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RECENT STREET RAILWAY EXTENSION IN GLASGOW.

By J. A. STEWART.

THE street railway system of Glasgow in its management by the community and for the community has a wide prestige. Popular interest is consequently attracted to the developments now going on there for the enlargement and greater usefulness of the plant, in view of the demands already made upon it and the anticipated requirements caused by the opening of the Glasgow International Exhibition next May.

The progress of the street railway service in Glasgow makes interesting reading. It is only a matter of thirty years since the useful tram-car made its debut on the streets of the Scottish metropolis. This approved modern mode of transportation was inaugurated in 1870 by the granting of a lease for twenty-one years by the city to a private corporation for the purpose. This contract, it is to be noted, contained the thoughtful provision for municipal ownership if desired.

At the end of the lease there were but 31½ miles of street railway in operation, and the company in possession declined to accede to the moderate requests for a better grade of service and for increased facilities. The municipality then decided to take over the management of the cars into its own hands. This determination on the part of the city was not carried out without opposition from the company, who even went so far, it may be recalled, as to run a competing line of omnibuses for a time, an attempt which was quite unsuccessful in its aim to defeat municipal operation, the omnibuses having to be taken off in less than six months.

As the result of five years of municipal management, the community enjoys improved service; reduced fares; increase of wages and shorter hours of labor for street car employees; besides growth in traffic. In addition, the municipality has increased its paid-up capital, kept its lines in good repair, and made increasingly larger allowances for depreciation, sinking funds, re-

newal and reserve funds. Among the corporation's first moves were to cut off one source of revenue from disfiguring advertisements; to dress the drivers and conductors in neat uniforms and to reduce the hours of labor to ten hours daily. Special reduced fares for workmen were established and 50 per cent. greater distance traversed for 2 cents. The following are the average distances that can now be traveled at the different fares:

Halfpenny fare, 0.58 mile; penny fare, 1.75 miles; three-halfpenny fare, 2.33 miles; two-penny fare,

This vast increase and the inevitable question of congestion have made electric traction a necessity. In November, 1897, the offer of the Westinghouse Company to provide the installation for a demonstration on the Springburn route was accepted. This involved, in addition to the equipment, permanent-way work by the Tramways Department, including the relaying of the track with a heavier section of rail, the laying of the ducts for the cables, and also the bonding of rails. The roadway under the railway bridge at St. Rollox had to be lowered 18 inches, so as to give a headway of 16 feet 6 inches, otherwise it would have been dangerous to use cars with top seats on this route.

The corporation had every reason to be satisfied with the results of the demonstration on the experimental route. The earnings averaged 28 cents per mile, and the working expenses 12.7 cents (6.38 d.) per car mile during the first year. The percentage of working expenses to receipts was 45.85 as compared with 73.89 for horse traction.

As has been stated, the fact that the Glasgow International Exhibition will open next May has expedited the extension of the street car service. The mileage will be increased from 84 at present to 121, including 34 miles of lines outside the city boundary. Next year Glasgow will bid adieu to horse traction forever. Electric traction will be adopted throughout the entire tramway system. The

plans include the adoption of the overhead electric system, the underground being found too costly. Under the plans promulgated by the able general manager, Mr. John M. Young, the scheme for carrying out the change divides the whole system, embracing both track and depots, into four sections. The track conversion and the extensions at the Partick and Dalwarnock depots are covered by the first section. The first two sections together measure 25 miles of double track and comprise generally all the lines directly connected with the exhibition.

All the electric cars have been built at the department's workshops at Coplawhill, additional ground extending to 12,923 square yards having been taken,



CAR BUILDING WORKS, GLASGOW CORPORATION TRAMWAYS.

3.47 miles; twopence halfpenny fare, 4.18 miles; three-penny fare, 5.34 miles.

