$$A_{n,3} = \frac{-(n-3)(n^2-9n+2)}{2^{n+3}(n-3)!\,3!\,a^4}$$

$$A_{n,4} = \frac{n^4 - 22n^3 + 131n^2 - 206n + 24}{2^{n+4}(n-4)!\,4!\,a^5}$$

etc.

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UNPUBLISHED MATHEMATICAL TABLES

171[F].—F. GRUENBERGER, *Lists of Primes*. Tabulated from punched cards. Deposited in the UMT FILE.

The list of primes is from 20 000 003 to 20 040 049 and contains 2390 primes.

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172[L].—NATIONAL PHYSICAL LABORATORY, *Tables of Multhopp's Influence Functions*. 72 foolscap pages + 3 pages of description. Deposited with the ROYAL SOCIETY (no. 16).

The following integrals occur in MULTHOPP's aerodynamic theory of wing loading:

$$i(X,Y) = 1 + \frac{1}{\pi}\int_0^{\pi} \frac{(1+\cos\phi)(2X-1+\cos\phi)}{\sqrt{(2X-1+\cos\phi)^2+4Y^2}}\,d\phi$$

$$j(X,Y) = \frac{4}{\pi}\int_0^{\pi} \frac{(2\cos^2\phi+\cos\phi-1)(2X-1+\cos\phi)}{\sqrt{(2X-1+\cos\phi)^2+4Y^2}}\,d\phi$$

$$ii(X,Y) = \int_{-\infty}^{X} i(t,Y)dt$$

$$jj(X,Y) = \int_{-\infty}^{X} j(t,Y)dt.$$

Four-decimal values, within a final unit, are tabulated in the half-plane $Y \geq 0$. For convenience of arrangement and economy of space, X and Y are replaced by R and ψ, where

$$R^2 = (2X-1)^2 + 4Y^2 \qquad X = \tfrac{1}{2} + \tfrac{1}{2}R\cos\psi$$
$$\tan\psi = 2Y/(2X-1) \qquad Y = \tfrac{1}{2}R\sin\psi$$

Values are given at the pivotal points

$$\psi = 0(1^\circ)180^\circ$$
$$R = .2(.05)2,\ 1/R = 0(.05).5.$$

The function $ii(X,Y)$ which becomes infinite with R, is replaced near $1/R = 0$ by the function $ii(X,Y) - \frac{1}{2}R(1+\cos\psi)$.

Except in certain exceptional regions near $\psi = 0$ and $\psi = 180^\circ$ where no provision is made for interpolation, the table is interpolable using second differences. Most of these are given.

173[L].—NATIONAL PHYSICAL LABORATORY, *Tables of*

$$\frac{J_0(x)}{H_0^{(2)}(x)} + \sum_{n=1}^{\infty} 2(-1)^n \frac{J_n(x)}{H_n^{(2)}(x)} \cos n(\pi - \theta) \quad \text{and}$$

$$\frac{J_0'(x)}{H_0^{(2)\prime}(x)} + \sum_{n=1}^{\infty} 2(-1)^n \frac{J_n'(x)}{H_n^{(2)\prime}(x)} \cos n(\pi - \theta).$$

10 foolscap pages. Deposited with the ROYAL SOCIETY (no. 19).

Two-decimal values of the real and imaginary parts are given for $x = 0(.2)2(.5)5(1.0)10$; $\theta = 0(.5°)5°$, $10°(10°)180°$. A second table gives these functions in polar form $re^{i\alpha}$ (r to 2D, α to .1°).

These functions occur in the theory of the reflexion of electromagnetic waves from infinite cylinders.

174[L].—NATIONAL PHYSICAL LABORATORY, *Table of an Integral used in Calculating Profiles of Water Waves.* 6 quarto pages. Deposited with the ROYAL SOCIETY (no. 20).

Writing $F = \int_0^{\pi/2} \sec^3\theta \cdot e^{-\alpha^2 \sec^2\theta} \cos(\beta \sec \theta) d\theta$, the four tables give three-decimal values of the functions indicated below. Modified second differences are given.

