an almost unique instance of the combination of abstract reasoning and practical inventiveness. An almost equally important problem, having both scientific and practical interest, arising out of the Newtonian gravitation formula, is the problem of the tides. Here also the first suggestions towards a theory were given in the 'Principia,' whereas the first attempt at a solution is contained in Laplace's great work. A closer approximation was reached by Sir W. Thomson in his extensive theoretical and practical use of Fourier's mathematics.

I shall have frequent opportunity to refer to the beneficial and fructifying influence which practical problems have exerted on scientific thought;[1] in fact, in spite of

has since been in use in submarine telegraphy. The best account of these discoveries and inventions is to be found in Lord Kelvin's own papers, a good summary being given in his short article in Nichol's 'Cyclopedia,' reprinted as No. 82, vol. ii. p. 138.

[1] How much science owes to the practical interests of navigation can be seen by a glance at the subjects contained in the third volume of Lord Kelvin's 'Popular Lectures and Addresses.' The Tides, Deep-Sea Sounding, Cable-Laying, and Terrestrial Magnetism all furnish important practical as well as highly abstract theoretical problems, the solution of which demands new instruments and new methods of calculation. The phenomena of the tides and those of terrestrial magnetism are intimately connected with two of the most refined mathematical theories which this century has developed. The former was first attacked by the so-called equilibrium theory—the problem being to find the figure of equilibrium of a rotating ellipsoid covered with water under the influence of various attracting forces. Laplace, followed by Airy and Thomson, showed how it is much more a question of dynamics than of statics, and that it resolves itself into the analysis and subsequent synthesis of a number of periodic movements, dependent upon the several periodic changes of the rotation of the earth and the revolutions of the moon round the earth and the sun. A general method of dealing mathematically with the superposition of several periodic changes had been invented by Fourier in the early part of this century, and it was this which, especially in the hands of Lord Kelvin and his brother—the late Prof. James Thomson—led to the harmonic analysis of tide motion and the subsequent invention of tide-predicting apparatus (see the above volume, p. 177 *sqq.*) The observation of the magnetism of the earth is connected with great improvements in the theory and construction of the mariner's compass, suggested and carried out by