on amount ϕ from the equilibrium position, a turning moment of amount $Ml \sin \phi$ appears. Such moments are readily added and can be used to realize expressions in the form $\sum_\alpha Ml_\alpha \sin \alpha\phi$, and $\sum_\alpha Ml_\alpha \cos \alpha\phi$, upon which harmonic analysis and synthesis can be based.

F. J. M.

22. H. WITTKE, "Mathematischen Maschinen und Instrumente vom Abacus zum Eniac," *Zeit. angew. Math. Mech.*, v. 29, 1949, p. 34–36.

This summary contains a list of dates in the development of computing machines, a list of European desk machines and a list of present large scale computers or computing projects.

23. K. ZUSE, "Die Mathematischer Voraussetzungen für die Entwicklungen logistiche kombinativer Rechenmaschinen," *Zeit. angew. Math. Mech.*, v. 29, 1949, p. 36–37.

A brief description of the fundamental theory needed for the development of a "logistic" computer and of the author's proposal for this theory based on the propositional calculus.

NOTES

120. TESTS OF RANDOM DIGITS.—KENDALL & BABINGTON-SMITH[1] have described four tests of local randomness to be applied to any set of locally random digits. These four are (a) the frequency test, (b) the serial test, (c) the gap test, and (d) the poker test. It is the purpose of this note to show how these tests may be applied to any set of digits, punched on IBM cards, mechanically and without regard to the order of the digits on the cards, using standard IBM equipment.

Kendall and Smith applied these four tests to their table[2] of 100,000 random digits, by hand, taking the digits in the order in which they are printed in the table.

The frequency test consists in counting the frequency of occurrence of each of the ten digits, with expected values of 10% for each digit. This test may most easily be made on the sorter, provided it is equipped with the card-counting device, counting the cards that fall into each pocket when sorting on any one column. Alternatively, a tabulator equipped with digit selectors can effectively sort any two columns simultaneously and print the tabulation at the end of a run of cards.

The serial test is essentially a frequency test of two-digit numbers, with each two-digit combination from 00 to 99 expected to occur 1% of the time. The cards can be sorted on any two columns first and then, with the tabulator controlling on those two columns, a card count will record the frequencies.

The gap test, as described by Kendall, consists in counting the gap between successive zeros in the table. As done by hand, the test is applied to the digits horizontally, row by row. Using punched cards, it is easier to apply the test vertically through the table, working down through the columns. If the cards are serially numbered, they can be sorted on any column and the serial numbers of the cards falling in the zero pocket reproduced onto another deck. First differences are then taken of these serial numbers, which are the required gaps. The cards are then restored to order, and the zeros sorted out on another column, and the process repeated, column by column. It is also possible to count the gaps between zeros directly on the tabulator by wiring from the upper brushes to a comparing relay and having the resulting unequal impulses pick up a selector which directs a counter, continuously adding the card count impulse, when to take a total. The comparing relays of the tabulator respond only to digits other than zero. With this latter method, many columns of the cards may be tested for gaps between zeros simultaneously.

The poker test consists in grouping any four digits into one of five types like poker hands: four of a kind, three of a kind, two pairs, one pair, and none alike. It is this test which is most easily applied with a tabulator. Any four columns (call them A, B, C, and D) are wired from both upper and lower brushes to six comparing relays, as follows: from upper brushes B B B C C A to six relays in that order, and from lower brushes, C A D A D D. Each of the four columns is thus compared with each of the others. The six unequal impulse hubs pick up six 10-position class selectors. There are only 15 combinations which can arise; the card count impulse is sent directly to five counters and "plug to C" is filtered through the selectors to indicate which of the five counters shall add.[3]

A tabulation on 1,000 cards (bearing 40,000 digits from Kendall and Smith's table), using ten random combinations of four columns, is as follows:

4 of a kind	14
3 of a kind	370
two pairs	279
one pair	4,258
none alike	5,079

for which a chi-square test shows $p = .50$, approximately, taking 10, 360, 270, 4,320, and 5,040 as the expected values, respectively.

It is probably possible, but not convenient, to extend such a test to 5-digit poker hands (having, in addition to the five types mentioned, "5 of a kind" and "full house," of the form a a a b b). However, it is relatively easy to analyze the 5-digit numbers found by reading down a column of the table; that is, taking five successive cards on the same card column. The tabulator can be set to take a total every five cards and print, using the digit selectors, a distinctive combination of ones for each of the seven possible poker "hands." These combinations can then be keypunched and tabulated separately.

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[1] M. G. KENDALL & B. BABINGTON-SMITH, "Randomness and random sampling numbers," R. Stat. Soc., *Jn.*, v. 101, 1938, p. 147–166; "Second paper on random sampling numbers," R. Stat. Soc., *Jn.*, *Supplement*, v. 6, 1939, p. 51–61.

[2] M. G. KENDALL & B. B. SMITH, "Tables of random sampling numbers," *Tracts for Computers*, No. 24, Cambridge University Press, 1939.

[3] The wiring diagram for the 4-digit poker test is available on request from the Computing Service, North Hall, University of Wisconsin, Madison. A tabulator, type 405 or 416, equipped with at least the selector capacity described, is needed. The wiring diagram shows the wiring for a machine equipped with six 10-position class selectors.