

Ciphers that Substitute Symbols

ΣQΔCΣ ΩΥ∅C∂ ∅ΥΣ∅Υ ∅Q∅Δ∅ ΝΥ°λ∅ †hΥ

Some historical simple substitution ciphers substitute symbols for plaintext letters. The ciphertext then looks less familiar – less friendly – but the techniques for cryptanalysis remain the same as for any simple substitution cipher – frequency analysis.

Edgar Allan Poe (1809 - 1849)

Edgar Allan Poe was an avid cryptologist. For six months, beginning in December, 1839, Poe wrote a cryptology column in *Alexander's Weekly Messenger*. In addition to expressing his own ideas about cryptology, Poe solicited cryptological challenges from his readers. Poe published his solutions in his column. About a year after his last column in *Alexander's*, Poe wrote "A Few Words on Secret Writing" for *Graham's Magazine*. In addition to this article, there were several follow-up articles about cryptology.

It was during this time that one of Poe's readers, a Mr. W. B. Tyler, submitted ... two cryptographs Poe never published solutions to Tyler's cryptographs. This fact alone makes them interesting - of the 100-plus cryptographs submitted by his readers, these are the only two not solved. Poe claimed that he did not have the time to work out their solution, but published them in Graham's for his readers to decipher. However, the most interesting aspect of these cryptographs is the possibility that they were not written by W. B. Tyler, but by Poe himself. There is only circumstantial evidence to corroborate the theory that Tyler was Poe's nom de plume. <http://www.bokler.com/eapoe.html>

Tyler's first cryptogram was published in *Graham's* in December 1841.

, + § : †] [, ? †) , [i ¶ ? , † ,) i , § [¶ ¶ ¶ , : ¶ ! [§ (, † § i ¶ (? † ? , * * († † i ([, ¶ * . † [§ i ¶ § i ¶] ; , † § [? (§ [: : († [. † (* ; (¶ (, † § i † [* : ,] ! ¶ † ¶] ? * ! ¶ † † § ¶ ¶ ¶ , * († i (, ? † § (i ¶ i ¶ [? (, ; § † ¶ †] † § § : († [† [¶ ? †] : * i ¶ : (§ ?) ! ¶ † § †] ; § ? † † i † † ¶ ! (, † § ? (¶ *] [§ i ' i , : , † § ¶) , ? ¶ *] ? , § § (! † i (, † § † [† !) *] [† : ?] ¶

It was solved in 1992 by Terrance Whalen.

"The soul secure in her existence smiles at the drawn dagger and defies its point. The stars shall fade away, the sun himself grow dim with age and nature sink in years, but thou shalt flourish in immortal youth, unhurt amid the war of elements, the wreck of matter and the crush of worlds."

According to Rosenheim's account in "The Cryptographic Imagination" Whalen's solution proceeded from recognition that the three-character pattern of "comma-dagger-section symbol", repeated seven times in eight lines, most likely represented the word "the" or "and". It turned out to be "the". <http://www.bokler.com/eapoe.html>

Tyler's second cryptogram was solved in June, 2000, by Gil Broza.

TO EDGAR A. POE, ESQ.

DR TIK OGWEX PjFyY nBUH TIA VQSMGø
XDtbjs SNB esvLNK8Yø]CP Tl HZGUC
LTLKTL Wv LQDn Rf jfKTLT Ta
QJTBXPeE yGwdU P BVA TS au tCDYR
DHB YFKXDGf ZNSMELL rO rO rO z h Mfg
wViegXHB AuL NKN AFKsO iybJVDV bPLFgsfeg
SPZl CEJMSW bGerth aNjma sYvThyAcs YakXDI
wS dNB Løu Lph njuj atg atg diky Wv o cEpidE
SEB dNB Løu Lph njuj atg atg diky Wv o cEpidE
ZyZ eIf kMK xyKSg HlitW Bø P bTb dYj rVv
Uøicame nk VFHVA IDah XMKTIax Ye vF adFw
XøKUMK UvAw sE B AgO iX umey rPC GIOG
NBLEmMQ nk LcOR SIBVtS NZø agjy hlgdy
RZuK CtX Wv JDMNVUøX QFUA NNDG
bzpL Lbt h fW eTøYd TIA VIRMFTV
vAHHP nNB NGI Wv jLVUctm cW jLVUctm
Mf YKiUin cW vaxwgiQ LmVA sE aFECtXky
AGG MjG ARNwAQ cmr rzr zri Ohtx zri
CFG zri P TSLBDI oajf ky cJ CFG
IyV atn cPREG B Vtda K vFpnj ePjç Wfpb
Kj wmy fDg

<http://www.bokler.com/eapoe.html>

Then, in July, Gil Broza, a software engineer living in Toronto, submitted what turned out to be the correct decryption. Tyler's cryptograph proved to be a polyalphabetic substitution cipher using several different symbols for each English letter. The number of different symbols is greater as the plaintext letter is more frequent in English text, for instance 'z' is encrypted by two symbols and 'e' by 14. Given the brevity of the cipher, this meant that there was almost no information about letter frequencies, which cryptographers count as their most potent tool for decryption. In addition, Broza's solution revealed that the original cipher had over two dozen mistakes introduced by the typesetters or the encipherer. Many of these were trivial (such as "warb" for "warm," "shaye" for

