ALAN TURING

A Study in Light and Shadow

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CONTENTS

Acknowledgment 9
Prologue 11
Chapter One
"A Very Unusual Little Boy" 15
Chapter Two
At Battle With The System 23
Chapter Three
Awakening 33
Chapter Four
The Princeton Years 43
Chapter Five
Solving The Enigma 57
Chapter Six
Delilah And The Ace 72
Chapter Seven
Machines That Think 85
Chapter Eight
"Too Hot A Flame" 96
Epilogue 107
Bibliography 109
Author Biography 111
End Notes 113
Index 119

For Andrew Hodges without whom
none of this would be possible.

ACKNOWLEDGMENT

This book has been possible only because of the earlier groundwork done by Andrew Hodges on Alan Turing's life for his own biography, *Alan Turing: The Enigma*. In the early 1980s, Hodges not only studied all of the written documents available dealing with Turing's life (stored in the Library Archives at King's College, Cambridge), but also interviewed nearly a hundred individuals who knew and worked with Turing. Active both in the gay liberation movement and a pure mathematician himself, Hodges is probably the only person in the world who could have brought Turing "back to life" in a complete and honest way. His work is a masterpiece both from the technical expertise it brings to the complex variety of Turing's work and from the perceptive analysis of Turing as a human being that Hodges provides. It seems unlikely that any future writer will match Hodges' tour-de-force biography. Although I have attempted to incorporate some more recent information not available to Hodges in the 1980s, this book can be little more than a modest effort to make the general outline of Turing's life and work more generally available to younger readers in the United States.

PROLOGUE

"Alan Turing. The name sounds familiar, but I don't know exactly who he was."

Small wonder! Among the greatest scientists and mathematicians of the twentieth century, Turing is almost certainly the least well known and appreciated among the general public. Partly because his most important work on cryptology was protected by Great Britain's War Secrets Act for thirty years after the end of World War II, most people have little knowledge of the remarkable work he did in solving the German government's most powerful code, the Enigma, and, by so doing, virtually assured Allied success in the war.

But those who knew Turing have been unstinting in their praise of his accomplishments. His colleague in the battle to unravel the Enigma, Peter Hilton, has said that Turing's "contribution to our success far exceeded that of any other individual."[1] Turing's talents went far beyond cryptanalysis, however. For example, he is widely regarded as one of the scholars who understood the mechanization of mathematical problems and designed and built machines by which such problems could be solved. As such, he is widely regarded as one of the fathers, if not the father, of the modern computer. According to one historian of computer science, Turing is regarded by many authorities in the field as "the greatest single figure in the history of computer science."[2]

Turing was also instrumental in establishing the field of artificial intelligence. In his *Historical Dictionary of Data Processing: Biographies*, James W. Cortada has called Turing "a saint for those who later studied artificial intelligence."[3] And, at the time of his death in 1954, Turing was making inroads into yet another field of science, morphogenesis, the study of the way plants and animals

grow and develop particular shapes and forms. As with other fields, Turing approached this subject with a fresh new approach that often startled his colleagues. The editor of Turing's collected works on morphogenesis, P. T. Saunders, has observed that he "understood the full significance of the problem [of morphogenesis] in a way that many biologists did not and still do not."[4]

Yet, a listing of Turing's academic accomplishments does not begin to provide any sense of the type of man he was. In her biography of her son, Sara Turing has described Alan as "a strange study in light and shade."[5] Her book is a treasure of personal remembrances about a warm, often funny, if independent man, whose own internal turmoil eventually led to suicide.

For example, Mrs. Turing has written about Alan's passion for long distance running. In fact, except for an injury sustained to his back, he might very well have qualified for the 1948 Olympic Games with the British team. Alan was generally quite serious about his running and often kept a careful record of his weight and time. On one occasion, when his wristwatch was broken, he tied an alarm clock around his waist to keep his time. His mother later recalled the scene as something "a little reminiscent of the crocodile in Peter Pan."[6]

Turing is also remembered by friends and colleagues as an eccentric, but charming, man. Peter Hilton, for example, tells about Alan's approach to the game of tennis. When playing doubles, Alan found that he was usually able to reach the correct place on the court to return a shot. But the shot too frequently ended up in the net. After performing some mathematical calculations, Alan found that loosening the strings on his racquet would solve this problem. Only when friends pointed out the questionable ethics of this approach did he abandon this plan.[7]

