

A NOTE ON THE ARITHMOMETER AS AN AID TO ACTUARIAL WORK.

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The arithmometer is peculiarly adapted for working out the chief details of a classified valuation of a life assurance office. The process is a simple one, being merely a series of multiplications, and the work can be carried out very rapidly by an ordinary computer. The results worked out and set down by one computer can be checked and verified by a second computer using a different machine, while any errors in the original work may be investigated by a third worker, using a third machine. By this means complete accuracy is ensured, and the use of the different machines avoids any possibility of error should either of them happen to fall out of order and become liable to repeat its own mistakes.

Several able expositions of the uses of the arithmometer have been published, and amongst them may be cited papers by Major-General Hannington and Mr. Peter Gray in the 16th and 17th volumes respectively of the *Journal of the Institute of Actuaries*. At the beginning of his paper Mr. Gray remarks:—"It is usual to describe the arithmometer as a machine which enables a person, however unskilled himself, to perform the operations of multiplication and division with facility, rapidity, and unfailing accuracy. This, as a description, is correct as far as it goes, but as an enumeration of the properties of the machine it is inadequate and defective. It entirely omits that property which forms its special adaptation to our purpose, and in default of which its utility would be comparatively limited. Besides the facilitation of the operations named the machine will also in forming the product of two given numbers either add that product to or subtract it from another given number according to the pleasure of the operator." Mr. Gray then proceeds to give illustrations of the adaptability of the machine for the construction of tables, and amongst the actuarial problems he investigates are:—

1. To form a table of assurances from a corresponding table of annuities.
2. To construct a table of policy values from a given table of annuities.
3. To construct commutation columns from any given mortality table.

Amongst modern tables constructed by the calculating machine must be mentioned those computed by Mr. David Carment, F.I.A. A copy of the work is submitted for inspec-

tion. These tables show the value at the end of any number of years of an endowment assurance for £100, payable at different ages and under different rates of interest, according to the "Institute of Actuaries H.M. Tables of Mortality." In constructing these tables Mr. Carment utilised a modification of Gray's continuous method, and, speaking briefly, the work consisted in placing upon the machine a constant (the reciprocal of a certain function) and multiplying this by the successive differences of another function, the results being, of course, taken down after each operation. The process of the work is lucidly explained by Mr. Carment in the preface to his tables. It must be noted that the multiplication referred to is performed continuously, and that each step is performed *without* erasing the result attained by the preceding operation. The correctness of each column of results is proved by a very simple calculation. The whole of the tables were calculated by means of the arithmometer, with the exception of a small portion at the end, which, owing to the partial breakdown of the author's machine, were done by another process; the book is an interesting example of the work that can be performed by the calculating machine.

I have frequently had occasion to use the arithmometer in the computation of different results, and have found it a most correct and expeditious means of performing work that might, under ordinary circumstances require a tedious mental application. The arithmometer now exhibited by Mr. Johnston is, as he has stated, of the latest pattern, and combines the original model with a stability and perfection of construction that should reduce to a minimum the possibility of errors arising from imperfect or impaired machinery.