being broken should always be very carefully made and positive proof sent in to the National office. It alone has a right to deal with trade relations which have been decided by the convention."

The new officers elected are:—President, Joseph Wright, Toronto; vice-president, W. Smith, London; vice-president for Ontario, John McKinley, Ottawa; vice-president for Quebec, P. J. Carroll, Montreal; vice president for New Brunswick, J. H. Doody, vice-president for Nova Scotia, John Borton, Halifax; vice-president for Manitoba, —. Irwin, Winnipeg; secretary, —. Mansell; treasurer, W. Briggs, Montreal; executive committee, one from each Province – Ontario, J. B. Fitzsimons, Toronto; Quebec, Arch. Picard, Quebec; New Brunswick, Thomas Campbell, St. John; Nova Scotia, Geo. A. Perrier; Manitoba, —. Stevenson, Winnipeg.

The social features of the convention included a drive given the members by the city, a banquet and a trip to Niagara Falls. The banquet was a magnificent affair, and was held in the Harry Webb Co.'s building, Yonge and Melinda streets. About 140 members and guests sat down to a dinner which was beautifully served and in which every dish was well worth the serving. Chairman Burroughes opened the toast list and a couple of hours were spent in speeches and song.

DETERMINATION OF THE HEATING POWER AND STEAM-PRODUCING VALUE OF COALS FROM A PRELIMINARY EXAMINATION.*

BY WILLIAM THOMPSON, MONTREAL WEST.

The principle of getting the best returns and most efficient service should underlie our system of purchasing our fuel, as of anything else. It is not my intention to discuss the merits or demerits of any particular variety of coal, but to try to establish a method whereby the heating power, and consequently, the value of any fuel, can readily be determined, and when the knowledge of conditions under which combustion must take place are understood, we shall, in some measure at least, be able to intelligently choose between any number of samples and varieties of coals that are most suited to our purpose. Undoubtedly the most correct method of determining the actual heating power of any substance is by the aid of the calorimeter, but when we consider the high cost and delicate manipulation required in an instrument of this kind, we find it is practically debarred from use, except by the expert chemist in his laboratory. Efforts have been made by scientists to construct a formula whereby the actual heating power of coals could be accurately ascertained by computation. That published by Dulong and also by Mahler, is perhaps the best. It is based upon an elementary analysis of the coal under examination, and the fact that the heating powers of coals of a like composition remained constant. They also establish the fact that the heating power of fixed carbon remains constant, as does also that of hydrogen when in combination with the same proportions of oxygen and nitrogen. Dulong accepts as the heat-producing elements of coal, carbon and hydrogen, giving each a constant calorific value, and at the same time determined that the oxygen of the coal renders unavailing for heating purposes one-eighth of its own weight of the hydrogen, and on this basis constructs the following formula:

$$Q = 14.544\ C + 62,100\ (H - O_8)$$

which for convenience might be written:

$$Q = 14\ 544\ C + 62,100\ H - 7.762.50$$

Where Q equals calorific value of fuel,

14.544 = constant heating power of carbon
62,100 = " " " hydrogen
7.762 5 = " neutralizing power of oxygen

Mahler, at more recent date, and after a series of lengthy experiments, amended Dulong's formula slightly by accepting Berthelet's more recent determination of the heating power of carbon as 14.52 B.T.U., and using the empirical constant, 5,400, at the same time taking note of the effect of nitrogen as well as that of the oxygen. Mahler's formula then became:

$$Q = 14.652\ C + 62,100\ H - 5,400\ (O + N)$$

Where Q equals calorific value of coal,

14.652 = constant value of carbon
62,100 = " " hydrogen
5,400 = " neutralizing effect of oxygen, less heat formed by formation of nitric acid.
$(N_2O_5 + H_2O)$ †

Both of these formulas are based upon an elementary analysis, which is difficult to make, and will give an inaccurate result, unless conducted by a chemist, experienced in this class of work. Consequently we must look for a formula constructed on the basis of a proximate analysis. An elementary analysis of coal is a definition used when it is understood that the whole of the elements composing the coal are determined and separately enumerated. A proximate analysis determines the moisture, volatile combustible matter, fixed carbon, and ash. The volatile combustible may consist of several elements, but is chiefly composed of carbon and hydrogen in combination as "hydro-carbons." This carbon is hereafter usually referred to as volatile carbon, and the carbon remaining in the free or solid state is referred to as fixed carbon. For example, the coke from gas works contains fixed carbon plus ash.

M. E. Goutal published in Progressive Age, Jan. 15, 1897, the following formula:

$$Q = 14670\ F\ C + A \times \text{volatile matter}$$

when Q equals calorific value of coal

14670 = constant heating power of fixed carbon,
A = 23400 when volatile matter equals from 2 per cent. to 15 per cent. of total combustible.
A = 18000 when volatile matter equals from 15 per cent. to 30 per cent of total combustible
A = 17100 when volatile matter equals from 30 per cent. to 35 per cent. of total combustible.
A = 16200 when volatile matter equals from 35 per cent. to 40 per cent of total combustible.

This formula may be taken as useful for the calorimetric value from a proximate analysis of coals of an anthracite, semi-bituminous and bituminous nature, but should not be used in cases where the volatile matter exceeds 35 per cent. of total combustible.

Up to this point I have dealt entirely with the estimation of the actual calorimetric value of coals. This, however, does not give us the information we require as engineers. Experience teaches us that there is often a wide difference between the industrial value of bituminous and anthracite coals, owing apparently to the increased percentage of volatile matter in bituminous varieties. A review of Mahler's calorimetric tests shows the interesting fact that the total calorimetric values of coals vary but little, and that a decrease of fixed carbon does not reduce the heating power of the coal in proportion to the increase of volatile combustible matter, while on the other hand repeated tests prove that the industrial value of coals decreases almost in the same proportion that volatile combustible increases.

We can safely take it as an established fact that the heating power of fixed carbon will remain constant. The same can be said of hydrogen in the absence of oxygen in the combustible, and the heating value of the hydrogen in the combustible will decrease in proportion to the increased percentage of oxygen within the combustible. Both Dulong and Mahler recognize this fact, and construct their formula accordingly. The actual calorific value of coals decreases in nearly the same proportion as the neutralizing effect of the oxygen on the hydrogen increases, and that the industrial heating value of the coals under the boiler decreases as the proportion of volatile carbon increases. We have this strongly exemplified in our daily practice. It requires but ordinary observation for us to readily see that anthracite coals produce practically no smoke, semi-bituminous coals very little, while bituminous coals produce dense, black clouds of smoke, varying in density and volume according to the quantity and composition of the volatile combustible matter in our fuel.

It has been said that the industrial value of a coal for steam-making purposes is practically fixed by the percentage of fixed carbon in the fuel, but we cannot take this method of determination as a permanent basis for calculation with any degree of accuracy. It has been established fairly satisfactorily, however, that volatile matter of similar composition will give off like quantities of heat. The adoption of the principles underlying Goutal's formula, and multiplying by the average percentage of efficiency of the various classes of coals for industrial steam-making purposes, as determined by Schurer-Kestner on European coals and Johnston on American coals, leads me to the belief that a formula constructed as follows will be of especial

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*Abstract of a paper read before the Canadian Electrical Association.

† $N_2O_5 + H_2O = 2\ HNO_3$. The calorific value of 1 lb. nitric acid equals 187.79 B.T.U.