The Glasgow lines radiate in twelve different routes, all of which pass through the heart of the city, a triangle bounded by three railway stations, the St. Enoch, Central and Queen Street stations. An increasingly large number of people is using the cars. This growing usefulness of the tramway service may be judged when it is stated that while the number of passengers carried by the Glasgow Tramway and Omnibus Company, Limited, during its last year of possession was about fifty million, the number carried by the corporation cars last year was nearly one hundred and fifty millions.



DOUBLE-DECKED CARS OF THE GLASGOW CORPORATION TRAMWAYS.

on which new carworks, sheds, etc., are being erected. It was decided by the corporation that the Tramways Department should erect their own power station. A very suitable plot of ground, 18,802 square yards in extent, has been secured for the purpose. It is close to the canal at Port Dupdas and is connected with both the Caledonian and British Railways.

Mr. H. F. Parshall, M.Inst.C.E., M.I.E.E., of London, was made consulting engineer. His plan for generating and distributing the current provides for one main generating station and five sub-stations. Several of the existing depots will be utilized for the latter.

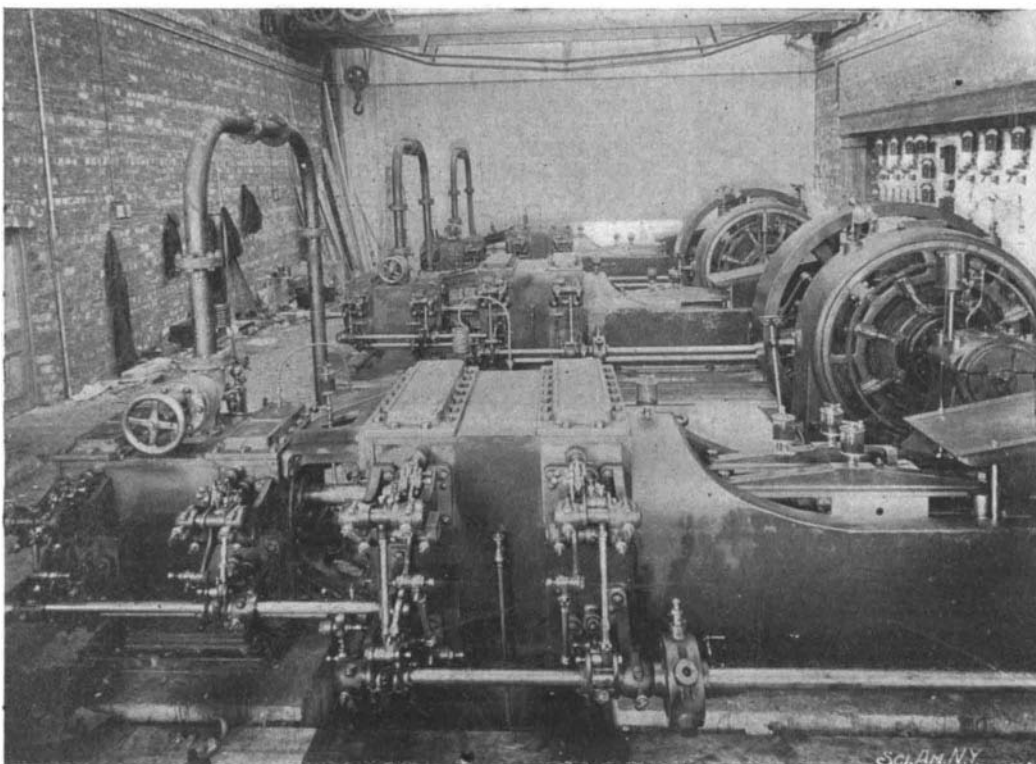
It is interesting to note that the electrical machinery installed is all made in America, partly by Westinghouse and partly by Brush. Two of the power engines come from Milwaukee and two are of English manufacture. The motors are provided by the Brill Company, and the equipment and controllers by Westinghouse. The rails used on the Glasgow roadways weigh 98 pounds per yard and are rolled in 60 foot lengths. Cast-iron chilled paving blocks are laid along each side of the rails in the busier thoroughfares to prevent excessive wear by the wheels of ordinary vehicles. The total cost of conversion from horse haulage to electric traction is estimated at \$5,000,000.