“share,” “langomr” for “langour”), but even after Broza corrected obvious errors, the final plaintext is sometimes garbled:

It was early spring, warm and sultry glowed the afternoon. The very breezes seemed to share the delicious langour of universal nature, are laden the various and mingled perfumes of the rose and the -essaerne (?), the woodbine and its wildflower. They slowly wafted their fragrant offering to the open window where sat the lovers. The ardent sun shoot fell upon her blushing face and its gentle beauty was more like the creation of romance or the fair inspiration of a dream than the actual reality on earth. Tenderly her lover gazed upon her as the clusterous ringlets were edged (?) by amorous and sportive zephyrs and when he perceived (?) the rude intrusion of the sunlight he sprang to draw the curtain but softly she stayed him. “No, no, dear Charles,” she softly said, “much rather you’ld I have a little sun than no air at all.”

<http://www.bokler.com/eapoe.html>

Poe is also famous, at least among cryptologists, for his short story “The Gold Bug.” The focus of his story is the solution of a simple substitution cipher that holds the key to locating buried treasure. In the story, Poe provides an excellent tutorial in cryptanalyzing a simple substitution cipher.

Edgar Allan Poe (1802-1842)

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THE GOLD-BUG (1843)

mitted it to my inspection. The following characters were rudely traced, in a red tint, between the death's-head and the goat:

53††1305)6*;4826)4†);806*;48†8†60)85;18*
†18†83(88)5*†;46(:88*96*?;8)*†(;485);5*†2:*†(;4
956*2(5*—4)8†8*;4069285);)6†8);4††;1(†9;48081;8:
8†1;48†85;4)485†528806*81(†9;48;(88;4(†?34;48)4†
;161;188;†?;

"But," said I, returning him the slip, "I am as much in the dark as ever. Were all the jewels of Golconda awaiting me on my solution of this enigma, I am quite sure that I should be unable to earn them."

"And yet," said Legrand, "the solution is by no means so difficult as you might be led to imagine from the first hasty inspection of the characters. These characters, as any one might readily guess, form a cipher—that is to say, they convey a meaning; but then, from what is known of Kidd, I could not suppose him capable of constructing any of the more abstruse cryptographs. I made up my mind, at once, that this was of a simple species—such, however, as would appear, to the crude intellect of the sailor, absolutely insoluble without the key."

"And you really solved it?"

"Readily; I have solved others of an abstruseness ten thousand times greater. Circumstances, and a certain bias of mind, have led me to take interest in such riddles, and it may well be doubted whether human ingenuity can construct an enigma of the kind which human ingenuity may not, by proper application, resolve. In fact, having once established connected and legible characters, I scarcely gave a thought to the mere difficulty of developing their import.

THE GOLD-BUG

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"In the present case—indeed in all cases of secret writing—the first question regards the *language* of the cipher; for the principles of solution, so far, especially, as the more simple ciphers are concerned, depend on, and are varied by, the genius of the particular idiom. In general, there is no alternative but experiment (directed by probabilities) of every tongue known to him who attempts the solution, until the true one be attained. But, with the cipher now before us, all difficulty is removed by the signature. The pun on the word 'Kidd' is appreciable in no other language than the English. But for this consideration I should have begun my attempts with the Spanish and French, as the tongues in which a secret of this kind would most naturally have been written by a pirate of the Spanish main. As it was, I assumed the cryptograph to be English.

"You observe there are no divisions between the words. Had there been divisions, the task would have been comparatively easy. In such case I should have commenced with a collation and analysis of the shorter words, and, had a word of a single letter occurred, as is most likely, (*a* or *I*, for example,) I should have considered the solution as assured. But, there being no division, my first step was to ascertain the predominant letters, as well as the least frequent. Counting all, I constructed a table, thus:

Of the character	8	there are	33.
;	"	"	26.
4	"	"	19.
†)	"	"	16.
.	"	"	13.
5	"	"	12.
6	"	"	11.
† 1	"	"	8.

Of the character	0	there are	6.
	9 2	"	5.
	:	3	4.
	?	"	3.
	¶	"	2.
] —	"	

"Now, in the English, the letter which most frequently occurs is *e*. Afterwards, the succession runs thus: *a o i d h n r s t u y c f g l m w b k p q x z*. *E* however predominates so remarkably that an individual sentence of any length is rarely seen, in which it is not the prevailing character.

"Here, then, we have, in the very beginning, the groundwork for something more than a mere guess. The general use which may be made of the table is obvious—but, in this particular cipher, we shall only very partially require its aid. As our predominant character is 8, we will commence by assuming it as the *e* of the natural alphabet. To verify the supposition, let us observe if the 8 be seen often in couples—for *e* is doubled with great frequency in English—in such words, for example, as 'meet,' 'fleet,' 'speed,' 'seen,' 'been,' 'agree,' &c. In the present instance we see it doubled no less than five times, although the cryptograph is brief.

"Let us assume 8, then, as *e*. Now, of all words in the language, 'the' is most usual; let us see, therefore, whether there are not repetitions of any three characters, in the same order of collocation, the last of them being 8. If we discover repetitions of such letters, so arranged, they will most probably represent the word 'the.' On inspection, we find no less than seven such arrangements, the characters being ;48. We may, therefore, assume that the semicolon represents *t*, that 4 represents *h*, and

that 8 represents *e*—the last being now well confirmed. Thus a great step has been taken.