Turing was a gay man. It appears that he never made any attempt to hide or disguise his sexual orientation, although he hardly made a special effort to talk with friends about it. Indeed, a number of his closest friends and colleagues have said that they knew nothing about his sexuality until after his death. And it is fortunate for the world that such was the case. For, had the British

government learned of this fact, Turing would have been removed from work on the Enigma, and the favorable resolution of World War II for the Allies might have been long delayed, or its fate even changed. As one of his close friends, I. J. Good has written, "It is fortunate that the authorities did not know during the war that Turing was a homosexual; otherwise, the Allies might have lost the war."[8]

All in all, Turing's short life was, indeed, characterized by "shade and light," glimpses of which are available even from his earliest childhood . . .

CHAPTER ONE

"A VERY UNUSUAL LITTLE BOY"

It was a particularly inauspicious beginning for the new school year. Fourteen-year-old Alan had been riding his bicycle for the better part of two days. The general strike of 1926 had brought all public transportation to a halt in England, and Alan's bicycle was the only means he had of reaching his new school in time for classes.

For Alan, the 60-mile trip from Southampton to Sherborne was an adventure. For his teachers and the residents of Sherborne, the trip was a matter of some curiosity, worthy of mention in the local newspaper. What an amazing young man he must be, they thought, to be able to find his way alone from his home across the English Channel on the Brittany Coast, and then across Southern England to his new school! In later years, when his status at the school was at a low point, one teacher was still able to credit this remarkable achievement: "Well, after all he *did* bicycle here," the teacher is reported to have said.[9]

The notoriety connected with Alan's arrival at Sherborne was to follow him through his four years at the school. He never adapted to the rules and regulations, the customs and traditions, associated with Sherborne and, indeed, with the English public school concept in general. The school utterly failed in shaping Alan into "the proper English gentleman" that was supposed to emerge from the educational system. Instead, Alan consistently fought back against that system, insisting on doing things in which *he* was interested in ways *he* chose to do them. The Alan Turing who left Sherborne in 1930 was still the adventurer unconstrained by social customs. And so he was to remain to the end of his life.

* * *

The Turing name in Great Britain goes back to A.D. 1316 The family was of Norman ancestry, and first settled in the British Isles in the region of Angus in Scotland.[10] The family later moved to Foveran, in Aberdeenshire, where they remained until the late nineteenth century. At various times, the family name was given as Turyne, Thuring, Turin, and Turing. The modern spelling apparently dates from the early 1600s when James VI of Scotland (later James I of England) knighted William Turin, who then added the letter *g* to his name.

The Turing family motto was *Fortuna audentes juvat*, or "Fortune rewards the daring." But observers have pointed out that such was not always the case with the early Turings. During the civil wars of the 1630s, for example, John Turing fought on the side of Charles I, who had earlier made him a baron. When the king's forces were defeated at the battle of Worcester, Turing lost most of the lands that had belonged to his family for over 300 years.

In succeeding generations, male members of the family often traveled overseas to make their fortunes. A number served in the East India Company, while others followed diplomatic service on the Continent. Alan's grandfather, John Robert Turing, attended Trinity College, where he majored in mathematics, but eventually joined the priesthood. He was ordained in 1849 and served for many years thereafter as chaplain of Trinity College and curate at Great St. Mary's Church in Cambridge. He and his wife, the former Fanny Montagu Boyd, had ten children, of whom one was Julius Mathison Turing, Alan's father.

Julius Turing was educated at Bedford School and then at Corpus Christi College, Oxford. He inherited neither his father's interest in or talent for mathematics, nor his devotion to the church. Instead, he chose a career in the Indian Civil Service, where he was assigned to the Presidency of Madras in December 1896. More than a decade later, on a return voyage to England, Julius met and fell in love with Ethel Sara Stoney.

The Stoney family is thought to have originated in Denmark,

but by 1379, had become established in Yorkshire. In the late seventeenth century, George and Mary Stoney were among those who accepted William and Mary's offer of land in Ireland, part of the government's effort to settle more Protestants in England's newest Catholic colony. The Stoneys established their new homesite in Knockshegowna ("Hill of the Fairies") in the northern part of County Tipperary.