A further reduction of fares is to go into effect at the beginning of the century. For one cent one may then ride three-quarters of a mile, and two cents worth will carry the passenger about three miles. Three consecutive one cent stages can be taken for two cents. It is worthy of note that in Glasgow every third person pays only a cent, and the average fare for the whole year is only three-quarters of a cent. The desire, as in America, is "to spread the population," and next year the Glasgow workman may ride six miles to his suburban home for the same fare the American pays for a single block. Apropos of the skillful and honest management, it is of interest to note the financial status of the tramways under civic control. The total amount of borrowing powers authorized was \$4,500,000. Of the amounts borrowed from time to time, there has, up to

was afterward the subject of prolonged litigation. The novel proposition was presented to the court of a patent for not doing something, namely, for not permitting nitrates to find their way into the nickel solutions employed in nickel plating, and the court held that the exclusion of nitrates was an essential condition of successful nickel plating, and that a process involving this condition was just as patentable as a process involving any other special condition necessary for successful execution, and the patent was sustained.

ARTIFICIAL ILLUMINATION.

The subject of artificial illumination has developed wonderfully within my recollection. In my boyhood I lived in New Bedford, Massachusetts, the most important whaling port in the world at that time. More than 300 ships went out from that port and sailed the seas in search of whales, some going to the North Atlantic along the ice fields; others around the Cape of Good Hope to the Indian Ocean; and others again doubled Cape Horn and sailed up the Pacific through Behring Straits into the Arctic Seas, often being absent for more than three years from port. The business was very uncertain, but on the whole very profitable. If a ship made a first-rate voyage, it might bring back 4,000 barrels of sperm oil, worth over \$200,000; the same quantity of whale oil would be worth over \$100,000. At first, the whalebone of the "right whale" had so little value in the market that it was hardly worth while to bring it home; but as this substance became more and more useful in the arts, finally reaching a price of several dollars per pound, it became an important item in the catch. Each member of the ship's crew received a certain fraction of the catch as his share of the voyage. I remember the cooper's share was about one-fortieth of the catch. It was believed in those days that there was no other material that could ever compete with sperm oil, either as an illuminating agent or as a lubricator for fine machinery, such as cotton spindles, and my last recollection of the price of sperm oil in those days was \$1.75 per wine gallon, which is the legal gallon in the United States. The whale



INTERIOR OF POWER STATION, GLASGOW TRAMWAY SYSTEM.

May, 1899, been repaid by means of the sinking fund \$1,225,000. By the Glasgow Corporation Tramways Act, 1899, additional borrowing powers to the extent of \$12,500,000 were conferred. The total amount of capital expenditure has been about \$3,500,000. All the extra capital expenditure for extensions and additions to the plant has been met out of surplus revenue. The revenue of the department for the last financial year reached a grand total of \$2,195,000, being an average of 23.2 cents per car mile. The working expenses averaged 16.8 cents per car mile, which left a balance of \$665,000, or 6.4 cents per car mile, to meet all fixed charges.

[Continued from SUPPLEMENT, No. 1294, page 20737.]

CHEMICAL AND TECHNICAL EDUCATION IN THE UNITED STATES.*

By Prof. C. F. CHANDLER, Ph.D., M.D., LL.D., D.Sc., Oxon.

NICKEL PLATING.

