A NEW BOOK.

A Treatise on Toothed Gearing. By J. Howard PH.B. (New York, John Wiley & Sons.)

In this work the author endeavors to set before the student in a concise and simple manner the principles governing the design of toothed gearing. Commencing in the first three sections with a discussion of the proper form of tooth-profiles, the conditions necessary for minimum friction and for uniform velocity, and the comparative advantages and disadvantages of cycloidal and involute teeth, he goes on in the next six sections to explain the various gears (internal, bevel, screw and hyperbolic) and the methods employed for laying out the teeth. Sections IX to XV are devoted to a consideration of the relations between diameter, circumference, pitch, number of teeth, velocity-ratios, arcs of approach and recess and contact, the strength of teeth and arms, &c. After setting forth complete detailed designs of different wheels, and giving certain special practical applications, the work concludes with an appendix shewing the relative values of circumferential and diametral pitches, and an explanation of the process of cutting gear-teeth.

In compiling this treatise the author has made use of the works of many standard authors, and in order to meet the demands of those mechanics, "who continue to look with extreme distrust upon anything in the shape of book, because books are generally too deep and too theoretical," he has a number of simple rules and formulæ, for performing each and every operation necessary in the design of the different gears.

NOTES ON ELECTRICITY AND MAGNETISM.

BY PROF. W. GARNETT.

(*Continued from page* 219.)

Applying this test to copper and zinc at ordinary temperatures it appears that the difference of potential is less than the millionth part of the electro-motive force developed by a pair of copper and zinc plates immersed in dilute sulphuric acid, and moreover the copper is at a h gher potential than the zinc. Hence it appears that the difference of potential due to the contact of zinc and copper may safely be neglected in discussing the theory of the Voltaic cell.

If we apply the same test in order to determine the difference of potential between either of the metals and the acid in contact with it, we at once meet with a new difficulty, for we can no longer say that when work is done by the electric forces, the only source of energy is the heat absorbed, or that when work is done against the electric forces the whole of the energy expended must appear as heat, inasmuch as a chemical action is going on in contact with the metallic surfaces. If we knew how much heat was being developed or absorbed by this chemical action we might apply the necessary corrections, but though we know what is the whole amount of heat developed (or absorbed) in the battery cell (or the decomposing cell) we do not knew what is the exact nature of the action which takes place in the neighbourheod of each metal plate. For example, in the case of a copper and a zinc plate immersed in dilute sulphuric acid we know how much heat is developed when a pound of zinc is dissolved, and the corresponding amount (about half an ounce) of hydrogen liberated ; but when the battery is in action the hydrogen is not liberated at the zinc plate, but in contact with the copper plate, and we do not know what is the condition of hydrogen while it is travelling from the the zinc through the acid to the copper plate.

Thus, it may happen that the hydrogen before it can be liberated as free gas at the surface of the copper plate must absorb a considerable amount of heat, and this effect would mask the heat developed or absorbed by the electricity in entering the copper plate from the acid ; while in the neighbourhood of the zinc plate the heat developed by the chemical action would be in excess of that due to the solution of the zinc and the liberation of *free* hydrogen, by the unknown amount of heat absorbed by the hydrogen when liberated from the copper plate.

In 1843 Prince Louis Napoleon, then a prisoner, writing to Arago, described two forms of battery in which only one metal was employed, so that there was nowhere a contact of dissimilar metals. The first consisted of a copper plate immersed in dilute nitric acid, (which acts strongly on the copper), contained in a porous cell. The porous cell was placed in a jar containing dilute sulphuric acid in which was immersed a second copper plate. On connecting the plate with a galvanometer, a current flowed through the galvanometer from the plate immersed in the sulphuric acid to that immersed in the nitric acid. With a battery consisting of two of these cells he decomposed potassic iodide and cupric sulphate. The second battery consisted of two zinc plates, one immersed in dilute sulphuric acid contained in a porous pot, and the other in tepid water in a vessel surrounding the porous pot. This battery produced effects similar to that just described.

Napoleon then attempted to reverse " the usual order of the metals." He placed a copper plate in dilute nitric acid contained in a porous jar, while a plate of zinc was placed in pure (?) water surrounding the porous jar. On connecting the metals a current flowed from the zinc to the copper through the wire. These experiments alone seem sufficient to condemn the contact theory, as held by those who maintain that the E. M. F. of a battery is due simply to the contact of dissimilar metals. More recently several other forms of battery have been devised, in which there is no contact of dissimilar metals. Napoleon complained that he was unable to measure the E. M. F. of his batteries, as the iron bars of his prison interfered with his galvanometers.

If we suppose that when the zinc and sulphuric acid are in contact and in equilibruim the potential of the acid is very much greater than that of the zinc, and similarly in the case of copper and sulphuric acid, the potential of the acid is much greater than that of the copper, but the difference in the case of the copper is less than in the case of the zinc, while we further suppose, as vindicated by the Peltier effect, that there is no sensible difference of potential between copper and zinc when in contact, we can explain the action of the Voltaic cell.

Suppose a plate of copper and a plate of zinc to be immersed in sulphuric acid, but no contact to be made between the plates. Then the acid must be at the same potential throughout, or it could not be in electrical equilibrium. Hence, since the difference of potential between the acid and the zinc is greater than that