Subsequent generations of the Stoney family were marked by a number of prominent scientists and engineers. Francis G. M. Stoney, for example, invented the "Stoney Sluice," a device for controlling the flow of water through canals and irrigation systems. The Stoney sluice was used in the construction of an early Aswan Dam, on the Manchester Ship Canal, on the Richmond Bridge over the River Thames, and at other locations around the world. Francis' brother, Edward Waller Stoney, was a prominent engineer on the Madras and Southern Mahratta Railway in India. Edward's greatest fame was due to his invention of "Stoney's Patent Silent Pukah-Wheel," a large ceiling fan that operated much more quietly than previous models.

Perhaps the best known member of the family today is George Johnstone Stoney (1826-1911), a second cousin of Alan's great-grandfather. In 1891, George Stoney suggested the name *electron* for the fundamental particle of electricity that many people in the late nineteenth century believed to exist, although it was not actually discovered until six years later.

Edward Waller Stoney, whom Alan's biographer Andrew Hodges has described as a "hard-headed, grumpy man,"[11] married another English transplant to Ireland, Sarah Crawford. Among their four children was Alan's mother, Ethel Sara, born at Podanur, Madras Presidency, India, on 18 November 1881. Ethel Sara was educated at the Alexandra School and College in Dublin and at the Cheltenham Ladies' College, and then, in 1900, returned to her family in India. She remained there until 1907, when she set sail again for Great Britain. On that voyage, Ethel Sara met Julius Turing. The two were married on 1 October 1907, shortly after they reached Dublin.

The Turings' first son, John Ferrier, was born on 1 September 1908, in Coonoor, Nilgris, after their return to India. Their second son, Alan Mathison, was conceived in India, although his birth occurred in England. The Turings had scheduled their leave to coincide with Alan's birth so that he could be born on English soil. That birth occurred at Warrington Lodge, Maida Vale, London, on 23 June 1912.

Alan's childhood was one that might raise the eyebrows of the average American today. It was spent almost entirely apart from one or both of his parents, he at foster homes in England, they at British outposts in India. Yet, such childhoods were not uncommon during the heyday of the British Empire. While civil servants and military fathers (accompanied by their spouses) maintained control of lands and administered governments in virtually every part of the world, their children remained at home, in foster homes and preparatory and private schools, watched over, educated, and brought up by nannies, professional foster parents, and teachers. Andrew Hodges has exquisitely described this kind of life as one "in exile from exile," that is, one in which children are separated from their parents overseas, who were themselves away from homes in England.[12]

The first few months of Alan's life were spent with his family, first in England and then, during a holiday with them, in Italy. But by the spring of 1913, Alan's father had returned to India and, a few months later, his mother had joined her husband. Fifteen-month-old Alan and his brother were then sent to stay with a Colonel and Mrs. Ward at St.Leonards-on-Sea. Hodges describes Colonel Ward as "remote and gruff as God the Father" and Mrs. Ward as one who "believed in bringing up boys to be real men."[13]

The next decade was a period during which the two boys saw one or both of their parents only sporadically. For example, Mrs. Turing returned to England for the summer of 1915, taking private rooms at St. Leonard's. And both parents returned in March 1916, Mr. Turing heading back to India in August and his wife remaining with the children until the end of World War I (December 1919). The next visit for the Turings was not until 1921, Mrs. Turing arriving early in the year, her husband in December.

It is somewhat poignant to realize that much of what the Turings knew of the joys and tribulations of their sons' childhoods came from letters sent by the Wards, by relatives, and by the boys themselves, or from their own relatively brief visits. Yet, a fairly clear picture of young Alan emerges from these letters and from Mrs. Turing's own biography of her son, published forty years later. He was apparently a quite normal child, happy, bright, "quite free from shyness and ready to greet anyone," as his mother tells us in her book.[14]

But Alan was an entirely average child. One of Mrs. Turing's friends remembered Alan many years later as a "very unusual little boy."[15] Even at the early age of three, he seems to have shown some interest in scientific experimentation. When one of his toy soldiers was broken, he planted it in the garden, expecting that it would eventually grow into a complete new soldier over time.