"But, having established a single word, we are enabled to establish a vastly important point; that is to say, several commencements and terminations of other words. Let us refer, for example, to the last instance but one, in which the combination ;48 occurs—not far from the end of the cipher. We know that the semicolon immediately ensuing is the commencement of a word, and, of the six characters succeeding this 'the,' we are cognizant of no less than five. Let us set these characters down, thus, by the letters we know them to represent, leaving a space for the unknown—

^t eeth.

"Here we are enabled, at once, to discard the 'th,' as forming no portion of the word commencing with the first *t*; since, by experiment of the entire alphabet for a letter adapted to the vacancy we perceive that no word can be formed of which this *th* can be a part. We are thus narrowed into

^t ee,

and, going through the alphabet, if necessary, as before, we arrive at the word 'tree,' as the sole possible reading. We thus gain another letter, *r*, represented by (, with the words 'the tree' in juxtaposition.

"Looking beyond these words, for a short distance, we again see the combination ;48, and employ it by way of *termination* to what immediately precedes. We have thus this arrangement:

the tree ;4 (t?34 the,

or, substituting the natural letters, where known, it reads thus:

the tree thr t?3h the.

"Now, if, in place of the unknown characters, we leave blank spaces, or substitute dots, we read thus:

the tree thr...h the,
when the word 'through' makes itself evident at once. But this discovery gives us three new letters, o, u and g, represented by t, p and s.

"Looking now, narrowly, through the cipher for combinations of known characters, we find, not very far from the beginning, this arrangement,

83(88, or egree,

which, plainly, is the conclusion of the word 'degree,' and gives us another letter, d, represented by t.

"Four letters beyond the word 'degree,' we perceive the combination

;46(88*.

"Translating the known characters, and representing the unknown by dots, as before, we read thus:

thtree.

an arrangement immediately suggestive of the word 'thirteen,' and again furnishing us with two new characters, t and n, represented by 6 and *

"Referring, now, to the beginning of the cryptograph, we find the combination,

53ttt.

"Translating, as before, we obtain
.good,

which assures us that the first letter is A, and that the first two words are 'A good.'

"To avoid confusion, it is now time that we arrange our key, as far as discovered, in a tabular form. It will stand thus:

5	represents	a
t	"	d
8	"	e
3	"	g
4	"	h
6	"	i

*	represents	n
t	"	o
("	r
:	"	t

"We have, therefore, no less than ten of the most important letters represented, and it will be unnecessary to proceed with the details of the solution. I have said enough to convince you that ciphers of this nature are readily soluble, and to give you some insight into the rationale of their development. But be assured that the specimen before us appertains to the very simplest species of cryptograph. It now only remains to give you the full translation of the characters upon the parchment, as unridled. Here it is:

*"A good glass in the bishop's hostel in the devil's seat
twenty-one degrees and thirteen minutes northeast and
by north main branch seventh limb east side shoot from
the left eye of the death's-head a bee line from the tree
through the shot fifty feet out."*

"But," said I, "the enigma seems still in as bad a condition as ever. How is it possible to extort a meaning from all this jargon about 'devil's seats,' 'death's-heads,' and 'bishop's hostels?'"

"I confess," replied Legrand, "that the matter still wears a serious aspect, when regarded with a casual glance. My first endeavor was to divide the sentence into the natural division intended by the cryptographer."

"You mean, to punctuate it?"

"Something of that kind."

"But how was it possible to effect this?"

"I reflected that it had been a point with the writer to run his words together without division, so as to increase the difficulty of solution. Now, a not over-acute

Sherlock Holmes

Sir Arthur Conan Doyle's fictional detective Sherlock Holmes also faced a simple substitution cipher in "The Adventure of the Dancing Men." Holmes used his cryptanalysis of the dancing men cipher to trick a murder into being captured.

"Precisely. Consider what the Ritual says. How does it run? "Whose was it?" "His who is gone." That was after the execution of Charles. Then, "Who shall have it?" "He who will come." That was Charles the Second, whose advent was already foreseen. There can, I think, be no doubt that this battered and shapeless diadem once encircled the brows of the royal Stuarts."

"And how came it in the pond?"

"Ah, that is a question that will take some time to answer.' And with that I sketched out to him the whole long chain of surmise and of proof which I had constructed. The twilight had closed in and the moon was shining brightly in the sky before my narrative was finished.

"And how was it then that Charles did not get his crown when he returned?" asked Musgrave, pushing back the relic into its linen bag.

"Ah, there you lay your finger upon the one point which we shall probably never be able to clear up. It is likely that the Musgrave who held the secret died in the interval, and by some oversight left this guide to his descendant without explaining the meaning of it. From that day to this it has been handed down from father to son, until at last it came within reach of a man who tore its secret out of it and lost his life in the venture."

"And that's the story of the Musgrave Ritual, Watson. They have the crown down at Hurststone—though they had some legal bother and a considerable sum to pay before they were allowed to retain it. I am sure that if you mentioned my name they would be happy to show it to you. Of the woman nothing was ever heard, and the probability is that she got away out of England and carried herself and the memory of her crime to some land beyond the seas."

