only 65 per cent., while in another it was as much as 98 per cent. Also in the first case the quantity of chloride and sulphate of sodium, which were impurities, was as high as 18 per cent., and in the second case as low as 0.5 per cent. Further, there was present in the first case as much as 16 per cent. of water, and only 0.3 per cent in the second. Thus there was a marked difference between the two.

The Porter-Clark process had the advantage of purifying the water before it was pumped into the boiler, whereas all boiler compositions treated the water after it was pumped in, so that while the Porter-Clark process threw down the impurities outside the boiler, the compositions threw them down inside The Porter-Clark process, however, at present was only adapted to deal with carbonates, whereas most of the waters the Association met with were impregnated with sulphates It was hoped that the Porter-Clark process might be extended so as to render it applicable to waters impregnated with sulphate of lime as well as to those impregnated with carbonate of lime —*Engineering*

## "ON THE PRESERVATION OF IRON BY ONE OF ITS OWN OXIDES."

BY BENJAMIN HOWARTH THWAITE, ASSOC. M INST. C.E.

*(A paper read before the Inst. of Civil Engineers.)*

*Concluded from page* 331.

In this process the rustier the articles are, the more effective and speedy is the process of oxidation. Old cast-iron water and gas pipes, that were were so covered with rust as to be commercially valueless, have been converted into a condition more durable and valuable than they were when first withdrawn from the moulder's sand. The magnetic oxide coating produced by the Bower furnace, on the surface of the roughest castings is smooth to the touch. The smoothness of the surface is, however, more apparent than real, as by microscopical examination the surface presents a granular appearance. If occasionally the articles are slightly warped, they can, by a judicious reheating, accompanied by the application of pressure produced by weights, &c., be brought back to their original shape. A French chemist, Mr. Dodé, discovered some years ago, a singularly cheap and beautiful process for depositing from their salts the noble metals upon the surface of a special description of enamel, which was fused upon the surface of iron and steel articles; but it was discovered that corrosion unfortunately set up under the coating of enamel, and eventually threw it off It was decided to try Mr Dodé's process upon the magnetic oxide coating as produced by the Bower process, and the experiments proved a decided success. The Société Française d'Inoxydation et de Platinage, though proprietors of Mr. Dode's patent, also purchased the continental patents of Mr. Bower, and eventually those of Mr. Barff as well. By a special arrangement of the furnaces, Mr. Roque, the engineer of the Societe Francaise, is able to treat articles of a very considerable length.

The colour of the magnetic oxide coating, as it emerges from the furnace, is a light tint of French grey, which can be made to have a silvery lustrous appearance by merely filling the muffle with the vapours of volatilized liquid hydrocarbon, produced from oil poured into a special siphon formed as already described. The colour of French grey will be retained by the magnetic oxide as long as it is free from contact with liquid grease, oil, or other hydro-carbons. The least touch of any of these instantly converts the light French grey colour into one of a bluish black appearance, which no energy of washing or rubbing will remove. But of course the grease or oil is volatilized on exposure to heat, leaving the oxide with its original colour. All articles that are likely to be handled should be oiled. Mineral oil is the most suitable; and as the coating of magnetic oxide rapidly absorbs the oil, the least application is sufficient, and after the superfluous oil has been thoroughly rubbed off, the oxide presents a dark and polished appearance, which to some people is preferable to the delicate natural colour of the oxide.

A very pretty effect may be obtained, upon ornamental castings, by oiling the minor or subordinate parts of the ornament, leaving the prominent or main parts untouched. In the preliminary experiments with the magnetic oxide, it was was noticed, that if any foreign metal was rubbed upon its surface, part of the latter was deposited or left on the former, a property not possessed, as far as the Author knows, by any other oxide, this remarkable discovery led Mr Bower to make a series of experiments with various descriptions of metallic brushes with wires of all the noble metals, as well as of various alloys, in all cases the results were the same, and oxidized castings can be gilded, plantanized, or bronzed, &c, most charmingly, cheaply and quickly, by merely rubbing over the surface of the magnetic oxide coating, with metallic brushes, with bristles of any description of metallic wire other than iron. In order to permanently fix the gilt, the gilded castings are exposed to very moderate temperature, say 600° Fahrenheit, for about thirty minutes.

As already mentioned, the Société Française d'Inoxydation et de Platinage utilizes the magnetic coating as a base for receiving their special enamel. Upon this enamel, or even direct upon the magnetic oxide coating, gold, silver, platinum, &c., can be permanently deposited by mixing the chlorides of these metals with certain essential oils, and then placing the iron articles, washed with the metallic chlorides, in the furnace for a short time.

The novel feature of both the attrition and Mr Dodé's principle of gilding, platinizing &c., is that the same iron article can be ornamented with various articles in conjunction, if desired, with other coatings, such as variously coloured enamels When the oxidized castings require to be enamelled, no costly preliminary process of annealing is necessary, and the enamel can be deposited direct upon the coating of magnetic oxide.

That the strength of constructional ironwork is practically unaltered by the Bower-Barff process, will be seen by the subjoined table of tests made by Sir Joseph Whitworth, and considered by him to be "very satisfactory." Metal tested before and after being subjected to Professor Barff's process :—

No. of METAL, 433.

| Before. | | After. | |
|---|---|---|---|
| Pressure in Tons. | Alteration. | Pressure in Tons. | Alteration. |
| Per square inch | Inch. | Per square inch | Inch. |
| 18 | Nil | 18 | Nil |
| 19 | " | 19 | " |
| 20 | " | 20 | " |
| 21 | 0·0002 | 21 | 0·0007 |
| 22 | 0·0009 | 22 | 0·0023 |

No. of METAL, 603.

| Before | | After. | |
|---|---|---|---|
| Pressure in Tons. | Alteration. | Pressure in Tons | Alteration. |
| Per square inch | Inch. | Per squere inch | Inch. |
| 18 | Nil | 18 | Nil |
| 19 | " | 19 | " |
| 20 | " | 20 | " |
| 21 | 0·0002 | 21 | 0·0007 |
| 22 | 0·0009 | 22 | 0·0023 |

The following may be taken as a fairly accurate list of the thicknesses of the magnetic oxide coatings required for various descriptions of iron :

| | Inch. |
|---|---|
| Light sheet iron, a thickness of | 0·0035 |
| " wrought " " | 0·0104 |
| Heavy " (such as tubes) a thickness of | 0·0188 |
| Light cast " | 0·0183 |
| Heavy " " | 0·0200 |

As the magnetic oxide is not very pliable, it is not suited for articles which have to be bent after their treatment, and if struck very violently with another hard metallic body, it is liable to chip off at the point of contact; but when the process is properly accomplished, the oxide-coating will withstand all ordinary concussions. If a piece of the oxide-coating is, however, removed, the corrosion which may set up in the