

carbon is heated in carbonic acid gas, CO is formed with a disappearance of heat; and, when nitrogen and oxygen are sufficiently heated together, an oxide of nitrogen is formed with a disappearance of heat; and, that in these cases the heat which has disappeared has become chemical energy in the molecules of CO or NO. Whether it be *atomic* energy or not is not at present known, but as the molecule includes the atoms, it is certainly "molecular" as distinguished from ordinary mechanical, or molar energy. Since many chemical changes, which only take place at very high temperatures, appear to be attended with a disappearance of heat, it is at least not improbable that some of the changes, by which minerals are formed in the interior of the earth, may also be attended with a storage of energy."

"Perhaps Dr. Irving takes exception to the supposition that mechanical energy may be directly transformed into chemical energy. If so, you may reply that the known effects of pressure upon chemical changes, when those changes are attended by a change of volume, afford support to the supposition. Recent observations on the influence of surface tension on chemical change by Liebreich, J. J. Thomson, and others, lead in the same direction, so that it cannot be said that the supposition is unreasonable, even in the light of recent advances in physical chemistry."

Finally I am told that the assertion that "chemical combination must generate heat" is certainly incorrect, and that the examples CO and NO to the contrary are "only two out of an immense number."

HARLTON, CAMBRIDGE, 13 Dec.

O. FISHER.

#### DYNAMOMETAMORPHISM.

STR,—I must apologize to Dr. Irving for having overlooked the observations to which he refers. Unfortunately I had not read the work in question at the time when I wrote my letter.

As regards the main subject of his letter in your December number, I would offer only a few words. In assuming that the whole of the work done in the compression, deformation, and friction of rock-masses passes into heat, Dr. Irving misses the idea which underlay the whole of my remarks, and was more explicitly stated in Mr. Fisher's article. The *direct* correlation of mechanical and chemical energy was, I believe, first mooted by Dr. Sorby in 1863; but the practical verification of it rests on such experiments as those of Cailletet, Pfaff, and Spring. To take an example: Spring subjects a mixture of sulphur and copper filings to a pressure of 5000 atmospheres, and finds it converted into crystallised copper sulphide. The operation is conducted slowly, and the temperature of the apparatus kept constant. In other words, so much of the mechanically-developed energy as takes the form of heat is carefully removed; but chemical combination still takes place. It follows that the energy absorbed in this combination comes directly from the mechanical work done, without the intervention of heat.

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