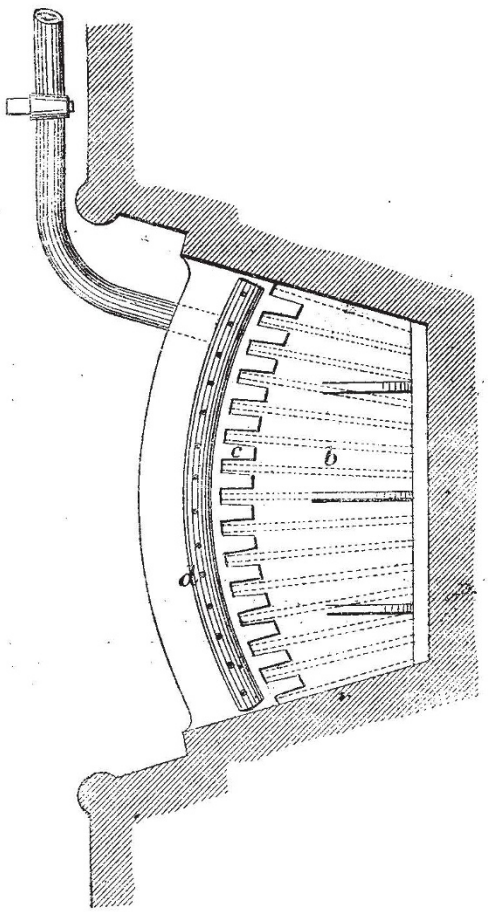
grate, viz.:—(1) the gas-pipe (*d*) with holes of about $\frac{1}{16}$ inch diameter, 1·5 inch apart along the upper side inclining inward, and (2) an angular plate (*a*) of either cast or wrought iron, with projecting ribs (*b*) extending from front to back on its underside, either cast with or riveted to the same, presenting a considerable area, and serving the double purpose of supporting the additional part on the existing grate, and of providing the heating-surface produced by the copper plate and frill-work in my first arrangement. In using iron instead of copper it is necessary however to increase the thickness of these plates and ribs in the inverse ratio of the conductivity of the two metals, or as regards the back plate, from $\frac{1}{4}$ inch to $\frac{5}{8}$ inch.

The arrangement will be rendered more perfect by the use of the bent plate fastened to the lower grate bar, which directs the incoming air upon the heating-surfaces.

The front edge of the horizontal plate has vandyked openings (*c*), so as to form a narrow grating, through which the small quan-




tity of ashes that will be produced by combustion of the coke and anthracite in the front part of the grate discharge themselves down the incline towards the back of the hearth, where an open ash-pan may be placed for their reception.

In adapting the arrangement to new grates, the horizontal grating had better be dispensed with, and the casting with its lower ribs extended downwards, so as to find its fixed support between the back of the fireplace and the inclined deflector plate.

Mr. Fletcher speaks of the large amount of ashes that would be produced, but this amount can surely not be as great as in the case of a coal fire, seeing that the consumption of solid fuel is reduced to less than one-half, of which nearly one-half is anthracite, a fuel remarkably free from ashes. Neither do I participate in Mr. Fletcher's fear regarding opposition on the part of housemaids, except it be from an apprehension on their part that, with Othello's and the chimney-sweeps', their "occupation be gone."

The tendency of grate-builders of the present day, and also of your correspondents, appears to be to look for economy to brick-linings, which no doubt have the effect of producing hot radiating surfaces. I maintain however that such radiation is obtained at too great a cost of fuel, and that superior economical results will, on the contrary, be attained by abstracting the heat from the back of the fire, and concentrating it upon the purely carbonaceous material in front of the same.

To illustrate my reasoning I may here refer to an experiment which can easily be made of throwing a shovelful of bituminous coal into a steel-melting furnace; the result is an instantaneous dispersion of the coal, accompanied with a powerful refrigerative action on the furnace. In constructing gas-producers I take advantage of hot walls to turn solid into gaseous fuel, and a fireplace with hot brick bottom and sides is very much in the condition of a good gas-producer, giving out radiant heat no doubt, but combined with rapid distillation of combustible gases into the chimney. This action is made apparent in placing on the fuel towards the back of such a grate when in full glow a piece of wood, which will be seen to dwindle away rapidly without giving rise to flame, the atmosphere immediately over the glowing fuel being essentially a reducing one.

