Electric currents have long been suspected of various results of other kinds, but little has yet been directly traced to their action, except such as come under the general head of chemical effects.

Under examples of *mechanical action*, there are the beating of waves on a coast, the falling of water in cascades or rain, the shakings of earthquakes, the sliding of rocks, the motion of the atmosphere in winds, each of which produces heat whenever the action meets with resistance, on the principle that motion corresponds to an amount of heat, or that heat is transformed motion. The heat thus resulting is, however, of little geological importance. But the friction attending uplifting, plicating, shoving along fractures, and crushing of rocks has often been an efficient and wide-reaching source of heat and of geological work. These shovings have flexed strata many thousands of feet in thickness, made displacements along fractures of 10,000 to 20,000 feet, and worked in this way over areas more than 1000 miles long and some hundreds in width. The amount of heat developed has therefore been enormous; but how far available for geological changes would depend in part on the rate at which such work went forward. It has been sufficient, beyond question, for a large amount of consolidations, and for recrystallizations or metamorphism on a large scale, and it has probably been sufficient for much fusion of rocks in the earth's interior wherever the temperature was on the margin of fusion.

Mallet concluded, from his calculations, that 7200 cubic miles of crushed rock would cause heat enough to make all the volcanic mountains of the globe; and that, since the ejections of volcanoes have been going forward through a very long period, the action would require but an infinitesimal amount of annual crushing — not over 0·606 of a cubic mile. (Trans. Roy. Soc., 1872.) But his theory is accepted only in a general way.

II. EXPANSION AND CONTRACTION.

1. *Amount of expansion.* — The amount of expansion of rocks is mostly between 1 and 10 millionths for 1° F.; and one millionth corresponds to 1·2 thousandths of an inch for 100 feet. Colonel Totten, in experiments, made in 1830 to 1833, on effects of change of temperature, found that an inch of fine-grained granite expands for 1° F., 0·000004825; an inch of the granular limestone of Sing Sing, N.Y., 0·000005668; of red sandstone, from Portland, Conn., 0·000009632. Adie (Trans. R. Soc., Edinburgh, xiii., and Q. J. G. Soc., 1847) found for the expansion of gray Aberdeen granite for 1° F., 0·00000438; for white marble of Sicily, 0·00000613. Pfaff found for the expansion between the ordinary temperature and red heat (about 1750° F.) of granite from the Fichtelgebirge, 0·0168; for porphyry from the Tyrol, 0·0127; and for basalt of Auvergne, 0·0120.

2. *Effects of changes in temperature due to the sun, or the climate.* — (*a*) The sun is producing somewhere, at all times, alternations of temperature, and thereby *change of size and position*; and the same effect comes from changes of temperature, whatever the source. The cause is universal in its action.