gines made as high as 22 revolutions, and gave an average of 19 with 13 inches of steam, cutting off at half-stroke. The engines are fitted with Sickle's adjustable cut-off, which gave much satisfaction.

On the trip to Charleston, she made the run under steam, to Cape Hatteras, in 27 hours, while from there to Charleston Bar, she was 51 hours, caused by a severe gale of wind ahead, the severity of which may be judged when, during its continuance, a speed of 4 miles per hour was the most that could be obtained, carrying 16 inches of steam and working full stroke. The "Southerner," bound from Charleston to New York, laid by 24 hours behind her time, although the wind would have been with her.

The "Philadelphia" is the first side wheel sea steamer built at this port, and her builders may well be proud of their success; she will give them credit wherever she may go. If our merchants had a portion of that enterprise which distinguishes our sister city, New York, the time would soon come when we would have regular lines to Charleston, Havana, New Orleans, Liverpool, and Havre. Until they attempt to divert the stream, they must be satisfied with such trade as may happen to fall to their share.

B.

On a Formula for Calculating the Expansion of Liquids by Heat. By

WILLIAM JOHN MACQUORN RANKINE, ESQ., *Civ. Eng.**

Having been lately much engaged in researches involving the comparative volumes of liquids at various temperatures, I have found the following formula very useful:

$$\text{Log. } V = Bt + \frac{C}{t} - A$$

Log. V represents the common logarithm of the volume of a given mass of liquid, as compared with its volume at a certain standard temperature, which, for water, is the temperature of its maximum density, or 4°·1 centigrade, and for other liquids 0° centigrade.

t is the temperature measured from the absolute zero mentioned in my paper on the Elasticity of Vapors, in the Edinburgh New Philosophical Journal, for July, 1849, and is found by adding 274°·6 to the temperature according to the centigrade scale.

A, B, and C, are three constants, depending on the nature of the liquid, whose values for the centigrade scale, corresponding to water, mercury, alcohol, and sulphuret of carbon, are given below.

	A.	Log. B.	Log. C.
Water,	0·4414907	4·8987546	1·7890286
Mercury,	0·0229130	5·9048766	1·3703897
Alcohol,	0·2615033	4·8414452	1·2893056
Sulphuret of carbon,	0·2540074	4·8483872	1·2192054

The data from which the constants have been computed have been taken from the following authorities:—for water, from the experiments of Hallström; for mercury, from those of Regnault; and for alcohol and sulphuret.

* From the Edinburgh New Philosophical Journal, for October, 1849.

of carbon, from those of Gay-Lussac. As the experiments of M. Gay-Lussac give only the apparent expansion of the liquids in glass, I have assumed, in order to calculate the true expansion, that the dilatation of the glass used by him was $\cdot 0000258$ of its volume for each centigrade degree. This is very nearly the mean dilatation of the different kinds of glass. M. Regnault has shewn that, according to the composition and treatment of glass, the coefficient varies between the limits $\cdot 000022$ and $\cdot 000028$.

Annexed are given tables of comparison between the results of the formula and those of experiment. The data from which the constants were calculated are marked with asterisks.

The table for water shews that, between 0° and 30° centigrade, the formula agrees closely with the experiments of Hallström, and that from 30° to 100° its results lie between those of the experiments of Gay-Lussac and Deluc.

The experiments of Gay-Lussac originally gave the apparent volume of water in glass, as compared with that at 100° . They have been reduced to the unit of minimum volume by means of Hallström's value of the expansion between $4^{\circ}\cdot 1$ and 30° , and the coefficient of the expansion of glass already mentioned.

In the fifth column of the table of comparison for mercury, it is stated which of the experimental results were taken from M. Regnault's own measurements on the curve, representing the mean results of his experiments, and which from his tables of actual experiments, distinguishing the series.

In the experimental results for alcohol and sulphuret of carbon, the respective units of volume are the volumes of those liquids at their boiling points, and the volumes given by the formula have been reduced to the same units.

