economize the escape of water in the form of steam, and thereby also economize heat and fuel; also, when fresh water is available to use it as much as possible; and further, to avoid using sea water as much as possible near coasts and in parts of seas where sulphate of lime is most abundant. From the incrustation on the boilers of sea-going steamers, the attention can hardly fail to be directed to that which often forms, to their no small detriment, in the boilers of locomotive railway engines, and of engines employed in mines and in the multifarious works to which steam power is now applied. These incrustations will of necessity be very variable, both in quantity and quality, according to the kind of ingredients held in solution in the water used for generating the steam. Hitherto I have examined two specimens only of incrustations taken from the boilers of locomotive engines, and a single one only from the boiler of a steam engine employed on a mine—a mine in the west of Cornwall. The latter was fibrous, about half an inch thick, and consisted chiefly of sulphate of lime, with a little silica and peroxide of iron, and a trace of fluorine. The former were from one-tenth of an inch in thickness to one inch. They were laminated, of a grey color, and had much the appearance of volcanic tufa; they consisted principally of carbonate and sulphate of lime with a little magnesia, protoxide of iron, silica, and carbonaceous matter—the last two, the silica and carbonaceous matter, probably chiefly derived from the smoke of the engine and the dust in the air. From the engineer's report it would appear that the thinnest—the incrustation of about one-tenth of an inch, had formed in about a week, during which time the locomotive had run about 436 miles, and consumed about 10,900 gallons of water.—*Ibid.*

*On the Value of the Gaseous Escape from the Blast Furnaces at the Ystalyfera Iron Works, in Continuation of a Paper read at the Meeting of the British Association in 1848. By MR. PALMER BUDD.**

Mr. Budd stated that, since the meeting of the Association at Swansea, he had continued, and with increased success, to apply the waste gases that escaped from the top of blast furnaces, to the manufacture of iron; and it was the result of his further experience applied to the whole of his furnaces (nine in number) since that period, that he now wished to submit to the Section. Mr. Budd then referred to his mode of applying the gaseous escape, and said it was well known that there were two descriptions of furnaces used for metallurgic purposes. The one was the blast furnace, into which air was injected, by mechanical means, at a great density, so as to penetrate upwards of 40 feet of dense materials; and the other was the reverberatory furnace, where the fire was produced by means of the draught of a chimney stack. What he had accomplished was by combining these two, so that the gaseous products of the furnace, instead of escaping through the tunnel head, were drawn sideways by a high stack, and passing through the stoves and boilers, leave behind the necessary temperature of the blast and of the steam. In a blast furnace the ores are smelted before the *tuyères* by the conversion of the solid carbon into carbonic acid, which, passing up through the middle region

* From the London Athenæum, for August, 1850.