As he grew older, Alan continued to display an interest in and a particular talent for learning about the natural world. His mother tells of her visit to England in 1921, during which time she allowed Alan to remain on the street while she was shopping. He occupied his time on this occasion, she wrote, by searching for metal filings in the street gutter. "What he did with these [filings] I do not know," she wrote, "nor indeed how he came to expect metal filings there."[16]

Alan's talent for invention is reflected in a second episode from his parents' visit a year later. To while away the long summer evening, Mrs. Turing tells, the family would hold a contest to see who could blow discarded gooseberry skins the farthest. Alan always won this contest because he found a way to inflate the skins before he propelled them.

Alan's interest in numbers manifested itself early on also. Mrs. Turing describes his passion, even at the age of five, for studying numbers that he came across on the street, such as those imprinted on lamp posts. The problem was that he had trouble remembering whether to read the numbers from left to right or from right to left. To solve this problem, he placed a dot of red ink on his left thumb, a dot he called "the knowing spot." Whenever he

encountered a new number, he would check "the knowing spot" to see from which direction to start reading.

For all the charming little episodes like these that we have from Alan's early life, a more substantial issue remained in the background: his formal education. As with any family of its class, the Turings assumed and expected that John and Alan would obtain the best possible education: attendance at a preparatory school followed by a good public school, and then a college education, preferably at Cambridge, Oxford, or one of the other great universities.

For Alan, this sequence began in the summer of 1918 when he was enrolled at St. Michael's, a pre-preparatory school at St. Leonard's, for the purpose of learning Latin. He apparently made quite an impression on his teachers at St. Michael's for, upon his departure in 1921, the headmistress wrote that Alan "has genius."[17]

The next step in Alan's education was preparatory school. In January 1922, he entered Hazelhurst, near Tunbridge Wells, where his brother was in his last year. John was apparently somewhat embarrassed by his younger sibling's presence at the school. Alan found it difficult to adapt to the formal schedule of classes and constantly looked for distractions more to his liking. One of these was paper folding, a skill he developed on his own and then taught to other boys at the school. Andrew Hodges says that John was somewhat disconcerted to find himself "confronted everywhere with paper frogs and paper boats."[18]

Alan's interest in mathematics continued to reveal itself in somewhat unusual ways. For example, he did not care very much about outdoor sports, but did enjoy acting as linesman for some of the games because the position allowed him to calculate the angle at which a ball left the playing field. This characteristic was noted in a couplet written by his classmates at the end of the term:

> Turing's fond of the football field
> For geometric problems the touch lines yield.[19]

His efforts on the hockey field were also devoted more to the

study of nature than to the game itself. When his mother heard about this fact from another end-of-the-year song, she made a sketch of Alan leaning on his hockey stick, "watching the daisies grow."[20]

Much of Alan's time at Hazelhurst was devoted to experimentation, invention and teaching himself about science. In a 1925 letter to his parents, for example, he reports that he is teaching himself organic chemistry with the aid of an encyclopedia. He encloses structural formulas for methyl ether and ethyl alcohol to show that he understands the concept of isomers.

He also wrote his parents about inventions on which he was working: an original camera, his own typewriter, a homemade fountain pen, and a patent ink. Unfortunately, one of the letters he wrote with his fountain pen and ink was almost illegible since the pen "leaked enough for four."[21]

Even with the finest writing implements, Alan's letters were a chore to read. His mother writes that, at the age of 12, his writing "was so appalling that in the Easter holidays of 1924 . . . he and I settled down to reform it."[22] By the end of the year, however, they had to admit that it was "as bad as ever." Indeed, Alan's written presentations continued to be a challenge for readers as long as he lived.

As Alan found more and more experiments he wanted to do, he gradually evolved a single guiding principle for his work. "I always seem to want," he wrote his mother, "to want to make things from the thing that is commonest in nature and with the least waste of energy."[23] What a remarkable observation for a young man not yet 13 years of age! Nor did the principle fail him. In his later years—even to the last weeks of his life—Alan continued to pursue the ideal of simplicity and efficiency.

Possibly the most important single event during Alan's years at Hazelhurst was his discovery of the book *Natural Wonders Every Child Should Know*, by E. T. Brewster. The book was written, its author explained, to give young readers a general introduction to the subject of human physiology, to help them answer the questions "What have I in common with other living things and how do I

CHAPTER TWO

AT BATTLE WITH THE SYSTEM

Sherborne School, founded in 1550, was one of the public schools that formed the heart of British education. In contrast to that which the name suggests, Sherborne and other "public" schools were not—and are not—comparable to public schools in the United States, open equally to all students who want to attend. Instead, they are private boarding schools where competition for acceptance is intense.

