ADDITIONS to the Article, Of Rivers, vol. i. p. 251.

I.

Additional Observations on the Theory of running Waters.

PAGE 266. Concerning the theory of running waters, I have to add a new observation which I made since I established mills, by which the different celerities of water may be pretty accurately ascertained. These mills are composed of nine wheels, some of which are impelled by a fall of water of two or three feet, and others by a fall of five or six feet high: I was at first surprised to find, that all the wheels turned more quickly in the night than in the day, and that the difference was greater in proportion to the height and breadth of the column of water. For example, if the water falls six feet, the wheel will turn a tenth, and sometimes a ninth quicker in the night than in the day; and, if the fall is less high, the difference of celerity will likewise be less; but it is always so sensible as to be easily recog-

recognised. I ascertained this fact by placing white marks upon the wheels, and reckoning the number of revolutions in equal times, both during the day and the night; and I uniformly found, by a great number of observations, that the time when the wheels moved with the greatest celerity was the coldest hour of the night, and that they moved slowest when the heat of the day was greatest. In the same manner, I afterwards found, that the celerity of all the wheels is greater in winter than in summer. These facts, which have escaped the observation of philosophers, are of importance in practice. The theory of them is extremely simple: This augmentation of celerity depends solely on the density of the water, which is encreased by cold and diminished by heat: And, as the same volume of water only can pass by the trough, this volume, which is denser in winter and during the night, than in summer or in the day, acts with more force on the wheel, and, of course, communicates to it a greater quantity of motion. Thus, *cæteris paribus*, there will be less loss of water, if we stop the machines during the heat of the day, and work them during the night. By observing this method in my forges, its influence in the process of making iron amounted to one twelfth part.

Another observation merits attention: Of two wheels, the one nearer the canal than the other, but

but perfectly equal in every other respect, and both moved by an equal quantity of water, the wheel nearest the canal moves quicker than the one more remote, and to which the water cannot arrive till after it has run over a certain space in the particular runner that terminates in this wheel. It is well known, that the friction of water on the sides of a canal diminishes its celerity. But this circumstance is not sufficient to account for the considerable difference in the motion of these two wheels. It is owing, in the *first* place, to the water in this canal not being pressed laterally, as it is when it enters by the trough of the canal, and to its striking immediately the ladles of the wheel. *Secondly*, This inequality of motion, depending on the distance of the wheels from the canal, is likewise owing to the water, which passes through a trough, not being a column of equal dimensions with the trough; for the water, in its passage, forms an irregular cone, which is depressed on the sides in proportion to the breadth of the volume of water in the canal. If the ladles of the wheel are very near the trough, the water acts very near as high as the aperture of the trough: But, if the wheel is more distant from the canal, the water sinks in the runner, and strikes not the ladles of the wheel at the same height, nor with equal celerity, as in the first case. The union of these two causes produces that

that diminution of celerity in wheels which are distant from the canal.

II.

Of the Saltness of the Sea, p. 275.

ON this subject there are two opinions, and both of them are partly true. Halley attributes the saltness of the sea solely to the salts of the earth carried down by the rivers; and even supposes that the antiquity of the world may be discovered by the degree of saltness in the waters of the ocean. Leibnitz, on the contrary, believes, that the globe having been liquified by fire, the salts and other empyreumatic substances produced with the aqueous vapours a salt lixivium, and, consequently, that the sea received its saltness from the beginning. The opinions of these two great philosophers, though opposite, should be united, and may even coincide with my own. It is extremely probable, that, at the beginning, the action of fire combined with that of water dissolved all the saline substances on the surface of the earth; and, of course, that the first degree of saltness in the sea proceeded from the cause assigned by Leibnitz; but this prevents not the second cause assigned by Halley from having considerable