of the furnace into a bath of carbon, was re-converted into carbonic oxide, capable of combining with a further dose of oxygen. It would be thus seen that the whole of the carbon of the fuel should be present at the top of the furnace in a gaseous form. When the British Association met at Swansea, he had not used the gaseous escape at any great distance from the furnace, his stoves and boilers being very closely contiguous. Further experience, however, had proved that by the aid of a stack at the end of the chain of sufficient dimensions, the gaseous escape from the furnace might be made to travel in the most tortuous directions, descending to the stoves built for heating by the usual fire-places, and traversing the boilers; the only condition absolutely necessary being that there should be an unbroken communication with the high stack at the end, into which the gaseous escape might at last pass, and by which it was drawn forward, instead of passing off wastefully at the tunnel-head. When, however, the draft was carried downward, and to long distances, he had found it necessary to drop into the top of the furnace a hopper or funnel, made of sheet-iron, which acted as a shield at the mouths of the horizontal flues, and prevented them from either being affected by high winds, or from being choked up by materials thrown into the furnace. The reason, no doubt, why this funnel was not applied before was the great apparent temperature at the funnel-head. In practice, however, it was found that until the gaseous escape mingled with the atmosphere, its heating power was not such as to injure sheet iron, or even to make it red-hot. In fact, so long as there was an escape upwards, the iron funnel would not be injured. The damage arose during and after stoppages of the furnace, when the blast was obstructed in its passage upwards by the settlement of the materials in the furnace, so that the atmosphere rushed down to meet the ascending gases, and, of course, caused a very high local temperature. His practice was to exclude the atmospheric air as much as possible. The affinity of the gases for oxygen was so great that the air leakage raised the temperature quite sufficient for safety, whilst the full combustion of the gaseous escape would melt down the bricks in the flues, and destroy the texture of the iron tube. It was not possible for him to say what combinations took place at high temperatures, where carbonic oxide, carbonic acid, hydrogen, and nitrogen, were mixed in such proportions. At any rate, he found a smothered combustion to be the most suitable and economical for the purposes in view. He was happy to say that, at length, the application of the gaseous escape had been tried in Scotland; and that at Dundyvan and elsewhere it was now in successful operation. The peculiar quality of the furnace coal of Scotland being what was called in South Wales "free burning," which, when put into the furnace raw, coked sufficiently in its descent, gave out an enormous escape, so much so that, upon a rough estimate, he calculated that the waste from one furnace in Scotland was sufficient to heat the blast, and to raise the steam for three. With anthracite coal, the minimum effect was obtained, as it was a dense fuel of nearly 95 per cent. of solid carbon; but in Scotland there would be an enormous surplus at the tunnel head. He observed that the saving at the Dundyvan Iron Works was stated to be about $1\frac{1}{4}$ tons for each ton of iron produced. Supposing, therefore, 600,000 tons

of iron to be the produce of Scotland, and supposing the value of the coal used to be 3s. a ton, the saving that would thus be effected on the make of Scotland would amount to 112,500*l.* a year; to which might be added 20,000*l.* a year of saving in wages and repairs, which would make a total saving of 132,500*l.*, or about 4s. 5d. a ton on the produce of Scotland, which on the present price of 44s. per ton, was about 10 per cent. on the value. If the gaseous escape could be extended to the uses of the forge, a further saving of three tons of coal would be effected,—thus making, at least, a saving of 20s. a ton on all the iron manufactured into bars, sheets, and rails.—*Ibid.*

On a Peculiar Form produced in a Diamond when under the influence of the Voltaic Arc. By S. P. GASSIOT.*

M. Jaquelin was the first to show that when the diamond is submitted to the high temperature and influence of the voltaic arc, it quickly becomes converted into a black carbonaceous matter, having all the appearance of coke:—the diamond when in a native state is an insulator or non-conductor of electricity, but when thus changed into coke it becomes an excellent conductor. At the Chemical Section of the British Association, held at Oxford, in 1847, Dr. Faraday exhibited some specimens of the diamond coke which had been forwarded to him by M. Jaquelin, and subsequently, on the 16th of June, 1848, he publicly showed the experiment in London, in the theatre of the Royal Institution. On repeating the experiment a short time since before a few private friends, I obtained a product so totally different from that of M. Jaquelin, that I am induced to bring the subject before this Section, in the anticipation that it may tend to elicit some observations on a phenomenon which at the time attracted the attention of many electricians. The apparatus I used in the experiment consisted of forty series of the usual size of Grove's nitric acid battery,—the terminals were made from two pieces of well burnt box-wood charcoal, that attached to the positive or platinum end of the battery, being formed in the shape of a small cup or crucible, in which the diamond was placed,—to the negative or zinc end of the battery, a piece of the same charcoal (but *pointed*) was attached. The experiment was then made in the same form as described by M. Jaquelin, by first making contact with the two charcoal terminals, then bringing the flame in such a position as to cause it to *surround* the diamond;—in less than one minute the diamond as well as the electrode became in a state of intense ignition. The diamond gradually increased in size, rolling about in the heated crucible, when it suddenly expanded, forcing itself upward on the negative terminal, at which moment I separated the electrodes. The diamond, which was in a state of intense ignition, remained attached to the negative terminal. When cool, it exhibited the same state as it now presents. It was expanded to eight or ten times its original bulk. Instead of becoming a black carbonaceous substance, and a good conductor, it has a vitreous white opaque appearance, and remains a non-conductor. It has also a deep circular cavity

* From the London Athenæum, August, 1850.