able 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.