by friction, and will be affected therefore by the character of the surfaces over which it has to pass, which may be rough, smooth, or irregular. It will follow, therefore, that other things being the same, greater velocities will be attained at higher altitudes than at low ones, the wind at higher altitudes being further removed from retardation by friction.

Though we are of opinion that no bridge or viaduct is likely to be built in such a situation as to expose it to wind pressures equal to those which have been occasionally indicated by the disc on the Bidston Observatory, yet even if that were possible, a bridge or viaduct constructed according to the rules we have given would not be subjected to strains nearly equal to its theoretical strength.

On the other hand, there will be many structures of small altitude or in sheltered situations which never can be exposed to the wind pressure we have assumed, and where the application of the rules we have given would require modification.

Some modification of the rules may also be required in the case of suspension or other bridges of very large span, but such cases will be of rare occurrence, and we recommend that they should be specially considered when they arise.

Additional clause proposed to be added by Sir W. S. Armstrong and Prof. G. G. Stokes.

The evidence before us does not enable us to judge as to the lateral extent of the extremely high pressures occasionally recorded by anemometers, and we think it desirable that experiments should be made to determine this question. If the lateral extent of exceptionally heavy gusts should prove to be very small, it would become a question whether some relaxation might not be permitted in the requirements of this Report.

Method of deducing the Maximum Pressure of the Wind during a storm from the maximum run of wind in any one hour during the same storm.

In order to deduce the maximum pressures from the maximum runs of the wind in any one hour it is necessary to have recourse to some good station where both of these sets of quantities have been measured. The station selected for the formation of such a table is the Bidston Observatory. This station is very suitable, both from the wide range of the velocities and pressure experienced, and from the care and order with which the observations have been recorded and published. The table has been formed from the published results of the Bidston observations from January 1st 1870, to December 31st 1877. The method of forming the table was as follows :—

As the object of the table was to deal with the higher velocities and pressures of the wind, no notice was taken of maximum hourly runs of the wind smaller than 35 miles in an hour. A first subsidiary table was then formed of all the maximum hourly runs of the wind lying between 35 and 45 miles in an hour with the maximum pressures corresponding . these were respectively added up and an average result obtained of a maximum pressure of 14·7 lbs per square foot for a maximum hourly run of the wind of 40 miles. A second subsidiary table was then formed of all the maximum hourly runs of the wind lying between 45 and 55 miles in an hour with the maximum pressure corresponding, and an average result obtained as before. A third subsidiary table was then formed of all the maximum hourly runs of the wind being between 55 and 65 miles in an hour with the maximum pressures corresponding. And so on to the highest velocities registered. The results obtained in this manner were as follows :—

Maximum Hourly run of the Wind in Miles.	Maximum Pressure in lbs. on the sq. ft.
40	14·7
50	23·7
60	33·9
70	48·0
80	65·5

On an examination of the above figures it is seen that the pressures are very near proportional to the figures of the velocities in every case, and that the simple formula $\frac{V^2}{100} = P$ will serve with tolerable accuracy as the basis for the computation of a table connecting the maximum run of the wind in miles in any one hour (V) with the maximum pressure in lbs. on the square foot (P) at any time during the storm to which (V) refers.

NOTE.—Since the erection of the first viaducts on high piles in France it has been customary to adopt the following wind pressures in the calculations :—150 kilogrammes per square metre when a train is supposed to pass over the viaduct without a risk of being thrown off the rails, 270 or 275 kilogrammes per square metre for the bridge or viaduct without any rolling load.

These figures correspond to about 30·8 lbs. per square foot in the first case, and 56·4 lbs. per square foot in the second case.

CHARCOAL AS A FUEL FOR METALLURGICAL PROCESSES.[‡]

BY JOHN BIRKINBINE, PHILADELPHIA.

The great iron industry of the United States, and, in fact, of the world, was established with charcoal as fuel. Long before the value of mineral coal was recognized, the carbonization of wood was carried on in connection with various metallurgical processes, but at the present time we look upon establishments using charcoal as the remnant of a former greatness, and are apt to sympathize with the operators because they have no other fuel to depend upon. In the iron industry there are now a number of works consuming charcoal which are believed to exist only because some of our ancestors erected them in particular locations. With but few exceptions, however, these locations are found to be advantageous, both an account of a good wood supply and the existence of remarkable beds of iron ore Constructed at a time when transportation facilities were limited, a majority of such plants have no railroad connections, but some which have been remodelled and operated in the light of present knowledge are very successful ventures.

It is proper, in view of the prevalent opinion concerning the early abandonment of charcoal as a metallurgical fuel, that before the processes of manufacture are considered some idea as to the quantity consumed be obtained, for, while in many locations the denudation of forests fixes a limit to the manufacture of charcoal, and in other instances a wilful waste destroys what might be a permanent supply of wood, the amount and value of charcoal used is not generally appreciated.

Charcoal at present produces 18 per cent. of all the pig iron made in the country. In the year 1881, 638,838 net tons of pig iron and 84,606 net tons of blooms and billets, a total of 723,444 net tons, were made with this fuel, consuming about 1,000,000 net tons of it. Never in the history of the iron trade have so great quantities both of pig iron and blooms been made with charcoal as fuel, and it is probable that the product of 1882 will considerably exceed that of 1881. The world's yearly production of charcoal pig iron is nearly 2,000,000 gross tons.

If to the amount of this fuel used at iron works, we could add that consumed in the various smelting works of the silver and other metallurgical industries, the total annual consumption of charcoal in the United States would be found to approximate 2,000,000 net tons. This, therefore, establishes the importance of considering this fuel, so far as quantity is concerned, and the quality may now be investigated.

Analysts tell us that average wood is composed of 40 per cent of carbon, 20 per cent. of water, and 20 per cent. of hydrogen and oxygen, in proportions closely approximating those in which they form water. These even percentages are affected by small quantities of ash, and by special compounds differing in various woods.

The following analyses of wood and charcoal will be of interest.

Analyses of Dried Woods. By M. Eugene Chevandier.

Woods.	Composition.				
	Carbon.	Hydro.	Oxygen.	Nitrogen.	Ash.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Beech	49.36	6.01	42.69	0.91	1.00
Oak	49.64	5.92	41.16	1.29	1.97
Birch	50.20	6.20	41.62	1.15	0.81
Poplar	49.37	6.21	41.60	0.96	1.86
Willow	49.96	5.96	39.56	0.96	3.37
Average	49.70	6.06	41.33	1.05	1.80

[‡] A paper read before the American Inst. of Mining Engineers.