The Adventure of the Dancing Men

HOLMES HAD BEEN seated for some hours in silence with his long, thin back curved over a chemical vessel in which he was brewing a particularly malodorous product. His head was sunk upon his breast, and he looked from my point of view like a strange, lank bird, with dull gray plumage and a black top-knot.

"So, Watson," said he, suddenly, "you do not propose to invest in South African securities?"

I gave a start of astonishment. Accustomed as I was to Holmes's curious faculties, this sudden intrusion into my most intimate thoughts was utterly inexplicable.

"How on earth do you know that?" I asked.

He wheeled round upon his stool, with a steaming test-tube in his hand, and a gleam of amusement in his deep-set eyes.

"Now, Watson, confess yourself utterly taken aback," said he.

"I am."

"I ought to make you sign a paper to that effect."

"Why?"

"Because in five minutes you will say that it is all so absurdly simple."

"I am sure that I shall say nothing of the kind."

"You see, my dear Watson"—he propped his test-tube in the rack, and began to lecture with the air of a professor addressing his class—"it is not really difficult to construct a series of inferences, each dependent upon its predecessor and each simple in itself. If, after doing so, one simply knocks out all the central inferences and presents one's audience with the starting-point and the conclusion, one may produce a startling, though possibly a meretricious, effect. Now, it was not really difficult, by an inspection of the groove between your left forefinger and thumb, to feel sure that you did *not* propose to invest your small capital in the gold fields."

"I see no connection."

"Very likely not; but I can quickly show you a close connection. Here are the missing links of the very simple chain: 1. You had chalk between your left finger and thumb when you returned from the club last night. 2. You put chalk there when you play billiards, to steady the cue. 3. You never play billiards except with Thurston. 4. You told me, four weeks ago, that Thurston had an option on some South African property which would expire in a month, and which he desired you to share with him. 5. Your check-book is locked in my drawer, and you have not asked for the key. 6. You do not propose to invest your money in this manner."

"How absurdly simple!" I cried.

"Quite so!" said he, a little nettled. "Every problem becomes very childish when once it is explained to you. Here is an unexplained one. See what you can make of that, friend Watson." He tossed a sheet of paper upon the table, and turned once more to his chemical analysis.

I looked with amazement at the absurd hieroglyphics upon the paper.

"Why, Holmes, it is a child's drawing," I cried.

"Oh, that's your ideal!"

"What else should it be?"

"That is what Mr. Hilton Cubbit, of Riding Thorpe Manor, Norfolk, is very anxious to know. This little conundrum came by the first post, and he was to follow by the next train. There's a ring at the bell, Watson. I should not be very much surprised if this were he."

A heavy step was heard upon the stairs, and an instant later there entered a tall, ruddy, clean-shaven gentleman, whose clear eyes and florid cheeks told of a life led far from the fogs of Baker Street. He seemed to bring a whiff of his strong, fresh, bracing, east-coast air with him as he entered. Having shaken hands with each of us, he was about to sit down, when his eye rested upon the paper with the curious markings, which I had just examined and left upon the table.

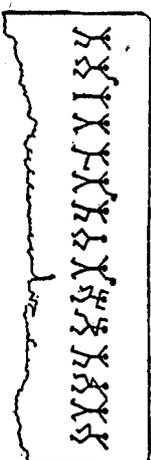
"Well, Mr. Holmes, what do you make of these?" he cried. "They told me that you were fond of queer mysteries, and I don't think you can find a queerer one than that. I sent the paper on ahead, so that you might have time to study it before I came."

"It is certainly rather a curious production," said Holmes. "At first sight it would appear to be some childish prank. It consists of a number of absurd little figures dancing across the paper upon which they are drawn. Why should you attribute any importance to so grotesque an object?"

"I never should, Mr. Holmes. But my wife does. It is frightening her to death. She says nothing, but I can see terror in her eyes. That's why I want to sift the matter to the bottom."

Holmes held up the paper so that the sunlight shone full upon it. It

was a page torn from a notebook. The markings were done in pencil, and ran in this way:



Holmes examined it for some time, and then, folding it carefully up, he placed it in his pocketbook.

"This promises to be a most interesting and unusual case," said he. "You gave me a few particulars in your letter, Mr. Hilton Cubbit, but I should be very much obliged if you would kindly go over it all again for the benefit of my friend, Dr. Watson."

"I'm not much of a story-teller," said our visitor, nervously clasping and unclasping his great, strong hands. "You'll just ask me anything that I don't make clear. I'll begin at the time of my marriage last year, but I want to say first of all that, though I'm not a rich man, my people have been at Riding Thorpe for a matter of five centuries, and there is no better known family in the County of Norfolk. Last year I came up to London for the Jubilee, and I stopped at a boarding-house in Russell Square, because Parker, the vicar of our parish, was staying in it. There was an American young lady there—Patrick was the name—Elsie Patrick. In some way we became friends, until before my month was up I was as much in love as man could be. We were quietly married at a registry office, and we returned to Norfolk a wedded couple. You'll think it very mad, Mr. Holmes, that a man of a good old family should marry a wife in this fashion, knowing nothing of her past or of her people, but if you saw her and knew her, it would help you to understand."