Although Sherborne was, in 1926, only "moderately distinguished,"[26] according to Alan's biographer, Andrew Hodges, its acceptance of Alan was a great relief to the Turings. Like their contemporaries in the middle classes, the Turings saw a public school education as the highest gift they could offer their sons. Such an education provided virtually the only stepping-stone to many of the perquisites available to "gentlemen" in England's highly class-conscious society.

As such, Sherborne and other public schools were designed to train young men—and young men it was, since women were not expected to follow the paths of their male counterparts—for the roles they would be expected to play in adult society. Such schools, in fact, were often described as "the nation in miniature." As such, a crucial—and often primary—goal was the development of respect, patriotism, discipline, cooperation, and other social skills. These social objectives were often thought to be far more important, as is often the case with American schools, than a sophisticated level of academic training.

The public school model on which Sherborne operated spelled

This formula had been known for some time and was taught in the sixth form at Sherborne. Yet, Alan had re-discovered it on his own. When presented with Alan's work, his math teachers announced that the boy was "a genius." That judgment, according to Hodges, however, "sank like a stone in the Sherborne pond."[34]

Alan also produced some original work in the field of chemistry. One of the most interesting projects made use of seaweed he had collected on the beach near the family home in Dinard. Alan discovered on his own a method for extracting iodine from the seaweed. His mother later wrote that Alan's science teacher was "somewhat amused" to discover that his 14-year-old pupil had mastered a chemical technique that was normally introduced only much later in the secondary schools.[35]

Again, Alan's chemical experiments—"stinks" as they were generally known at school—were not highly regarded by most of his teachers. His housemaster wrote in late 1927, for example, that, while Alan's work had improved in some areas, "he should know by now that I don't care to find him boiling heaven knows what witches' brew by the aid of two guttering candles on a naked windowsill."[36]

Yet another field into which Alan plunged on his own was physics. During 1927 he appears to have become especially intrigued by Albert Einstein's theory of relativity. As was often the case, he decided to share his new interest with his mother, sending her an extended précis so that she too could develop an understanding of Einstein's work (!).

At one point in his letters home, Alan notes that Einstein has failed to state the general law of motion for bodies that will satisfy the general principle of relativity. "He [Einstein] does not actually give the law, which I think is a pity, so I will," Alan writes. "It is: 'The separation between any two events in the history of a particle shall be a maximum or minimum when measured along its world line.'"[37]

Mrs. Turing tried valiantly to follow Alan's instruction about relativity although the degree of her success was probably modest. She did acknowledge, however, the significance of her son's own

INDEX

A. M. Turing's ACE Report of 1946 and Other Papers, 77-80, 93
ACE, 77-92
ACM Turing Award Lecture, 41, 107
Aiken, Howard, 76
Artificial intelligence. *See* Machine intelligence
Atanasoff, J. V., 76
Atkins, James, 36, 44, 46
Automatic Computing Engine. *See* ACE
Babbage, Charles, 40-41
Bayley, Donald, 75
Bell, Alan, 103
Bletchley Park, 59-60, 63-68, 69, 70, 71, 74, 80, 81, 91
Bombe, 63-66, 70-71, 74
Brewster, E. T., 21-22
Carpenter, B. E., 77
Chess-playing machine, 70, 78-79
Church, Alonzo, 41-44, 47
Churchill, Sir Winston, 80
Clarke, Joan, 67, 69-70
Clayton, Fred, 93, 101
Clayton, Mrs. (Turing's housekeeper), 104
"Computable numbers" (paper), 44, 45, 46, 76
Computable functions, 38
Computing machine. *See* Turing machine
Cortada, James W., 11
Crick, Sir Francis, 86
Cryptology, 11, 47, 50, 57, 58, 59
Darwin, Charles Galton, 79, 90, 92