In my grate the heat, on the contrary, is confined to the coke immediately behind the bars, in contact with the heating gas flames and with the air of the room flowing in towards the chimney, whereas the coke at the back of the grate remains comparatively cool and unconsumed throughout the day. The cold furnace-back also means a cold chimney, and it is rather remarkable to observe that in the case of the application at my office, a thermometer held high up into the chimney showed a temperature of only 130° F., while the front of the grate was in a high state of incandescence. These, I maintain, are conditions most favourable to economy combined with entire absence of smoke or deleterious gases. C. WILLIAM SIEMENS

12, Queen Anne's Gate, S.W., November 24

## *CURIOUS IMPRESSIONS IN CAMBRIAN SANDSTONE NEAR LOCH MAREE*

IN course of the short excursion to Loch Maree and its neighbourhood, Mr. Walter Carrutliers, of the *Inverness Courier*, happened, on June 13, to light upon an interesting portion of the Cambrian or Torridon Red Sandstone of the district, forming part of the bed of the burn, near Loch Maree Hotel, on which occur what have been called the Victoria Falls, so named from the fact that the Queen visited them. There an exposed surface of the rock about sixteen feet in length, nearly as much in breadth, and almost perfectly level, is marked by several double grooves quite discernible, and each divided by a very thin raised line. These traverse the whole length of the rock in a perfectly straight line, and on both sides of them are roughnesses which, if we could entertain the idea that the grooving had been caused by some living creatures, might be produced by footprints which have been to a great extent obliterated. The impressions were so striking that they immediately suggested a recollection of the footprints discovered in the sandstones of Morayshire and Tarbatness, though there was no other resemblance than their marked character on the broad, flat rock. Having heard that Mr. William Jolly, H.M. Inspector of Schools, was in the neighbourhood, Mr. Carruthers called his attention to the subject, and indicated where he should find the markings. Mr. Jolly was not slow to examine the spot, and he writes to Mr. Carruthers as follows, as given in the *Inverness Courier* of July 1:—

"I found your curious lines without difficulty, guided by your accurate description of their locality. They are assuredly no 'mare's nest,' but *bonâ fide* ancient impressions of some kind, which should receive the attention of geologists, both on their own account and as existing in the second oldest geological formation in Britain, in which, as yet in Scotland, no evidences whatever of organic life have been discovered.

"The lines or bands in question occur in the chocolate-coloured Torridon sandstone, the Cambrian of Murchison and Geikie, which is so well developed around Loch Maree, and rises into the great dome of the Slioch, or the Spear Head, that guards its waters. The most distinct of the impressions consists of two continuous flat bands side by side, 1¼ to 1⅓ inch broad, and about a quarter of an inch deep, running quite straight across the flat layers of sandstone *in situ*, and perfectly distinct for sixteen feet, disappearing on the west side under the superincumbent rock, and broken only where portions of the sandstone have

been weathered out. In some places a third line runs alongside the two, but this is much less distinct and persistent. The double band resembles nothing more nearly than the hollow impression that would be left by double bars of iron placed closely together and neatly inserted in the rock for clasping some structure on it, if the iron were subsequently removed; or, as you suggest, the marks of a gouge driven by a carpenter across a board. The bands, when looked narrowly into, consist of very fine close hair-like lines, continuous and parallel to their sides, resembling very minute striæ left by glaciation, and look as if caused by some object drawn along the original red sand, before it became the present indurated rock.

"A similar double line runs parallel to this one, about two feet lower down, seven feet long, and a third parallel double line on the other or upper side, three feet long, both of the same breadth as the first. Besides those pointed out by you, which occur on the same flat of sandstone, other lines exist farther down, on the other side of the pool below this rocky flat, on a similar bed of sandstone, part of the same layer—one three feet in length, another six feet, running more or less parallel to those above. Indications of others may also be seen, and, no doubt, several more may be discovered on more careful examination.

"What they are I can scarcely even surmise, having seen nothing of the *same* kind elsewhere. They do suggest the possibility of their being the indentations of the caudal appendage of some huge creature, similar to the hollow tail-lines between the footprints on the sandstone at Tarbatness and along the shores of Morayshire—a suggestion strengthened by the fact of the existence, on both sides of the line, of numerous rounded hollow marks, very like the footprints on these reptiliferous rocks, occurring, as in them, at intervals. But the continuous even breadth and square section of the bands would seem to render this impossible. Then they might be the depressions left on the soft sand by the hinder portions of the shell of some large crustacean—a more likely cause, rendered more probable by the existence of very good ripple marks on the same sandstone, in the same and neighbouring layers. The striæ-like lines of which the grooves consist would seem to point to some moving agent, organic or physical. They may, however, be the casts or impressions of some great land reed or sea fucoid, the hair-lines being the marks of the fine structure of its stem or the parallel veins of its leaves. It would be desirable to have the superincumbent layer of rock carefully removed where the bands in question disappear under the upper rock, which might shed some light on the nature of the strange marks. I was sorry I could not spend more time on their examination."

The impressions occur about 300 or 400 yards above the Victoria Falls, and immediately beside the last of three lesser waterfalls on the west side of the stream.