NICKEL plating is a most useful application of electrolysis. It was invented by Isaac Adams, of Boston. Adams wondered why all attempts to plate nickel upon other metals had proved unsuccessful, and he began a careful investigation to ascertain the cause of the difficulties experienced. He soon found that the real difficulty was due to the presence of nitrates in the solution employed; nickel always appearing in commerce in the metallic form, it was natural when any one desired a solution to dissolve it in nitric acid, to precipitate the nitrate with carbonate of soda, and dissolve the carbonate of nickel in the proper acid for the solution desired. No one ever washed the carbonate of nickel with sufficient care to remove the last portions of the nitrate of soda; consequently all the nickel solutions previously experimented upon had contained nitrates, the presence of which Adams found to be fatal to successful nickel plating. This fact having been ascertained, successful nickel plating was the immediate result. Adams obtained a patent for this process which

oil sold for 80 cents a gallon. Artificial illumination with sperm oil, or even whale oil, was a pretty expensive luxury in those days, and various substitutes for these oils were successively introduced upon the market, particularly lard oil, rosin oil, spirits of turpentine, sold under the name "camphine," and a mixture of spirits of turpentine and alcohol, sold under the name of "burning fluid." The camphine and burning fluid, while much cheaper than the sperm oil, were very dangerous on account of their inflammability, and the escaping vapors which they evolved, and many accidents occurred in their use.

From the sperm oil, particularly that obtained from the head of the sperm whale, known as head matter, the spermaceti was extracted by chilling and pressing, and from that our best candles were manufactured. A small percentage of bleached beeswax was added to diminish the tendency to crystallization in the mould. Sometimes the spermaceti was poured into chilled candle moulds in order to produce a chill on the surface like the chill on a cast iron car wheel.

So profitable was this industry that New Bedford came to be the richest city of its size in the United States. Acres of casks of oil were stored in the city, and there were numerous oil refineries and candle works in operation.

COAL OIL.

In 1855 I saw for the first time in use in Berlin an oil called "photogen." On inquiring of Prof. Magnus, who lectured on industrial chemistry, as to the nature of this oil, I was informed that it was an artificial hydrocarbon oil obtained by distilling bituminous shales, and I subsequently visited a large establishment in Hamburg in process of erection for the manufacture of this "photogen oil" and paraffin from boghead coal imported from Torbane Hill, Scotland. On my return to New Bedford in the autumn of 1856 I informed my New Bedford friends of this new departure in artificial illumination, and found them extremely incredulous. They could not bring themselves to believe that any material could ever be found that could successfully compete with sperm oil.

As a matter of fact, however, there were several persons in America who had been engaged for some time in the manufacture of artificial hydrocarbon oils.

Abraham Gessner had been at work since 1846 in the effort to produce oil economically by the destructive distillation of bituminous materials; and as early as 1850 Luther Atwood succeeded in making a fair quality of oil for lubricating purposes from coal tar. This was brought out by Samuel Downer of Boston and was put upon the market under the name of "coup oil," from the coup d'etat of the Emperor Louis Napoleon. In 1852 James Young, of Manchester, secured a patent in the United States for the manufacture of paraffin oil from bituminous coal.

The first company to engage in the manufacture of coal or shale oil in the United States was the North American Kerosene Gas Light Company, of New York, which was organized in the early part of 1854, working under the kerosene patents of John H. and George W. Austin. The works were erected opposite New York on Long Island, and an oil was put upon the market under the name of kerosene. Some time elapsed, however, before the oil came into use, for the reason that there were no suitable lamps available for burning it, and the invention of proper lamps occupied a year or two and delayed the introduction of this new oil.

In 1855 or 1856 a company was formed to manufacture oil and paraffin from the Breckinridge canal coal of Kentucky. Another company manufactured oil from albertite found in Nova Scotia. This albertite is a very curious material. It has the vitreous appearance of certain asphaltums and is probably natural petroleum residuum. It yielded about one hundred gallons of oil to the ton. Another company was formed to manufacture oil from the grahamite of Ritchie County, West Virginia, another natural petroleum residuum, quite different from albertite; it had the appearance of a piece of ordinary coking coal, but was entirely soluble in spirits of turpentine, and in benzole, and yielded over 100 gallons of oil to the ton. This "coal oil" industry rapidly extended, and on January 1, 1860, there were forty coal oil factories on the Atlantic coast, 38 of which employed boghead coal imported from Scotland, while two employed albertite. Thus artificial illumination was revolutionized by the introduction of this artificial hydrocarbon oil, which soon came to be known as kerosene.