Delilah, 74-75
Dirac, P. A. M., 104
Doran, R. W., 77
Eckert, J. Presper, 76
EDVAC Report, 76, 81
Eisenhart, L. P., 45
ENIAC, 76
Enigma machine, 11, 13, 60-66, 70, 71, 72, 74, 74, 76, 107
Entscheidungsproblem, 38, 40, 41, 49
Fibonacci, Leonardo, 97
Fibonacci sequence, 97-98
Forster, E. M., 34
GC&CS. *See* Government Code and Cypher School
Gödel, Kurt, 37, 42, 47
Good, I. J., 13, 31, 70
Government Code and Cypher School (GC&CS), 58-60, 63, 65, 69
Hardy, G. H., 34, 43
Hazelhurst School, 20-22, 24
Hilbert, David, 36-38, 40, 41, 46, 47
Hilton, Peter, 11, 12, 106
Hodges, Alan, 9, 17, 18, 20, 22, 23, 26, 27, 28, 29, 30, 38, 43, 44, 46, 48, 49, 58, 59, 60, 65, 66, 69, 74, 79, 80, 90, 91, 92, 93, 99, 100, 102, 106, 107, 108
Hollymeade (Turing's home), 93, 100, 101, 102
Hut 8, 64, 70, 74
Ince, D. C., 94, 99
"Intelligent Machinery" (paper), 88
Jefferson, Godfrey, 99, 106
Johnson, Neville, 91
Kahn, David, 57
Keynes, John Maynard, 34
Kjell (Turing's acquaintance), 104
Lambda calculus, 41-42
Leibniz, Gottfried Wilhelm, 40
Mac Phail, Donald, 59
Mac Phail, Malcolm, 48

Machine Intelligence, 90
MADAM, 81, 92, 99
Manchester Automatic Digital Machine (MADAM). *See*. MADAM
Mauchly, John William, 76
Michie, Donald, 24, 68, 70, 90
Morcom, Christopher, 27, 29
Morcom Science Prize, 31
Morphogenesis, 11-12, 96-98, 104
Murray, Arnold, 100-102
National Physical Laboratory (NPL), 75, 77-84, 85, 87, 90-93, 95
Natural Wonders Every Child Should Know, 21
Newman, Max H. A., 36, 38, 41, 42, 81, 91, 102
Newman, Lyn (Mrs. Max), 27
Radio Security Service, 74
Rejewski, Marian, 63
Riemann, Georg Friedrich Bernhard, 46-47, 59
Rozycki, Jerzy, 63
Scherbius, Arthur, 60
Schmidt, Hans-Thilo, 63
Sherborne School, 15, 22, 23-32, 96
Sierpinski, Waclaw, 63
Speech encipherment, 72-75
St. Michael's School, 20
Stibitz, George. 76
Stimson, Henry L., 57-58
Stoney, Edward Waller, 17
Stoney, Francis G. M., 17
Stoney, George Johnstone, 17
"Thinking machines". *See* Machine intelligence
Thompson, D'Arcy, 97
Turin, William, 16
Turing, Alan Mathison,
ACE Report of 1946, 77-80 arrest and sentencing, 102-103 at Bletchley Park, 63-71 at Hazelhurst School, 20-22 at home in Wilmslow, 93 at Manchester University, 92-95, 98-99 at the National Physical Laboratory, 75-84 at Princeton University, 43-50 at Sherborne School, 23-32 birth, 18 child-

hood, 18-20 death, 104-106 on chess-playing machines, 78-79 on computable functions, 38-40 on computing machines, 77-79 on machine intelligence, 88-90 on morphogenesis, 96-98 on speech encipherment, 72-75 relationship with Christopher Morcom, 27-29 relationship with Arnold Murray, 100-102
Turing, John (ancestor), 16
Turing, John Ferrier (brother), 18, 20, 22, 102
Turing, John Robert (grandfather), 16
Turing, Julius Mathison (father), 16, 18, 22, 82
Turing, Sara (mother), 12, 16, 17, 18, 19, 21, 22, 26, 31, 44, 67, 68, 83, 96, 105
Turing family (ancestry), 16-17
Turing machine, 39-41
Ultra, 64, 80
Von Neumann, John, 42, 43, 49-50, 76, 90
Ward, Colonel and Mrs., 18-19, 22
Watson, James, 86
Weinberg, Martin, 103
Welchman, Gordon, 64-65, 70
Wilde, Oscar, 33, 69
Wilkinson, J. H., 77, 81, 82, 92
Wittgenstein, Ludwig, 58
Womersley, J. R., 75, 76, 77, 78, 79, 81, 83
X-system. *See* Speech encipherment
Young, John, 98
Zeta function, 46-48, 59
Zygalski, Henryk, 63