"She was very straight about it, was Elsie. I can't say that she did not give me every chance of getting out of it if I wished to do so. 'I have had some very disagreeable associations in my life,' said she, 'I wish to forget all about them. I would rather never allude to the past, for it is very painful to me. If you take me, Hilton, you will take a woman who has nothing that she need be personally ashamed of, but you will have to be content with my word for it, and to allow me to be silent as to all that passed up to the time when I became yours. If these conditions are too hard, then go back to Norfolk, and leave me to the lonely life in which you found me.' It was only the day before our wedding that she said those very words to me. I told her that I was content to take her on her own terms, and I have been as good as my word."

"Well, we have been married now for a year, and very happy we have

been. But about a month ago, at the end of June, I saw for the first time signs of trouble. One day my wife received a letter from America. I saw the American stamp. She turned deadly white, read the letter, and threw it into the fire. She made no allusion to it afterwards, and I made none, for a promise is a promise, but she has never known an easy hour from that moment. There is always a look of fear upon her face—a look as if she were waiting and expecting. She would do better to trust me. She would find that I was her best friend. But until she speaks, I can say nothing. Mind you, she is a truthful woman, Mr. Holmes, and whatever trouble there may have been in her past life it has been no fault of hers. I am only a simple Norfolk squire, but there is not a man in England who ranks his family honour more highly than I do. She knows it well, and she knew it well before she married me. She would never bring any strain upon it—of that I am sure.

"Well, now I come to the queer part of my story. About a week ago—it was the Tuesday of last week—I found on one of the window-sills a number of absurd little dancing figures like these upon the paper. They were scrawled with chalk. I thought that it was the stable-boy who had drawn them, but the lad swore he knew nothing about it. Anyhow, they had come there during the night. I had them washed out, and I only mentioned the matter to my wife afterwards. To my surprise, she took it very seriously, and begged me if any more came to let her see them. None did come for a week, and then yesterday morning I found this paper lying on the sundial in the garden. I showed it to Elsie, and down she dropped in a dead faint. Since then she has looked like a woman in a dream, half dazed, and with terror always lurking in her eyes. It was then that I wrote and sent the paper to you, Mr. Holmes. It was not a thing that I could take to the police, for they would have laughed at me, but you will tell me what to do. I am not a rich man, but if there is any danger threatening my little woman, I would spend my last copper to shield her."

He was a fine creature, this man of the old English soil—simple, straight, and gentle, with his great, earnest blue eyes and broad, comely face. His love for his wife and his trust in her shone in his features. Holmes had listened to his story with the utmost attention, and now he sat for some time in silent thought.

"Don't you think, Mr. Cubitt," said he, at last, "that your best plan would be to make a direct appeal to your wife, and to ask her to share her secret with you?"

Hilton Cubitt shook his massive head.

"A promise is a promise, Mr. Holmes. If Elsie wished to tell me she would. If not, it is not for me to force her confidence. But I am justified in taking my own line—and I will."

"Then I will help you with all my heart. In the first place, have you heard of any strangers being seen in your neighbourhood?"

"No."

"I presume that it is a very quiet place. Any fresh face would cause comment?"

"In the immediate neighbourhood, yes. But we have several small watering-places not very far away. And the farmers take in lodgers."

"These hieroglyphics have evidently a meaning. If it is a purely arbitrary one, it may be impossible for us to solve it. If, on the other hand, it is systematic, I have no doubt that we shall get to the bottom of it. But this particular sample is so short that I can do nothing, and the facts which you have brought me are so indefinite that we have no basis for an investigation. I would suggest that you return to Norfolk, that you keep a keen lookout, and that you take an exact copy of any fresh dancing men which may appear. It is a thousand pities that we have not a reproduction of those which were done in chalk upon the window-sill. Make a discreet inquiry also as to any strangers in the neighbourhood. When you have collected some fresh evidence, come to me again. That is the best advice which I can give you, Mr. Hilton Cubitt. If there are any pressing fresh developments, I shall be always ready to run down and see you in your Norfolk home."

The interview left Sherlock Holmes very thoughtful, and several times in the next few days I saw him take his slip of paper from his notebook and look long and earnestly at the curious figures inscribed upon it. He made no allusion to the affair, however, until one afternoon a fortnight or so later. I was going out when he called me back.

"You had better stay here, Watson."

"Why?"

"Because I had a wire from Hilton Cubitt this morning. You remember Hilton Cubitt, of the dancing men? He was to reach Liverpool Street at one-twenty. He may be here at any moment. I gather from his wire that there have been some new incidents of importance."

We had not long to wait, for our Norfolk squire came straight from the station as fast as a hansom could bring him. He was looking worried and depressed, with tired eyes and a lined forehead.

"It's getting on my nerves, this business, Mr. Holmes," said he, as he sank, like a wearied man, into an armchair. "It's bad enough to feel that you are surrounded by unseen, unknown folk, who have some kind of design upon you, but when, in addition to that, you know that it is just killing your wife by inches, then it becomes as much as flesh and blood can endure. She's wearing away under it—just wearing away before my eyes."

"Has she said anything yet?"

"No, Mr. Holmes, she has not. And yet there have been times when the poor girl has wanted to speak, and yet could not quite bring herself to take the plunge. I have tried to help her, but I daresay I did it clumsily, and scared her from it. She has spoken about my old family, and our reputation in the county, and our pride in our unsullied honour, and I always felt it was leading to the point, but somehow it turned off before we got there."

