and substitute $l + \frac{8S_1^2}{3l}$ for L_1 we have

$$P_1 = P_0 + aE\left[\frac{8S_1^2}{3lL_0} + \frac{l}{L_0} - 1 - \alpha t\right] \quad - \quad - \quad (5)$$

which is the equation used for Charts I. and II. Chart I. is for copper wire and Chart II. for aluminum. Substituting the numerical values in above equation and letting

$L_0 = l + \frac{8S_0^2}{3l}$, we obtain

$$P_1 = 5{,}900 + 23.239\,S_1^2 - 4{,}321 - 30.16\,t$$

or $$P_1 = 23.239\,S_1^2 + 1{,}580 - 30.16\,t$$

Chart I. is constructed from Tables III. and IV., and Chart II. from Tables V. and VI., using equations 4 and 5.

Comparing results of equations 3 and 5, it is seen that no appreciable error is introduced by adopting equation 5.

Tables V. and VI. are for aluminum wire. Size, weight, etc., are printed on Chart II.

The boundaries of the shaded area are the limitations to which the sag and the tension are confined. Since max. loading is specified at 0° F., the curve w_0 could not extend further to the left of the temperature curve of 0°, accounting for the edge chipped off in the left-hand upper corner. The ice limit at 32° F. shows the ice loading curves running outside along the 30° curve down to the w_2 loading curve. From there it runs along the latter curve to 60°, where a maximum wind of 15 lbs. is liable to occur. From here the line runs to the intersection of the w_1 curve with the 120° curve, *i.e.*, highest temperature with no ice and wind.

It is to be noticed from Chart I. that the maximum sag does not occur at the highest temperature, but at 30° with a maximum loading. These curves show very plainly what effect the temperature and the loading has upon the tension and the sag of the wire.

In Chart I. it is seen that a change in loading affects the tension more than the sag, while a temperature change has an equal effect on tension and sag. In Chart II. a change in loading is affecting the tension far more than the sag and a change in temperature has a greater effect upon the sag than the tension, especially noticeable with the w_1 curve.

[This article deals with spans of 600 feet only; in a later article Mr. Maerker will extend the information to include spans ranging from 200 to 1,000 feet.—EDITOR.]

NORTHERN WATER-POWERS.

The statement is sometimes made by the uninitiated that the water powers north of the settled parts of our Dominion are of little value. The existence of numerous falls and rapids in these parts is not denied, but the argument is advanced that the temperature and other climatic conditions existing where these falls and rapids are situated will prevent their utilization. As a direct contradiction to the above assertion, we need only turn to Norway, the latitude of which is about the same as that of the Yukon and where climatic conditions are similar to those of northern Canada. In size, Norway is only slightly larger than our Maritime Provinces, and yet we find their water-power plants with a total capacity of over 1,500,000 h.p., either in actual operation or in course of construction. Hydro-electric stations of considerable size have been constructed in different parts of that country. Many of the smaller ones have been erected for municipal use; but the larger ones are for the electro-chemical industry, in which a main factor of success is cheap and plentified electric power.

AMERICAN PIG-IRON, ROLLED IRON AND STEEL.

The official statistics of American pig-iron production in the first half of 1914 make the following comparisons, in tons of 2,240 lbs.:—

	First half.	Second half.	Year.
1911	11,666,996	11,982,551	23,649,[illegible]47
1912	14,072,274	15,654,623	29,726,937
1913	16,488,602	14,477,550	30,966,152
1914	12,536,094	....	....

Thus there was a decrease of 24 per cent. from the tonnage in the best half-year—the first half of 1913. An interesting feature in the statistics is that while the total production greatly decreased, the production of foundry iron was larger in the first half of this year than in the second half of last year. The explanation probably is that too much foundry iron was made in the first half of last year, while in the second half the stocks were liquidated, with unusually light production, and production this year returned to normal.

The production of rolled iron and steel in 1913 has just been officially reported, and we include in the table below the production of steel ingots, already reported for 1913:—

	Total rolled. Tons.	Rolled iron. Tons.	Rolled steel. Tons.	Steel ingots. Tons.
1911	19,039,171	1,460,615	17,578,556	23,029,479
1912	24,656,841	1,637,582	23,019,259	30,284,682
1913	24,791,243	1,678,257	23,112,986	30,280,130

The rolled material is reported in the form in which it suffered its last hot rolling, the material of course being sheared or cropped thereafter. Thus no billets or sheet bars are included, except those exported, plus rolled forging billets, while rods and skelp are returned as such, and black-plates rather than tinplates are included.

In the past two years the difference between steel ingots and rolled steel has averaged about 7,200,000 tons. A small part of this difference was absolutely lost, but the great bulk of the difference represented new scrap. In addition, there is new scrap produced in fabrication. A small tonnage of sheet mill scrap is used in charcoal forges, but in general there is indicated a supply of about 7,500,000 tons annually, which went to the open-hearth steel works, thus constituting 35 per cent. of the production of 21,599,931 tons of open-hearth steel ingots and castings. The production of basic pig-iron in 1913 was 12,500,000 tons, while there was perhaps 750,000 tons of Bessemer and low-phosphorus iron used in the acid open-hearth steel process. With these figures available, it is evident that the consumption of old scrap in the open-hearth process is really not large.

It is stated by Mr. J. H. Plummer, president of the Dominion Steel Works at Sydney, N.S., that indications point to a speedy resumption of operations of some of the mills of the works. Orders have already been received from England for 2,000 tons of nails and 2,000 tons of wire rods, and negotiations are pending regarding an order for rails.

Although the production of coal in North Dakota in 1913 was only 495,320 short tons, valued at $750,652, some interesting facts regarding the possibilities of the vast deposits which underlie the state are shown in a statement by E. W. Parker just made public by the United States Geological Survey. All the present mineral fuel produced in North Dakota is brown coal, or lignite. Considerable areas of sub-bituminous coal of usable quality and workable thickness are believed to underlie portions of the lignite areas, but no attempt to exploit the sub-bituminous coals has been made. At present the lignite is used chiefly for domestic purposes, but with proper equipment it can be used with satisfaction as a boiler fuel. A convincing example of what may be accomplished with lignite for such use is presented by the irrigation plant of the United States reclamation service at Williston. The lignite used here is taken from the only coal mine owned and operated by the Government. As the gas-producer and internal-combustion engines in large units come into more general use in the West, as they are rapidly doing in the East, the lignites of North Dakota will be recognized as possessing great potentialities in the settlement and economic development of the state. Experiments also show that lignite can be successfully briquetted, after which it stands transportation well and its heat value is increased 50 to 70 per cent.