PETROLEUM.

While this industry was developing there were enterprising men in New Haven, Connecticut, who were considering the possibilities of petroleum. They consulted Prof. Benjamin Silliman, Jr., of Yale College, as to the possibility of securing petroleum, and he called their attention to the petroleum of Western Pennsylvania, which had been collected by the Indians in small quantities and distributed by the druggists as a cure for rheumatism under the name of "Seneca Oil." They visited Oil Creek in Venango County, Pa., and collected a few gallons of this oil by skimming it from the surface of ponds, and on April 16, 1855, Prof. Silliman made a report upon this petroleum. This report is published in full in *The American Chemist*, vol. 2, page 18, and is very interesting reading. Prof. Silliman points out the fact that this petroleum can be readily refined, with the production of a variety of oils suitable for many purposes, but particularly for burning in lamps, for lubricating, and for making candles. He made photometric experiments, and found that in a camphine lamp he obtained an eight candle-power flame with the consumption of $1\frac{1}{4}$ ounces of oil per hour. He mentions that at that time illuminating gas was selling in New York at \$3.50 per 1,000 feet, that sperm oil cost \$2.50 per gallon, colza oil \$2, camphine 65 cents, and silvic oil from resin, 50 cents, and he pronounced the oil to be a most desirable material for artificial illumination. These gentlemen, Messrs. Eveleth, Bissell, and Reed, had organized in 1854 the Pennsylvania Rock Oil Company for the purpose of developing the natural petroleum of Western Pennsylvania. They had great difficulty in getting any considerable quantity of oil. They first skimmed the surface of the water with skimmers, subsequently ditches were dug in which water accumulated, and upon which the oil appeared as a scum, and instead of skimming it they took it up with blankets, which were held by the four corners and let down on the surface of the water; being already saturated with oil they absorbed no water, but took up whatever oil there was upon the surface. They were afterward wrung out over a tub. This was a pretty slow operation and the yield was extremely small, and it seemed as though the petroleum industry would never become a success.

To Col. G. L. Drake is due the credit of having made a success of this petroleum enterprise. He made diligent inquiry with regard to petroleum, and found that on two different occasions petroleum had flowed from salt wells. In 1819 oil was accidentally obtained in boring two salt wells on the Muskingum River in Ohio. It was used to a limited extent in the workshops in the neighborhood, but did not prove a satisfactory substitute for the animal and vegetable oils in use, as lamps suitable for burning it had not been invented. The oil was considered a great evil on account of its interference with the manufacture of salt. In 1829 a flowing well had been accidentally obtained at Burksville, Kentucky, and for two or three weeks the oil flowed over the surface of the Cumberland River and became ignited, causing some apprehension of conflagration by the inhabitants of the towns and villages lower down on the river.

Col. Drake decided, on the law of probabilities, that if on two occasions people had drawn oil by accident through salt wells from the bowels of the earth, there was no reason why he could not secure it by intention in the same way; therefore, much to the amusement of his friends and the Pennsylvania farmers, he began to bore an artesian well for oil, and on the 26th day of August, 1859, at a depth of 71 feet, the drill suddenly dropped into a cavity, and in a few minutes the oil made its appearance at the surface and flowed at the rate of 400 gallons a day. This oil sold for 55 cents a gallon at the well. The success of this oil well, as can readily be imagined, created a great excitement throughout the country. There was immediately a rush of prospectors to Oil Creek, and in a few months there appeared a forest of derricks in the valley, and numerous wells were bored.

The success which attended this enterprise led to prospecting in other districts, and wells were bored in West Virginia, Ohio, Kentucky, Indiana, and elsewhere. No mining enterprise had ever offered such

* Read at the nineteenth annual general meeting of the Society in London, in the theater of the Royal Institution, Albemarle Street, on Wednesday, July 18, 1900, Prof. C. F. Chandler, President of the Society, in the chair.