Expansion of Water.

Temperature on the Centigrade Scale.	Volume as compared with that at $4^{\circ}\cdot 1$ C. according to		Difference between Calculation and Experiment.	Authorities for the Experiments.
	the Formula.	the Experiments.		
0°	1-0001120	1-0001082	+ $\cdot 0000038$	Hallström.
* $4\cdot 1$	1-0000000	1-0000000	$\cdot 0000000$	Do.
10	1-0002234	1-0002200	+ $\cdot 0000034$	Do.
20	1-0015668	1-0015490	+ $\cdot 0000178$	Do.
*30	1-0040245	1-0040245	$\cdot 0000000$	Do.
....		1-0041489	— $\cdot 0001224$	Deluc.
40	1-0075000	1-0074800	+ $\cdot 0000200$	Gay-Lussac.
....		1-0077400	— $\cdot 0002400$	Deluc.
60	1-0171800	1-0167000	+ $\cdot 0004800$	Gay-Lussac.
....		1-0177300	— $\cdot 0005500$	Deluc.
80	1-0300700	1-0286500	+ $\cdot 0014200$	Gay-Lussac.
....		1-0309200	— $\cdot 0008500$	Deluc.
100	1-0457900	1-0429000	+ $\cdot 0028900$	Gay-Lussac.
....		1-0466400	— $\cdot 0008500$	Deluc.

Expansion of Mercury.

Temperature on the Centigrade Scale.	Volume as compared with that at 0° C. according to		Difference between Calculation and Experiment.	Remarks.
	the Formula.	M. Regnault's Experiments.		
* 0°	1.000000	1.000000	·000000	Curve.
90.22	1.016333	1.016361	— ·000028	Series I.
100.00	1.018134	1.018153	— ·000019	Curve.
100.52	1.018230	1.018267	— ·000037	Series I.
* 150.00	1.027419	1.027419	·000000	Curve.
198.79	1.036597	1.036468	+ ·000129	Series II.
205.07	1.037786	1.037805	— ·000019	Series IV.
205.57	1.037905	1.037910	— ·000005	Series III.
* 300.00	1.055973	1.055973	·000000	Curve.

Expansion of Alcohol.

Temperature on the Centigrade Scale.	Volume as compared with that at 78°·41 C. according to		Difference between Calculation and Experiment.
	the Formula.	M. Gay-Lussac's Experiments.	
3.41	·91795	·91796	— ·00001
* 18.41	·93269	·93269	·00000
33.41	·94803	·94799	+ ·00004
* 48.41	·96449	·96449	·00000
63.41	·98183	·98210	— ·00027
* 78.41	1.00000	1.00000	·00000

Expansion of Sulphuret of Carbon.

Temperature on the Centigrade Scale.	Volume as compared with that at 46°·60 C. according to		Difference between Calculation and Experiment.
	the Formula.	M. Gay-Lussac's Experiments.	
* — 13.40	·93224	·93224	·00000
+ 1.60	·94768	·94776	— ·00008
* 16.60	·96417	·96417	·00000
31.60	·98163	·98163	·00000
* 46.60	1.00000	1.00000	·00000

*Coals for the Steam Navy.**

We have received the second report on this interesting and important subject, by Sir Henry De la Beche, C. B., F. R. S., and Dr. Lyon Playfair, F. R. S., just presented to both Houses of Parliament. These reports embody the results of a long series of experiments, made at the request of the Lords of the Admiralty, at the laboratory of the Museum of Economic Geology, on a large number of specimens of coal from all parts of the kingdom, and on some foreign coal, on some manufactured fuels, and on coke. The main points of inquiry have been—the evaporative value of the fuel, its mechanical structure, bulk or space occupied in stowage, and the chemical construction of the fuels experimented on.

