your attention to these subjects; for what study is there more fitted to the mind of man than that of the physical sciences? And what is there more capable of giving him an insight into the actions of those laws, a knowledge of which gives interest to the most trifling phenomenon of nature, and makes the observing student find

“—tongues in trees, books in the running brooks,
Sermons in stones, and good in every thing.”

Patent Steel Plates.* By DAVID LIVINGSTONE.

River Zambesi, East Africa, 12th January, 1860.

SIR:—The insertion of the following note in the *Journal of the Society of Arts* may prove of public service in preventing any other expedition trusting to a vessel built of the “patent steel plates,” which have caused us so much toil, loss of time, and annoyance.

It is probable that there are purposes to which these patent steel plates might be applied with great advantage, but eighteen months experience in a steam punt constructed of this material, has proved that the substance cannot be trusted in tropical waters. Whatever may be the process by which the plates are converted into steel, a very remarkable decomposition soon takes place when exposed to the heat and moisture of this climate, and a considerable portion of the plate becomes what possibly is the black oxide of iron. In our case, the whole vessel was painted thoroughly, inside and outside, with Peacock's patent paint while on the deck of another vessel in the voyage out. But this proved no protection, for a process of decomposition began on both surfaces, altogether different from the common rust of iron. Scales of a jet black color were formed, and when detached the plates were found to be as smooth and black as if they had left the rollers but an hour before. The scales are black in their substance, too, and strongly magnetic. The paint, firmly adherent on the outer surface, showed that it had failed to prevent the process, and curiously enough, the rivets, which are probably of common steel, neither rusted nor decomposed. For a considerable time the process of scaling off and leaving a smooth, black, and even shining surface, made us believe that the plates were suffering no harm by exposure to the weather. Friction had no effect in wearing them. But the decomposition was going on at the same rate inside; blisters, also, were formed, and at the bottom of each there was a minute hole right through, and at the end of twelve months the removal of the internal surface scale left us with plates as thin as wafers, and so full of small holes our wretched craft might have been converted into a coffee strainer for the entire Society of Arts. The plates were only one-sixteenth of an inch in thickness at the beginning, and the internal scales are one-thirty-second of an inch. The framework being of the flimsiest contract style, any attempt at mending involving hammering or wedging would have been putting a new piece into an old garment, so we had to resort to puddling her with stiff clay. This served for a while, but the holes becoming too large, we were obliged to run down to the sea, and with the assistance of the tides,

* From the *Journal of the Society of Arts*, No. 406.

get her out of the water. By digging the sand from beneath, we reached the worst places, and the engineers, Messrs. Rae and Hill, assisted by men from H. M. S. *Lynx*, put planks outside and inside, with plies of canvass and white lead, sandwich fashion, and guaranteed her to float any time between three days and six weeks. New leaks, however, forced us to beach before the first period mentioned, and though rather annoyed at being kept tinkering, instead of doing good service to the cause of African civilization, we must, as we have often done with disagreeables before, "put up with it."

No advantage whatever has been gained by the employment of these steel plates. The contractor intended that by their use the vessel should draw thirteen inches only, but when we tried her fairly out here in salt water, without fuel, gear, crew, or water in the boiler, she drew twenty-three inches, and her paddle floats are, of course, ten inches too deep. It was promised that she could carry from ten to twelve tons, but four tons bring her down to 2 ft. 7 ins. and within a few inches of the paddle wheel shaft, while six tons would sink her altogether.

Nor have we gained the least in speed, for, instead of "ten knots, at least," promised, we have to be content with a top speed of $3\frac{1}{4}$. This may in part be owing to the peculiar form adopted—an imitation of the Niger canoes, *i. e.*, long, narrow, and turned up at the ends. The negro reasons for this shape are sensible enough. They cannot make them broader than the trees, and make up in length what they cannot have in breadth, and they are turned up at the ends to avoid the shock which would be felt in coming to a bank, were they not made to slide up. These reasons are not so very recondite as to induce us to forsake the wave line of Mr. Scott Russell surely. Here we often see canoes made out of crooked trees, and as they are simply hollowed out, the canoe retains the bends of the stock. Some future contractor, if using other people's money, may infer that these crooked canoes are exactly suited for turning round corners, instead of inferring that the owners had no straight trees near the river.

On Foot Valves in Condensers and Air Pumps.*

The subject of foot valves in air pumps has, by engineers, been too much overlooked. It is of the greatest importance in marine engines, particularly in propeller engines, where the machinery is applied direct to the propeller shaft. Captain Carlsund, in Motala, I believe was the first engineer who paid attention to the proper arrangement in air pumps and foot valves; he applies his machinery with the air pump direct to the propeller shaft, making 100 to 140 revolutions per minute, and is found to work exceedingly well, while in America and England they have been obliged to gear the air pump down to a slower motion, or when attempting to apply it direct to direct action machinery, it has sometimes ended in a total destruction of the whole; the true cause of the blunder has been concealed and made over and over again.

The disproportion of foot valves has caused the loss of millions of

* From the Lond. Artizan, Oct., 1860.