At this point the river is straight, deep, and of uniform cross section for a mile or so, and has been measured previously by the staff of the Harbor Commissioners, and last year by the college party under the same direction, and at about the same time of year. This year pole floats, and also Amsler electric current meter observations, were both taken; a cross section of the river taken again, and levels of water, etc. It is hoped these records may not only be of present, but of permanent, future value, as determining the volume and velocity of flow of the St. Lawrence in years of low water.

## GAS VERSUS ELECTRICITY DIRECT FROM COAL."

## BY D. M. DUNNING.

For a number of years we have heard of the great things that were to happen when science achieved the production of "electricity direct from coal;" yet it does not seem to have occurred to many that ordinary illuminating gas is, and always has been, produced "direct from coal." The purpose of this paper will be to show in a practical way that, with the modern gas works, handled in an up-to-date manner, an efficiency can be attained which is about all that could be produced, even should science succeed in the production of "electricity direct from coal." In doing this it will be desirable first to briefly describe the modern gas works and some of the essential advantages to be derived from it, in comparison with the works in use until the past few years.

In the way of the utilization of residuals, and illumination through incandescent lamps, it has, through the aid of science, made most rapid advances, and still presents, in these and other lines, the broadest fields for scientific research and investigation. At various times it has, in the minds of many, been threatened with serious, if not fatal, competition from electricity; yet the gas industry is probably to-day in a healthier and more prosperous condition than it would have been if electricity had never been a competitor, because the electric light has created a demand for more light and a stronger light, which, together with its competition, has stimulated the gas industry to improvement, and to advance and extend its business; and on these lines, and with the aid of lower prices, the future manager seems to have an almost unlimited field.

In the evolution of the modern gas works one of the first and most important steps was the construction of the "regenerative furnace." Only a few years ago, with the old-style furnace then in use, it was the common thing to consume fully one-half the coke produced in the furnace itself; and, with no special effort made to find a market for the other half, it often became a cumbrous thing about the works, and was disposed of in liberal measure and at nominal prices, which practically destroyed its market value. We now have in common use the "regenerative furnace," which, with its essential features of primary and secondary combustion, is a remarkably economical generator of heat. By secondary combustion I mean the combustion of the unconsumed products of the first combustion, which is brought about by a secondary supply of air at a point just above the furnace proper. In this manner, together with an ingenious arrangement of flues for heating the air-supply with the otherwise waste heat of the furnace, the efficiency of the furnace has become fully doubled, so that we are now able to carbonize our coal with about one-fourth of the coke produced. Another important advantage of the modern furnace is the transfer of the coke without quenching, whereas, with the old furnace, it was necessary to quench the coke, and then fire it up again. This furnace also affords a very marked saving in depreciation and labor, especially if run with moderate leat, as it should be; and the large amount of coke saved, if properly stored and marketed among people educated to its use, becomes a very important by-product, and, in such works as are in proximity to the bituminous coal fields, nearly, if not entirely, liquidates the coal bill.

And, with the great saving in this by-product, there has been achieved a still greater in the two other byproducts-namely, tar and ammonia. Within the memory of the writer, coal-tar was a serious annoyance to the gas manager, because it had to be disposed of in some way other than as ordinary sewage; and it was not an uncommon occurrence to be obliged to haul the major portion of it out into the country and there burn it, hoping to sell the remainder for local use for enough to defray such expense. To day it can probably be safely said that in no branch of chemistry has science delved so deeply as in that which deals with the black and sticky mass of coal-tar, and certainly from none has it produced more brilliant results, the productions being already numbered among the thousands, comprising nearly all of our most beautiful colors, such as the aniline series, and the most important of our medical remedies, one of which-phenacetine, of the anti-febrin class-has acquired a world-wide reputation; altogether, the list seems as limitless as the starry heavens, and as yet about as unexplored. Saccharin, a thousand times sweeter than sugar, suggests that, if we have sufficient faith, and work, we may yet live on tar. Coal-tar products have acquired so important a place in the arts, sciences and manufactures that this byproduct has become a well-established article of commerce, and undoubtedly pays, for the average gas works, about twenty-five per cent. of the coal bill.

Not until a recent period did gas companies-in this country at least-make much of an effort to save their third important by-product, ammonia; and it is an interesting feature of this saving that the necessary treatment of the gas in process of manufacture, in connection with such saving, has been so material an improvement over the old treatment as to more than compensate for any added expense caused thereby, leaving the ammonia saved out of the qustion. Formerly the gas was often washed in a shower-bath of cold water, and many of its illuminants were washed away with the ammonia into the sewer. Now only an exceedingly small quantity of water (which has great affinity for ammonia) is allowed to come in contact with the gas, and this contact, by ingenious mechanical contrivances, is continued over a long and sinuous course, entirely removing the ammonia without disturbing the illuminants, and producing a valuable article of commerce. The storage and concentration of ammoniacal liquor requires careful and skillful handling, as it is an extremely fugitive substance, always anxious to escape to the clouds, and return thence to the farmer in his fields. Five to seven pounds per ton of coal is a fair production of this by-product, and between thirty and fifty cents per ton of coal the average revenue.

This summary of the state of the gas industry at the present time, in respect to the saving of residuals,

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