We are informed in the report that each coal was subjected to experiment for three successive days, the draft being differently arranged for each day; by these means it became easy to ascertain when the gases escaping from the coals were most economically consumed. The mean of the three days gives more correctly the average evaporative value in steam vessels, where the exact draft depends in a great measure on circumstances over which the engineer has little control. The coals most liable to be influenced by different adjustments for the admission of air are those which, from their bituminous characters, are most apt to generate a large quantity of gaseous products on the first application of heat, such as those from the Northumberland, Durham, and Lancashire coal fields; and these, under different areas for the admission of air, vary much more than with the less bituminous kinds of the South Wales field; and in the highly gas-giving coals, as the Cannell coal of Wigan, it was found necessary to admit air behind the bridge, to complete the combustion of the escaping gases.

In experiments to ascertain how far mixtures of anthracite with bituminous coals were likely to prove advantageous in the manufacture of artificial fuel, the apparatus patented by Mr. Warlich, and now used in the dockyards, was placed at their disposal, and the various mixtures were tried under the boiler. It was, however, ascertained that the advantages of these additions was not such as to recommend their adoption. The cementing tar, although partially carbonized by the heat of the coking ovens, was so much more combustible than the dense and difficultly burning anthracite, that the latter remained unconsumed after the combustion of the former, accumulating on the bars in a state of powder, obstructing the draft, or falling through the grate and escaping combustion.

The coals on which experiments were made were selected with the greatest care; inquiries were made at the different ports, as to the kind of coal exported for steam purposes, information from steam navigation companies was obtained, and the local character of the fuel ascertained. Circulars were then forwarded to the owners of such coals, explaining the object, and requesting them to furnish two tons for experiment. In most cases they were sent; some, however, did not comply, and it is therefore probable that many more excellent varieties exist in the several coal fields than are given in Messrs. De la Beche and Playfair's reports. We select from the tables a few of the experiments made, taking the best of each

* From the London Mining Journal, No. 727.

district, the following twelve of which will give an accurate idea of the method adopted of showing their relative values:—

Names of Coals.	Space occupied by a ton.	Weight of a cubic foot.	Water evapor'd by a lb. of coal.	Water evapor'd by a cu. ft.
WALES.	cubic feet.	lbs.	lbs.	lbs.
Thomas's Merthyr,	42·26	53·0	10·16	538·48
Nixon's Merthyr,	43·32	51·7	9·96	514·93
Gadley, 9-feet seam,	40·87	54·8	9·56	523·88
Neath Abbey,	37·77	59·3	9·38	556·23
LANCASHIRE.				
Balcarras Arley,	44·35	50·5	8·83	445·91
Blackley Hurst,	46·66	48·0	8·81	422·88
Blackbrook Rushy Park,	40·50	55·3	8·02	443·50
Laffak Rushy Park,	42·58	52·6	7·98	419·74
NEWCASTLE.				
Andrew's House Tanfield,	42·99	52·1	9·39	489·21
Newcastle Hartley,	44·35	50·5	8·23	415·61
Hedley's Hartley,	43·07	52·0	8·16	424·32
Hasting's Hartley,	46·18	48·5	7·77	376·84

From this table, the twelve descriptions of coal which we select as a specimen, it will be seen that the South Wales coal field produces the best steam coal. It will also be seen that the coal, 1 lb. of which evaporates the most water, is not, as a matter of course, the most economical. For instance, 1 lb. of Thomas's Merthyr evaporates 10·16 lbs. of water, but a cubic foot, weighing only 53·0 lbs., evaporates 538·48 lbs.; while the Neath Abbey, although 1 lb. evaporates only 9·38 lbs. of water, a cubic foot weighs 59·3 lbs. and evaporates 556·23 lbs.; consequently, in evaporating powers, in proportion to stowage, it is the most economical. The same calculations can be made with the others. The following are the chemical constituents of these twelve descriptions of coal:—

