Observations on the Circumstances producing Ignition in Charcoal in Atmospheric Temperatures. By Mr. William Hatfield.*

The spontaneous combustion of charcoal under certain circumstances has been long observed, though it has not excited the attention which it merits; nor would it now, perhaps, have possessed much general interest, had it not been for the serious consequences which may result from its occurrence in some

* Abridged from the London and Edinburgh Philosophical Magazine, &c. for July 1833.

situations. As large quantities of charcoal are used in gunpowder manufactories and in other works, its spontaneous combustion in such places would manifestly endanger, not only much property, but a number of lives. The subject is, therefore, worthy of attention; since, if the cause could be assigned, the danger might be averted.

If 20 or 30 cwt. of charcoal, in a state of minute division, be put together in a heap and left undisturbed, spontaneous combustion generally ensues. The fact has been long known;—but no investigation, with the exception of that to which I have referred, has, to my knowledge, been instituted.

Spontaneous combustion does not often take place in what the manufacturers call *round charcoal*; that is to say, in fragments of considerable size; unless when large quantities are laid together, under which circumstances it is not very unusual. In this case the phænomenon is generally ascribed by the makers to the charcoal not having been sufficiently cooled after its production. This reason is, no doubt, sometimes, but not always, correct. On the contrary, I have known charcoal, which has been freely exposed to the atmosphere, when, though closely watched, it presented in the interval no appearance of the kind.

In one case charcoal was loaded in Manchester and conveyed by a cart to a distance of twenty miles. No combustion appeared during the loading, nor could the carter, though he carefully examined, perceive any indication of it, when, at 11 o'clock, he left it for the night. At 5 o'clock on the following morning, however, he was called up to save his cart, which he found on fire and nearly consumed.

This charcoal had been made three days before the accident. Care had been taken that it should be sufficiently cool before it was loaded, as a similar event had previously occurred to the same parties, who ascribed it to the charcoal being too new, when, as they conceived, fire lurked in it unextinguished.

These two instances may, I should think, be accounted for in the following manner:—

When large quantities of charcoal, as in the first example, are laid together, it is evident that the lower parts must be exposed to pressure, and, by the motion of the cart, to friction from the parts above; in this way, therefore, a portion of the charcoal is pulverised, forming a compact mass at the bottom, where it enters into spontaneous combustion.

In the second instance, pressure and friction had still greater influence. The carter, while he was loading, beat down the charcoal with a large hammer, to force it into a smaller compass. Conveyed for twenty miles in a cart, the pieces would rub

against each other, and the finer parts would be shaken to a compact mass; and possibly the friction might, in this case particularly, produce a degree of heat which might promote the ignition.

Before I proceed to an account of my own direct experiments, I will describe here another instance of spontaneous combustion which occurred casually. About 2,000lbs. weight of charcoal were loaded at Cornbrook, in the cart of Messrs. Williamson and Co., powder manufacturers, of Fernelee, near Buxton. The charcoal had been made several days before, and had lain freely exposed to the open air. No indications of combustion could be perceived. After being taken out of the cart at Fernelee, it was left for the night, and the next day finely pulverised as a preparation for making gunpowder. It was then thrown into a heap; and no appearance of a tendency to ignite ensued. This was on the Saturday evening; and on Sunday the building which contained it was observed to be on fire. The fire must have commenced with the charcoal, as every other source of heat was carefully excluded, on account of the gunpowder manufactory.

These, and a number of other accidents which have arisen from the same cause, united with the opportunities which I have possessed as a manufacturer of charcoal, have led me to take particular interest in the subject. And I therefore came to the determination of making, for my own satisfaction, a few experiments, which I shall proceed to describe.

Exp. 1.—120 pounds of charcoal, slightly pulverized, were put into a flour-barrel, and a leaden tube, of an inch and a half in diameter and 14 inches long, inserted in the middle, to hold a thermometer. The temperature of the charcoal when put into the barrel was 60°. In two days the charcoal acquired a temperature of 74°; from that time the temperature gradually diminished until, in two days more, it was reduced again to 60°,—the temperature of the surrounding atmosphere. This charcoal was rather old, having been made several weeks, and afterwards freely exposed to the open air.

Exp. 2.—120 pounds of fresh charcoal, pulverized as before, were put into the vessel used in the preceding experiment. The charcoal was then at 70°, and the surrounding air at 62°. In 24 hours it had acquired a temperature of 90°; in 36 hours, of 110°; and in 48 hours, of 120°: from this time the temperature fell; and in 48 hours more it was down to 70°, as at the commencement.

Exp. 3.—The same quantity of charcoal was taken as in the foregoing experiments: it was quite fresh, and ground into coarse powder. In 36 hours the temperature was 130°; it then gradually declined to 70°, when the experiment was given up.

From the preceding experiments I was satisfied that spontaneous combustion would not take place in so small a quantity. I therefore determined to make the experiment upon a larger scale.

Exp. 4.—10 cwt. of new charcoal was finely ground, and put into a hogshead, with a thermometer placed, as before, in a leaden pipe. Several holes were bored in the sides of the hogshead to admit the air. The charcoal when ground was 65° ; and particular care was taken in examining the charcoal, to see that it was free from ignition. It was put into the hogshead at about 10 o'clock in the morning, at night its temperature had rised to 90° ; the following morning to 150° ; and in the afternoon of the second day the thermometer stood at 180°.

I was surprised to find at this time that combustion had taken place at about five or six inches from the surface, and about the same distance from the leaden pipe which contained the thermometer, though the temperature, as indicated by the thermometer, was only 180° or 190°.

It may perhaps be proper to remark, that the combustion always takes place *near* to the surface ; or, if small charcoal be laid against a wall, the combustion generally begins either at the surface, or close to the wall.

On the 13th of October 1831, small charcoal was thrown into a heap, which covered about 10 feet square, was about 4 feet deep, and contained from two to three tons in weight. In three days the temperature had increased to 90°, though it was at first only 57°, being the same as that of the air. On the 19th it was 150° ; and on the 20th combustion had occurred in several places. Water was thrown upon it : and the fire was, to all appearance, effectually extinguished ; yet on the 21st it was again observed to be burning in different parts; and it continued to burn until it was removed and formed into smaller heaps.

The last experiment was the most satisfactory one which has ever come under my notice. The charcoal had been made for at least ten or twelve days before it was put together ; and had been lying, during the interval, in small heaps freely exposed in the open air.