"But you have found out something for yourself?"

"A good deal, Mr. Holmes. I have several fresh dancing-men pictures for you to examine, and what is more important, I have seen the fellow."

"What, the man who draws them?"

"Yes, I saw him at his work. But I will tell you everything in order. When I got back after my visit to you, the very first thing I saw next morning was a fresh crop of dancing men. They had been drawn in chalk upon the black wooden door of the tool-house, which stands beside the lawn in full view of the front windows. I took an exact copy, and here it is." He unfolded a paper and laid it upon the table. Here is a copy of the hieroglyphics:

XXXXXXXXXX
XXXXXX-XXXXX
XXXXXX

"Excellent!" said Holmes. "Excellent! Pray continue."

"When I had taken the copy, I rubbed out the marks, but, two mornings later, a fresh inscription had appeared. I have a copy of it here":

XXXXXXXXXX
XXXXXX-XXXXX
XXXXXX

Holmes rubbed his hands and chuckled with delight.

"Our material is rapidly accumulating," said he.

"Three days later a message was left scrawled upon paper, and placed under a pebble upon the sundial. Here it is. The characters are, as you see, exactly the same as the last one. After that I determined to lie in wait, so I got out my revolver and I sat up in my study, which overlooks the lawn and garden. About two in the morning I was seated by the window, all being dark save for the moonlight outside, when I heard steps behind me, and there was my wife in her dressing-gown. She implored me to come to bed. I told her frankly that I wished to see who it was who played such absurd tricks upon us. She answered that it was some senseless practical joke, and that I should not take any notice of it.

"If it really annoys you, Hilton, we might go and travel, you and I, and so avoid this nuisance."

"What, be driven out of our own house by a practical joker?" said I. "Why, we should have the whole county laughing at us."

"Well, come to bed," said she, "and we can discuss it in the morning."

"Suddenly, as she spoke, I saw her white face grow whiter yet in the moonlight, and her hand tightened upon my shoulder. Something was moving in the shadow of the tool-house. I saw a dark, creeping figure which crawled round the corner and squatted in front of the door. Seizing my pistol, I was rushing out, when my wife threw her arms round me and held me with convulsive strength. I tried to throw her off, but she clung to me most desperately. At last I got clear, but by the time I had opened the door and reached the house the creature was gone. He had left a trace of his presence, however, for there on the door was the very same arrangement of dancing men which had already twice appeared, and which I have copied on that paper. There was no other sign of the fellow anywhere, though I ran all over the grounds. And yet the amazing thing is that he must have been there all the time, for when I examined the door again in the morning, he had scrawled some more of his pictures under the line which I had already seen."

"Have you that fresh drawing?"

"Yes, it is very short, but I made a copy of it, and here it is."

Again he produced a paper. The new dance was in this form:

XXXXXX
XXXXXX-XXXXX
XXXXXX

"Tell me," said Holmes—and I could see by his eyes that he was much excited—"was this a mere addition to the first or did it appear to be entirely separate?"

"It was on a different panel of the door."

"Excellent! This is far the most important of all for our purpose. It fills me with hopes. Now, Mr. Hilton Cubitt, please continue your most interesting statement."

"I have nothing more to say, Mr. Holmes, except that I was angry with my wife that night for having held me back when I might have caught the skulking rascal. She said that she feared that I might come to harm. For an instant it had crossed my mind that perhaps what she really feared was that she might come to harm, for I could not doubt that she knew who this man was, and what he meant by these strange signals. But there is a tone in my wife's voice, Mr. Holmes, and a look in her eyes which forbid doubt, and I am sure that it was indeed my own safety that was in her mind. There's the whole case, and now I want your advice as to what I ought to do. My own inclination is to put half a dozen of my farm lads in

fears left him in a blank melancholy. He leaned back in his seat, lost in gloomy speculation. Yet there was much around to interest us, for we were passing through as singular a countryside as any in England, where a few scattered cottages represented the population of to-day, while on every hand enormous square-towered churches bristled up from the flat green landscape and told of the glory and prosperity of old East Anglia. At last the violet rim of the German Ocean appeared over the green edge of the Norfolk coast, and the driver pointed with his whip to two old brick and timber gables which projected from a grove of trees. "That's Riding Thorpe Manor," said he.

As we drove up to the porticoed front door, I observed in front of it, beside the tennis lawn, the black tool-house and the pedestalled sundial with which we had such strange associations. A dapper little man, with a quick, alert manner and a waxed moustache, had just descended from a high dog-cart. He introduced himself as Inspector Martin, of the Norfolk Constabulary, and he was considerably astonished when he heard the name of my companion.

"Why, Mr. Holmes, the crime was only committed at three this morning. How could you hear of it in London and get to the spot as soon as I?"

"I anticipated it. I came in the hope of preventing it."

"Then you must have important evidence, of which we are ignorant, for they were said to be a most united couple."

"I have only the evidence of the dancing men," said Holmes. "I will explain the matter to you later. Meanwhile, since it is too late to prevent this tragedy, I am very anxious that I should use the knowledge which I possess in order to insure that justice be done. Will you associate me in your investigation, or will you prefer that I should act independently?"

"I should be proud to feel that we were acting together, Mr. Holmes," said the inspector, earnestly.

