of senate-house examiners and examinees, without for a moment considering the question whether mathematical thought as distinguished from mathematical problems is capable of and has undergone any radical and fundamental change or development.

4. Use of mathematics.

Closely allied with this is the further question as to the use of mathematics. Two extreme views have always existed on this point.[1] To some, mathematics is only a measuring and calculating instrument,[2] and their interest

[1] Of the two greatest mathematicians of modern times, Newton and Gauss, the former can be considered as a representative of the first, the latter of the second class; neither of them was exclusively so, and Newton's inventions in the pure science of mathematics were probably equal to Gauss's work in applied mathematics. Newton's reluctance to publish the method of fluxions invented and used by him may perhaps be attributed to the fact that he was not satisfied with the logical foundations of the calculus; and Gauss is known to have abandoned his electro-dynamic speculations, as he could not find a satisfactory physical basis (*see supra*, p. 67). Others who were not troubled by similar logical or practical scruples stepped in and did the work, to the great benefit of scientific progress. Newton's greatest work, the 'Principia,' laid the foundation of mathematical physics; Gauss's greatest work, the 'Disquisitiones Arithmeticæ,' that of higher arithmetic as distinguished from algebra. Both works, written in the synthetic style of the ancients, are difficult, if not deterrent, in their form, neither of them leading the reader by easy steps to the results. It took twenty or more years before either of these works received due recognition; neither found favour at once before that great tribunal of mathematical thought, the Paris Academy of Sciences. Newton's early reputation was established by other researches and inventions, notably in optics; Gauss became known through his theoretical rediscovery of Ceres, the first of the minor planets (see above, vol. i. p. 182). The country of Newton is still pre-eminent for its culture of mathematical physics, that of Gauss for the most abstract work in mathematics. Not to speak of living authorities, I need only mention Stokes and Clerk-Maxwell on the one side, Grassmann, Weierstrass, and *Georg Cantor on the other.*

[2] Huxley said: "Mathematics may be compared to a mill of exquisite workmanship which grinds you stuff of any degree of fineness: but, nevertheless, what you get out depends on what you put in; and as the grandest mill in the world will not extract wheat-flour from peas-cods, so pages of formulæ will not get a definite result out of loose data"; and on another occasion he said that mathematics "is that study which knows nothing of observation, nothing of induction, nothing of experiment, nothing of causation." The former statement was endorsed by Lord Kelvin ('Pop. Lectures,' &c., vol. ii. p.