Table I	$2\alpha^2 F$	$\alpha = .2(.05)1$;	$\beta = 0(.1)1.5$
Table II	F	$\alpha = .2(.05)1$;	$\beta = 1.5(.1)3.0$
Table III	F	$\alpha = .2(.05)1$;	$\beta = 3.0(.1)6.0$
Table IV	F	$\alpha = .3(.1)1$;	$\beta = 6.0(.1)60\alpha^2$

This integral is used in calculating wave profiles and the wave resistance due to a ship's motion.

175[L].—D. H. SHINN, *Tables of Fresnel's integrals.* vii + 28 foolscap typescript and manuscript pages. Deposited with the ROYAL SOCIETY (no. 11).

Tables I and II give the functions $C(u)$ and $S(u)$, defined in UMT, **166**, to 5D for $x = \frac{1}{2}\pi u^2 = 0(.01).2(.02)1(.05)20$ and for $u = \sqrt{2x/\pi} = 0(.01).4$.

Table III gives 5D values of $R(u)$ and $\frac{1}{2}\pi u^2 = \theta(u)$ where

$$R(u) = [\{C(u) - \tfrac{1}{2}\}^2 + \{S(u) - \tfrac{1}{2}\}^2]^{\frac{1}{2}}$$

and

$$\theta(u) = \tan^{-1} \frac{C(u) - \frac{1}{2}}{-S(u) + \frac{1}{2}}$$

for $t = 1/u = 0.(01).3$.

176[L].—J. K. SKWIRZYNSKI, *Tables of the error integral of a complex variable.* 5 typescript foolscap pages + 2 pages of diagrams. Deposited with the ROYAL SOCIETY (no. 12).

These tables give real and imaginary parts of the function

$$\operatorname{erfc}(z) = \frac{2}{\sqrt{\pi}} \int_z^{\infty} e^{-t^2} dt = \frac{2i}{\sqrt{\pi}} \int_{i\infty}^{iz} e^{t^2} dt$$

to 4D, where $z = ae^{ib}$ for $a = 0(.05)1.3(.1)1.5$ and $b = 0(5°)45°$. There is also a brief introduction indicating the formulae used for the construction of the tables, and two pages of diagrams exhibiting the results.

AUTOMATIC COMPUTING MACHINERY

Edited by the Staff of the Machine Development Laboratory of the National Bureau of Standards. Correspondence regarding the Section should be directed to Dr. E. W. CANNON, 415 South Building, National Bureau of Standards, Washington 25, D. C.

TECHNICAL DEVELOPMENTS

THE CIRCLE COMPUTER

The Circle Computer is a fully automatic electronic digital computer. It has a memory of 1024 words, each consisting of forty binary digits plus two binary digits for sign. Single address instructions are used; instructions are stored in the same memory as numbers, with two instructions in each word. The memory and the operating registers appear on a magnetic drum rotating at 3540 rpm. Input and output to the computer is obtained by parallel operation of electric typewriters and punched paper tape.

In actual computation, the Circle Computer will be several hundred times as fast as a human computer using a desk calculating machine. Eight digit decimal numbers with sign can be read into or out of the Circle Computer, with the necessary conversion from or to binary, at a rate of one a second. This speed is primarily determined by the typewriter or tape handling devices. The conversion from decimal to binary or the reverse takes negligible time.

Historical. The Circle Computer was originally conceived and designed by people whose primary interest was in having such a machine for their use. Thus, the major emphasis in the design was to obtain a machine suitable for a medium size highly technical laboratory. Further, this machine had to be operable by physicists or mathematicians or engineers without an elaborate staff or specially trained computer operators. As time went on and it seemed that this goal might be obtained, it also became clear that such a machine would be of interest to many people. In order to further this aim, it was decided that it would be desirable to find an electronic equipment manufacturer to whom the construction of electronic equipment with a few thousand vacuum tubes was an old story holding few terrors. (The Circle Computer has several hundred vacuum tubes.) Such a manufacturer was found in Hogan Laboratories, Inc. Arrangements were made for Hogan Laboratories to offer Circle Computers for sale. Three such machines are now in process of manufacture.

It may be worthwhile to state again that the Circle Computer was designed from a functional standpoint by people whose main interest is in using it, whereas it is being designed from a circuit standpoint and built by people whose business it is to build electronic equipment of the same or greater complexity.

Purpose. In recent times, most calculation has been carried out on desk calculating machines, problems ranging in size from a few man minutes to several man months. The Circle Computer is intended to be used for a