## THE QUANTITIES OF WATER IN GERMAN RIVERS

AN attempt has recently been made by Herr Graeve (*Der Civil-Ingenieur*, 1879, p. 591) to determine the amount of water in German rivers and its apportionment in different seasons, a question very important for navigation, and also of much scientific interest. His research comprehends the chief rivers of Germany, excluding the Danube, which begins to be navigable only outside of Germany, and including the Vistula and the Memel. He first calculated, from the mean heights of water, the quantities of water flowing out per second, and he adds a table in which the amount of outflow is shown in relation to the extent of the corresponding river territory. When the amount of outflow per 100 sq. km. of the region of precipitation is calculated the following values are obtained:—(1) the Rhine at Coblentz above the Moselle mouth delivers per 100 sq. km. of land 1·070 cub. m. of water in a second; (2) the Weser at Minden, 0·826 cub. m.; (3) the Elbe at Sorgau, 0·579; (4) the Elbe at Barby, 0·554; (5) the Oder at Steinau, 0·460; (6) the Oder below the Warta mouth, 0·413; (7) the Warta near its mouth, 0·344; (8) the Vistula at Montau Spitz, 0·538; (9) the Memel at Tilsit, 0·600.

From these numbers it appears (*a*) that the average outflow of different rivers, from equal portions of their territory, differs much more than is usually thought, for in the Middle Rhine it is about three times, in the Middle Weser two and a half times, and in the Middle Elbe, as also in the Lower Vistula and Memel, more than one and a half times as much as in the Lower Warta. On the whole, it decreases from the Rhine to the Warta, and from the latter increases again to the Memel. (*b*) In one and the same river the quantity from equal portions of land seems as a rule to decrease down stream. (*c*) All calculations of quantity of outflow in streams, based merely on extent of the region of precipitation, must as a rule give incorrect results.

It was important to try and determine the relations of the quantity of outflow to the rainfall of the corresponding regions, and Herr Graeve, doing so by a method which he describes, obtained the following percentage numbers, corresponding to the above series of rivers:—(1) = 38·5 per cent.; (2) = 37 p.c.; (3) = 30 p.c.; (4) = 28·5 p.c.; (5) = 27·2 p.c.; (6) = 21·4 p.c.; (7) = 21 p.c.; (8) = 29 p.c.; (9) = 32·5 p.c.

From this the following conclusions (briefly) are drawn:—

(*a*) The percentage proportion of the amount of outflow to the rainfall differs very considerably in these several rivers, though far less than the amount of outflow from equally large regions of these rivers; hence the differences of the latter can be due only in part to differences in the rainfall.

(*b*) The percentage decreases from the Rhine to the Warta, and increases again from the latter to the Memel. In one and the same river a decrease is perceptible down the stream, at least so far as the phenomena in the Oder and the Elbe are general.

(*c*) Since in a mountainous region a greater part of the atmospheric precipitates is carried off by rivers than in the plain, the steady decrease in the percentage proportion of outflow to rainfall in the direction from the Rhine to the Warta must be primarily attributed to the increasing flatness of the region; so too must the decrease of the percentage down stream. The influence of more or less wood on the land could not be precisely determined.

(*d*) The marked increase of the percentage in the direction from the Warta to the Memel cannot be explained by the orographic conditions of the region of precipitation, because this region in the case of the Memel is not at all hilly, and in that of the Vistula only a little more hilly than that of the Warta, but since the amount of the evaporated part of atmospheric precipitates is considerably influenced by the mean temperature of the region of precipitation, and this in the region of the Vistula and the Memel is lower than in that of the Warta, the increase of percentage in question from the Warta to the Memel must mainly be attributed to climatic conditions.

(*e*) While the percentage in question must be chiefly governed by orographic and climatic conditions, there can be no doubt that other factors also act, *e.g.*, the relative amount of moisture in the air, which influences the degree of evaporation, and in general must decrease from the rainy Rhine region to the dry region of the Warta; further, the amount of plantation, which in the regions of the Vistula and Memel is larger than in those of all other German rivers; lastly, the nature of the ground, allowing more or less passage to the precipitates; the influence of all these factors, however, cannot be proved with the same certainty as the orographic and climatic conditions.

A comparison of the amounts of outflow in different years shows that in individual rivers more important differences occur than are generally supposed, that these differences in rivers of different character and unequal force are very different in amount, and that in the same river they decrease down stream.

With regard to the difference in amount of outflow in the various seasons and months, the following average values were obtained. The amount of outflow in winter (from the beginning of November to the end of April) is to that of summer, at the parts of the stream examined, in the Rhine as 1 : 0·922, in the Weser as 1 : 0·434, in the Elbe as 1 : 0·467, in the Oder as 1 : 0·525, and further down stream as 1 : 0·522, in the Vistula as 1 : 0·486, and in the Memel as 1 : 0·389. A better idea of the regularity of the quantities of outflow is given by the relations of these for the dryest and the wettest month of the year; in the case of the Rhine this ratio is 1 : 1·458, in the Weser 1 : 4, in the Elbe 1 : 5·238, in the Oder 1 : 4·5, and further down 1 : 3·68; in the Vistula 1 : 4·19, and in the Memel 1 : 4·51.

The causes of the difference in the ratio of the largest and least monthly amounts of outflow must chiefly be sought in the presence or absence of collecting basins, as also in the orographic and climatic conditions. In the Rhine all those factors combine which affect the regularity of outflow. It possesses in the Swiss lakes large reservoirs; its river-region comprises mountains of various height, and plains, so that the