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Percy Ludgate's Analytical Machine

The Feasibility of Ludgate's Analytical Machine	A small investigation by me of what Percy Ludgate's machine would have looked like and if it could have been built.
On A Proposed Analytical Machine	Percy Ludgate's paper from the Scientific Proceedings of the Royal Dublin Society 1909.

Offsite

Computer Journal 1971 14(3):317-326 - Ludgate's analytical machine	This contains a very good introduction by B.Randell to the full paper plus an extract from Nature where Professor C V Boys explains how the multiplier works.
From Analytical Engine to Electronic Digital Computer: The Contributions of Ludgate, Torres, and Bush	A very interesting paper by Brian Randell which describes a similar investigation done at Swansea
Percy Ludgate	Wikipedia article on Percy Ludgate

Ludgate's machine was designed around 1907-1909 to be a fast semi-portable computer with 192 words of 20 digit memory and using a paper tape for control. It would be driven using a separate electric motor rather like some of the sewing machines then current. Ludgate's machine was never built. The timings were projected as 10 seconds for a general multiply and 3 seconds for a load-add-store. The main points of interest I think are:

- The computation and storage was rod based rather than the more usual gear based forms as in Babbage's engines.
- The multiplication used an ingenious transformation,'Irish Logarithms', to change multiplications into additions.
- The basic unit of computation was a multiply-and-add so an add involved a multiply by one. Ripple carries were pipelined.
- Division was designed to use an initial estimate and successive approximation.
- The storage addresses were binary though the values stored in them were in decimal.

I'm not sure why gears were so much more popular for computation than rods. Gears can be made much more accurately and have less friction. On the other hand mechanisms made of rods or plates can be made smaller, need less precision, and can have power more easily coupled in to aid the workings. I'd guess the reason was more of a mindset with clockwork as the model. In 1840 Thomas Fowler built a small ternary rod based calculating machine out of wood which clearly showed the potential of both using rods and of using a smaller number base. Fowler didn't use direct ternary 0,1,2 but -1,0,1 with T for -1 (bar 1) so 5 is 1TT = 9-3-1.

The Z1 built by Konrad Zuse in 1936-1938 was also rod based and worked in binary. This wasn't very reliable, but it wouldn't have taken even Babbage's technology to make a reliable version if only he had thought of the ideas. About the only thing missing from Zuse's Z1 that was in Babbage's and Ludgate's designs was conditional execution, which is quite surprising since it would be quite easy to implement as a skip to mark on the tape, and his machines all tested for overflows and other abnormal conditions. I suppose it's because Zuse's aeronautical calculations didn't need conditional execution the way for instance Ludgate's accountancy did.

There is a misapprehension that nothing was done about automatic computation after Babbage till the electronic computer. It is clear however that there was a steady development of more capable

machines. Even Babbage's difference machine was developed by George and Edward Scheutz into a saleable product even if it wasn't as perfect as Babbage's design - a practice followed to this day by some major successful software producers :-)