"In that case I should be glad to hear the evidence and to examine the premises without an instant of unnecessary delay."

Inspector Martin had the good sense to allow my friend to do things in his own fashion, and contented himself with carefully noting the results. The local surgeon, an old, white-haired man, had just come down from Mrs. Hilton Cubitt's room, and he reported that her injuries were serious, but not necessarily fatal. The bullet had passed through the front of her brain, and it would probably be some time before she could regain consciousness. On the question of whether she had been shot or had shot herself, he would not venture to express any decided opinion. Certainly the bullet had been discharged at very close quarters. There was only the one pistol found in the room, two barrels of

which had been emptied. Mr. Hilton Cubitt had been shot through the heart. It was equally conceivable that he had shot her and then himself, or that she had been the criminal, for the revolver lay upon the floor midway between them.

"Has he been moved?" asked Holmes.

"We have moved nothing except the lady. We could not leave her lying wounded upon the floor."

"How long have you been here, Doctor?"

"Since four o'clock."

"Anyone else?"

"Yes, the constable here."

"And you have touched nothing?"

"Nothing."

"You have acted with great discretion. Who sent for you?"

"The housemaid, Saunders."

"Was it she who gave the alarm?"

"She and Mrs. King, the cook."

"Where are they now?"

"In the kitchen, I believe."

"Then I think we had better hear their story at once."

The old hall, oak-panelled and high-windowed, had been turned into a court of investigation. Holmes sat in a great, old-fashioned chair, his inexorable eyes gleaming out of his haggard face. I could read in them a set purpose to devote his life to this quest until the client whom he had failed to save should at last be avenged. The trim Inspector Martin, the old, gray-headed country doctor, myself, and a stolid village policeman made up the rest of that strange company.

The two women told their story clearly enough. They had been aroused from their sleep by the sound of an explosion, which had been followed a minute later by a second one. They slept in adjoining rooms, and Mrs. King had rushed in to Saunders. Together they had descended the stairs. The door of the study was open, and a candle was burning upon the table. Their master lay upon his face in the centre of the room. He was quite dead. Near the window his wife was crouching, her head leaning against the wall. She was horribly wounded, and the side of her face was red with blood. She breathed heavily, but was incapable of saying anything. The passage, as well as the room, was full of smoke and the smell of powder. The window was certainly shut and fastened upon the inside. Both women were positive upon the point. They had at once sent for the doctor and for the constable. Then, with the aid of the groom and the stable-boy, they had conveyed their injured mistress to her room. Both she and her husband had occupied the bed. She was

clad in her dress—he in his dressing-gown, over his night-clothes. Nothing had been moved in the study. So far as they knew, there had never been any quarrel between husband and wife. They had always looked upon them as a very united couple.

These were the main points of the servants' evidence. In answer to Inspector Martin, they were clear that every door was fastened upon the inside, and that no one could have escaped from the house. In answer to Holmes, they both remembered that they were conscious of the smell of powder from the moment that they ran out of their rooms upon the top floor. "I comment that fact very carefully to your attention," said Holmes to his professional colleague. "And now I think that we are in a position to undertake a thorough examination of the room."

The study proved to be a small chamber, lined on three sides with books, and with a writing-table facing an ordinary window, which looked out upon the garden. Our first attention was given to the body of the unfortunate squire, whose huge frame lay stretched across the room. His disordered dress showed that he had been hastily aroused from sleep. The bullet had been fired at him from the front, and had remained in his body, after penetrating the heart. His death had certainly been instantaneous and painless. There was no powder-marking either upon his dressing-gown or on his hands. According to the county surgeon, the lady had stains upon her face, but none upon her hand.

"The absence of the latter means nothing, though its presence may mean everything," said Holmes. "Unless the powder from a badly fitting cartridge happens to spurt backward, one may fire many shots without leaving a sign. I would suggest that Mr. Cubitt's body may now be removed. I suppose, Doctor, you have not recovered the bullet which wounded the lady?"

"A serious operation will be necessary before that can be done. But there are still four cartridges in the revolver. Two have been fired and two wounds inflicted, so that each bullet can be accounted for."

"So it would seem," said Holmes. "Perhaps you can account also for the bullet which has so obviously struck the edge of the window?"

He had turned suddenly, and his long, thin finger was pointing to a hole which had been drilled right through the lower window-sash, about an inch above the bottom.

"By George!" cried the inspector. "How ever did you see that?"

"Because I looked for it."

"Wonderful!" said the country doctor. "You are certainly right, sir. Then a third shot has been fired, and therefore a third person must have been present. But who could that have been, and how could he have got away?"

"That is the problem which we are now about to solve," said Sherlock Holmes. "You remember, Inspector Martin, when the servants said that on leaving their room they were at once conscious of a smell of powder, I remarked that the point was an extremely important one?"

"Yes, sir; but I confess I did not quite follow you."

"It suggested that at the time of the firing, the window as well as the door of the room had been open. Otherwise the fumes of powder could not have been blown so rapidly through the house. A draught in the room was necessary for that. Both door and window were only open for a very short time, however."

"How do you prove that?"

"Because the candle was not guttered."

"Capital!" cried the inspector. "Capital!"

