments in direct-current systems. The application of Nernst lamps in direct-current circuits encounters the serious objection that a black deposit gradually spreads from the negative toward the positive end of the glower and cuts down the candle power. In the matter of first cost the Nernst seems to be at a decided disadvantage compared with the incandescent lamp. Six dollars is reported to be the price of an 88-watt Nernst lamp, and this sum is about twenty times that of an incandescent lamp of equal wattage. The Nernst glowers must be renewed like incandescent lamps, and while the price of glowers is not at hand it seems fair to presume that the cost of their renewal will be as much as that of incandescent lamps that consume equal energy. Considering the remainder of the Nernst lamp, aside from the glowers, it seems that the rate of depreciation can hardly amount to less than 10 per cent of the first cost per annum. Interest at 6 per cent plus this depreciation brings the fixed yearly charge per lamp to 96 cents. If lamps operate 1,000 hours yearly and renewals are every 500 hours at equal cost of 30 cents for the incandescent and Nernst, then the renewals, interest and depreciation on the latter amount to 2.6 times the renewals of the former. The Nernst lamp taking 517 watts is said to cost $15, or about eight times as much as a group of six incandescent lamps of equal energy capacity. An inclosed arc lamp with a capacity of 500 watts costs approximately the sum just named for the Nernst lamp of that rating, and it is fair to assume that renewals, interest and depreciation on these two will not be far apart. In required cleaning and care in operation the Nernst appears fully up to the inclosed arc lamp.

The Nernst glower operates at a temperature between that of the incandescent filament and of the electric arc, and, as might be expected, the quality of light obtained is mediate between the other two sources. It thus seems that for some purposes the Nernst is superior to incandescent lamps, though not necessarily so much superior as are arcs. The claim urged as most important for Nernst lamps is that of high efficiency, and this deserves to be examined with some care. Complete data as to efficiency is available for only that size of Nernst lamp that consumes energy at the rate of 517 watts, and it is admitted that the 88-watt lamp has a somewhat lower efficiency. According to the figures published by its makers the best result obtainable with the 517-watt Nernst lamp is 149 mean spherical candle power in Hefner units. This corresponds to an efficiency of 3.47 watts per candle power. Measured in this same unit, either direct or alternating arcs of the inclosed type with clear outer globes yield a candle power for every 2.6 watts drawn from 110-volt constant-pressure mains. When these arcs are used on series circuits, so as to avoid the losses in steadying resistance, the rate of energy consumption falls to 2 watts per mean spherical candle. Incandescent lamps may commonly be had at either 3 or 3.5 watts per mean spherical candle power, the higher efficiency going with a shorter life.

In view of the foregoing the following conclusions may be reached as to the practical value of Nernst lamps: For street lighting the Nernst is not generally suited, because it is impracticable to operate it on series circuits, and because its efficiency is materially below that of series arcs. For divided indoor lighting Nernst lamps are less suitable than incandescent, because of the larger first cost, fixed charges and energy consumption of the former in the smallest units. Where large interior spaces are to have general illumination the Nernst lamp has some advantage over the incandescent in the quality of its light, and over the arc in the weight of conductors necessary. This advantage over arcs seems to be fully offset by the lower Nernst efficiency.

SCIENCE NOTES.

The King of Italy has conferred upon Signor Marconi the decoration of the order of St. Lourice and St. Lazarus.

The exploring vessel "Discovery," which has recently left New Zealand for the Antarctic, is quite unfit to proceed on her journey. She not only rolled badly, but also rocked. Her officers, however, profess confidence in the ship.

The shower bath has proved very successful in Public School No. 1, New York city. Its capacity is sufficient to bathe 150 to 200 boys per day. Fifteen minutes are allowed for the bath, including dressing and undressing.

The Pan-American Exposition Company is so deeply embarrassed financially that exhibitors will probably have to pay for the diplomas themselves. About 10,000 are to be issued, and the total expense will be $3,000, and this sum the company is unable to meet.

At a dinner of the new Aero Club of the United Kingdom, held in honor of M. Santos-Dumont, the latter stated that next summer, after his aerial trip from France to Corsica, he would return and make some trials of a steerable airship above London.

The Egyptian Exploration Fund has accomplished remarkable results in connection with the operations at Abydos. During the past year the association has completed the most important historical work that has ever come into its hands. The continuous order of seventeen kings has been established, and the foundations of Egyptian history have been settled in a manner that had hitherto been deemed beyond hope. The excavations at Abydos have provided the only contemporary history of the time, and completely vindicated the historical character of the lists which had been preserved by later ages. The historic character of Mena is substantiated, and the long line of a dozen kings back to Mena is rendered clear. The Egyptologists have seen and handled the gold, the crystal, the ivory with his name and engravings; and even kings that went before him are now better known by actual objects than one-half of the Saxon kings of England. No such complete materialization of history has ever before been obtained at one stroke from any other country or age. There remains to be examined at Abydos the great temple site, one of the most ancient and promising spots in that land of buried treasures.

The work of raising the Great Monolith at Stonehenge, England, has enabled archæologists to form a more reliable estimate regarding the epoch in which these druidical monuments were erected. There has hitherto been much controversy on this point, certain authorities clinging to the assertion that it was built in Roman times, while others contend that it was erected during the bronze period. While making excavations round the monolith for the concrete bedding, a large number of neolithic stone implements were unearthed that show every sign of having been used to cut and to square the stones. They all bore marks of hard working, and when of no further use for cutting, the stones had been apparently thrown aside and afterward used to make a bedding to support the uprights. Experts therefore now entertain little doubt that Stonehenge was built in the neolithic age, for had it been built in the bronze or iron age, bronze or iron tools would have been used. Although leading authorities do not quite agree as to the actual date of the introduction of bronze into Britain, it is generally conceded to have been about 1500 B. C. It is consequently apparent that Stonehenge must have been constructed at some period considerably previous to that date.