Names of Coals.	Specific Gravity.	Carbon.	Hydro.	Nitro.	Sulphur.	Oxygen.	Ash.
WALES.							
Thomas's Merthyr,	1·30	90·12	4·33	1·00	0·85	2·02	1·68
Nixon's Merthyr,	1·31	90·27	4·12	0·63	1·20	2·53	1·25
Gadley, 9-feet seam,	1·33	86·18	4·31	1·09	0·87	2·21	5·34
Neath Abbey,	1·31	89·04	5·05	1·07	1·60	—	3·55
LANCASHIRE.							
Balcarras Arley,	1·26	83·54	5·24	0·98	1·05	5·87	3·32
Blackley Hurst,	1·26	82·01	5·55	1·68	1·43	5·28	4·05
Blackbrook Rushy Park,	1·27	81·16	5·99	1·35	1·62	7·20	2·68
Laffak Rushy Park,	1·35	80·47	5·72	1·27	1·39	8·33	2·82
NEWCASTLE.							
Andrew's House Tanfield,	1·26	85·58	5·31	1·26	1·32	4·39	2·14
Newcastle Hartley,	1·29	81·81	5·50	1·28	1·69	2·58	7·14
Hedley's Hartley,	1·31	80·26	5·28	1·16	1·78	2·40	9·12
Hasting's Hartley,	1·25	82·24	5·42	1·61	1·35	6·44	2·94

A third report will be published, including the remainder of the coals thought necessary to examine; the investigations will continue to be con-

ducted, as before, under the superintendence of Messrs. De la Beche and Playfair, the actual experiments being entrusted to Mr. J. Arthur Phillips. In an appendix to the report, are given the details of each experiment during the three days, the situation, depth, local position, and geological character of each colliery, with copies of the certificates of the owners or agents of the coals under notice, as to their genuineness. The whole forms a most interesting document to those connected with the coal districts, and most important to the Government and steam vessel companies, as guiding them in their choice of a fuel, which, from practical experience, is known will prove the most safe and economical in all long voyages.

On Carbonate of Lime as an Ingredient of Sea Water. By JOHN DAVY, M. D., F. R. S. Lond. & Edin., &c.*

The manner in which limestone cliffs rising above deep water are worn by the action of the sea, as it were by a weak acid, such as we know it contains, viz., the carbonic—the manner, further, in which the sand on low shores, where the waves break, becomes consolidated, converted into sandstone, by the deposition of carbonate of lime from sea water, owing to the escape of carbonic acid gas,—are facts clearly proving that carbonate of lime is, as a constituent of sea water, neither rare of occurrence, nor unimportant in the economy of nature, inasmuch as the phenomena alluded to,—the one destructive, the other restorative,—have been observed in most parts of our globe where geological inquiry has been instituted.

Apart from the economy of nature, the subject under consideration is not without interest in another relation,—I allude to steam navigation. The boilers of sea-going steam vessels are liable to suffer from an incrustation of solid matter firmly adhering, and with difficulty detached, liable to be formed on their inside, owing to a deposition which takes place from the salt water used for the production of steam. On one occasion that I examined a portion of such an incrustation taken from the boiler of the "Conway," a vessel belonging to the West Indian Steam Packet Company, I found it to consist principally of sulphate of lime, and to contain a small proportion only of carbonate of lime. This vessel had been employed previously in transatlantic voyages, and also in intercolonial ones, plying between Bermudas and the Island of St. Thomas, and in the Caribbean Sea and the Gulf of Mexico.

The composition of this incrustation, like the preceding results, would seem to denote, if any satisfactory inference may be drawn from it, that carbonate of lime is in small proportion in deep water distant from land, and that sulphate of lime is commonly more abundant. The results of a few trials I have made, whilst rather confirmatory of this conclusion, showed marked differences as to the proportion of sulphate of lime in sea water in different situations. That from Carlisle Bay was found to contain 11·3 per 10,000. A specimen taken up in lat. 29° 19' and long. 50° 45', yielded about 2 per 10,000, with a trace of carbonate of lime. A specimen taken up off Fayal yielded about 9 per 10,000, also with a trace of carbonate of lime. One taken up off Portland Head, about fifteen miles

* From the London, Edinburgh, and Dublin Philosophical Magazine, for September, 1849.