their composition. Von Schreibers, at the fall of Staunern, ascribed to the stones a four-sided or three-sided pyramidal figure, but this has not been substantiated by more recent falls. Widmanstätten perceived upon the polished surfaces of the irons, etched with acid, the crystalline figures which bear his name, and most recently the structure of the stones has been examined by microscopic sections of their substance as well as by chemical and crystallographical descriptions of the parts. In illustration of the history of these stones, Prof. Tyndall exhibited upon the white screen numerous thin sections of their substance, prepared by Prof. Maskelyne, at the British Museum, for the microscope. A lunar-volcanic, or "lunar-ballistic," theory has been proposed for their origin from their common specific gravity most nearly equal to that of the moon, and from the scarcity of free oxygen which their composition betrays. But their high velocity renders a planetary, asteroidal motion round the sun more probably the native path in which they are intercepted by the earth. To illustrate the phenomena of the aurora, brilliant-colored discharges of electricity were passed through exhausted glass tubes and cells, when the transporting power of the magnet upon these currents was shown by their curvature and rotation about the magnetic poles. Observers were requested to communicate their observations of fireballs freely to the British Association, in the hope of deciding before long the laws of their return.

The Protection of Iron from Oxidation and Fouling.

By W. J. HAY, F. C. S., Assoc. I. N. A.,

(Read at the Institution of Naval Architects.)

From the Lond. Civ. Eng. and Arch. Journal, June, 1863.

The author remarked that a few years back the disadvantages arising from the oxidation and fouling of iron, and the consequent necessity for docking, as well as a loss of speed, almost led to a determination on the part of the Admiralty to discontinue the construction of iron sea-going ships. But at a time when the executive were debating about the sale of the whole of the iron ships, the results of several experiments became known. A preparation of oxide of copper had been tried upon the *Undine* and several other vessels, and answered so well that the Government decided upon retaining those iron vessels which they had not sold. The author had tried many experiments that had occurred to him, but none stood the required tests so well as oxide of copper. An experiment was tried on the *Rocket* in May, 1845. On examination the results were found so satisfactory that at the suggestion of Admiral Sir Hyde Parker, she was coated in June, 1847, with alternate stripes of red lead and copper composition, and when docked about the middle of 1848, she presented a curious appearance, many of the red lead patches being corroded and having weeds 3 or 4 feet long; while the patches of composition were generally covered with a little slime, but there was neither weed nor corrosion on them.

A second experiment was made in September 1845, on H. M. yacht

Fairy. Three different kinds of composition were then tried. With reference to the first two, one by a Mr. Owen, and the other by Baron Wetterstedt, oxidation had gone on very rapidly, while with the third, which consisted of a composition of pitch, naphtha, and copper oxide, chemically prepared by the author, no oxidation had taken place, and the only defect perceived in it was a partial flaking off, occasioned by its being put on the bottom while in a wet state.

Another experiment was tried on H. M. ship *Recruit*, in April, 1847. The copper oxide preparation was put on the port side, and burned linseed oil and red lead on the starboard side, excepting a space amidships 4 feet square, to which the oxide of copper preparation was applied. On her return from the Tagus, the port side was found to have no adhesion, except about one dozen small barnacles; while the starboard side, excepting the space 4 feet square, was covered with bushels of the *Lepus anatifera*, or duck-barnacles. Of all the various compositions tried, oxide of copper had up to the present time been unequaled as a protector of the iron.

The next best materials for protecting iron were the water-proof glue, and a varnish of foreign asphalt and mineral pitch dissolved in rectified naphtha, but these required great attention to the quality of materials, and also to the application of them. The basis of the anti-fouling preparation, which had for years past been used in H. M. service upon the author's recommendation, was sub-oxide of copper. The oxides of copper used for this purpose were the scales separated from sheets of copper in the "pickling" process. These scales, after being pulverized, were mixed with a varnish made of vegetable pitch and rectified naphtha. The author wished it understood that the protective coating, when used with the oxide of copper anti-fouling composition, was not intended merely to act as a non-conducting medium to prevent galvanic action, but to protect the iron from chemical action resulting from the action of air and sea-water on the iron. It appeared to him that this action was little understood, judging from printed statements which occasionally appeared, and which attributed the loss and corrosion of iron to galvanic action of copper preparations. The copper oxide paint could not act as a galvanic agent, as every particle of oxide of copper was insulated by the oil or varnish in which it was enveloped, and unlike preparations of a metallic character, which had been frequently tried, and required oxidation previous to combination with chloric acid, the oxide of copper was, as soon as uninsulated, ready for chemical combination with the elements of the sea-water. The author admitted that one great difficulty had existed since the first use of copper oxide—that of requiring careful supervision in its application, for when the varnish was made too thick it became locked up, and much of its usefulness was destroyed in not coming in contact with the sea-water; and, on the other hand, when the varnish was made too thin, the oxide sank to the bottom, and, if the mixture were not continually stirred, it got left there, and did not reach the ship. He had now, however, he stated, succeeded completely in suspending the copper oxide during its application. He takes the puce-colored or sub-

oxide of copper, and roasts it, till it takes up another equivalent of oxygen and is converted into black oxide. This is then boiled with linseed oil until it assumes its original pure color as sub-oxide; the oil so treated becomes a quick drying oil, and is capable of suspending a large amount of copper oxide.

In his plans for the anti-fouling composition, the author included the application of zinc plates inside and outside the hull of the ship to prevent oxidation from abrasion or other causes. There were numerous parts of iron ships of war which required chemical supervision, as not only should every metallic fitting electro-negative to the irons be insulated, but every piece of timber should be insulated, especially in the bilge; for when wood decayed in contact with iron and seawater, it produced sulphuretted hydrogen. Certain woods, however, were less liable to decay than others when in contact with iron, and among them were teak and stinkwood. In conclusion, the author alluded to the statements made respecting the foulness of the *Warrior's* bottom. He said that after she had been out of dock nine months she had no oxidation whatever on her bottom, although she was coated with the greatest expedition, it being then thought that her presence would be required in American waters.

Strength of Cast Iron Columns.

From the Practical Mechanic's Journal, June, 1863.

In an investigation on the strength of materials, Prof. Wiebe, of Berlin, is said to have arrived theoretically at the conclusion, that a solid round cast iron column is *weaker* than a solid round wrought iron one of the same dimensions; but a solid square cast iron column is *stronger* than a solid square wrought iron column of the same dimensions. Taken in all its generality, we doubt the possibility of such a result being correct.

On the Strength of Malleable Cast Iron. By M. TRESCA.

From the Practical Mechanic's Journal, June, 1863.

The malleable cast iron of M. Dalifol, of Paris, is made from mixed Scotch pig, and the tempering is effected by the castings being inclosed in crucibles filled with native iron oxide, and exposed to a very great heat. Experiments were made with four square bars, of from $\cdot 6$ to $\cdot 81$ metres length, and about 1, 4, 9, and 16 square centimetres sectional area, which were supported at the ends on sharp edges, and loaded in the middle. The smallest bar, $\cdot 39$ of an inch square ($\frac{3}{8}$ ths full), and 1.87 feet long between the supports, showed, up to a load of 78 lbs., a regular increase in deflection of $\cdot 0973$ inch for every 23 lbs., which gives a modulus of elasticity of about 12,600,000, the same as many good qualities of iron. The second bar gave a modulus of elasticity of 11,000,000; the third, 10,600,000; and the fourth, 10,800,000. Out of this last bar, 1.56 inches square was cut a fifth, only $\cdot 351$ inch