"Feeling sure that the window had been open at the time of the tragedy, I conceived that there might have been a third person in the affair, who stood outside this opening and fired through it. Any shot directed at this person might hit the sash. I looked, and there, sure enough, was the bullet mark!"

"But how came the window to be shut and fastened?"

"The woman's first instinct would be to shut and fasten the window. But, halloo! what is this?"

It was a lady's hand-bag which stood upon the study table—a trim little hand-bag of crocodile-skin and silver. Holmes opened it and turned the contents out. There were twenty fifty-pound notes of the Bank of England, held together by an india-rubber band—nothing else.

"This must be preserved, for it will figure in the trial," said Holmes, as he handed the bag with its contents to the inspector. "It is now necessary that we should try to throw some light upon this third bullet, which has clearly, from the splintering of the wood, been fired from inside the room. I should like to see Mrs. King, the cook, again. You said, Mrs. King, that you were awakened by a loud explosion. When you said that, did you mean that it seemed to you to be louder than the second one?"

"Well, sir, it awakened me from my sleep, and so it is hard to judge. But it did seem very loud."

"You don't think that it might have been two shots fired almost at the same instant?"

"I am sure I couldn't say, sir."

"I believe that it was undoubtedly so. I rather think, Inspector Martin, that we have now exhausted all that this room can teach us. If you will kindly step round with me, we shall see what fresh evidence the garden has to offer."

A flower-bed extended up to the study window, and we all broke into an exclamation as we approached it. The flowers were trampled down, and the soft soil was imprinted all over with footmarks. Large, masculine feet they were, with peculiarly long, sharp toes. Holmes hunted about among the grass and leaves like a retriever after a wounded bird. Then, with a cry of satisfaction, he bent forward and picked up a little brazen cylinder.

"I thought so," said he; "the revolver had an ejector, and here is the third cartridge. I really think, Inspector Martin, that our case is almost complete."

The country inspector's face had shown his intense amazement at the rapid and masterful progress of Holmes's investigation. At first he had shown some disposition to assert his own position, but now he was overcome with admiration, and ready to follow without question wherever Holmes led.

"Whom do you suspect?" he asked.

"I'll go into that later. There are several points in this problem which I have not been able to explain to you yet. Now that I have got so far, I had best proceed on my own lines, and then clear the whole matter up once and for all."

"Just as you wish, Mr. Holmes, so long as we get our man."

"I have no desire to make mysteries, but it is impossible at the moment of action to enter into long and complex explanations. I have the threads of this affair all in my hand. Even if this lady should never recover consciousness, we can still reconstruct the events of last night, and insure that justice be done. First of all, I wish to know whether there is any inn in this neighbourhood known as 'Elrige's?'"

The servants were cross-questioned, but none of them had heard of such a place. The stable-boy threw a light upon the matter by remembering that a farmer of that name lived some miles off, in the direction of East Ruston.

"Is it a lonely farm?"

"Very lonely, sir."

"Perhaps they have not heard yet of all that happened here during the night?"

"Maybe not, sir."

Holmes thought for a little, and then a curious smile played over his face.

"Saddle a horse, my lad," said he. "I shall wish you to take a note to Elrige's Farm."

He took from his pocket the various slips of the dancing men. With these in front of him, he worked for some time at the study-table.

Finally he handed a note to the boy, with directions to put it into the hands of the person to whom it was addressed, and especially to answer no questions of any sort which might be put to him. I saw the outside of the note, addressed in straggling, irregular characters, very unlike Holmes's usual precise hand. It was consigned to Mr. Abe Slaney, Elrige's Farm, East Ruston, Norfolk.

"I think, Inspector," Holmes remarked, "that you would do well to telegraph for an escort, as, if my calculations prove to be correct, you may have a particularly dangerous prisoner to convey to the county jail. The boy who takes this note could no doubt forward your telegram. If there is an afternoon train to town, Watson, I think we should do well to take it, as I have a chemical analysis of some interest to finish, and this investigation draws rapidly to a close."

When the youth had been dispatched with the note, Sherlock Holmes gave his instructions to the servants. If any visitor were to call asking for Mrs. Hilton Cubitt, no information should be given as to her condition, but he was to be shown at once into the drawing-room. He impressed these points upon them with the utmost earnestness. Finally he led the way into the drawing-room, with the remark that the business was now out of our hands, and that we must while away the time as best we might until we could see what was in store for us. The doctor had departed to his patients, and only the inspector and myself remained.

"I think that I can help you to pass an hour in an interesting and profitable manner," said Holmes, drawing his chair up to the table, and spreading out in front of him the various papers upon which were recorded the antics of the dancing men. "As to you, friend Watson, I owe you every atonement for having allowed your natural curiosity to remain so long unsatisfied. To you, Inspector, the whole incident may appeal as a remarkable professional study. I must tell you, first of all, the interesting circumstances connected with the previous consultations which Mr. Hilton Cubitt has had with me in Baker Street." He then shortly recapitulated the facts which have already been recorded. "I have here in front of me these singular productions, at which one might smile, had they not proved themselves to be the forerunners of so terrible a tragedy. I am fairly familiar with all forms of secret writings, and am myself the author of a trifling monograph upon the subject, in which I analyze one hundred and sixty separate ciphers, but I confess that this is entirely new to me. The object of those who invented the system has apparently been to conceal that these characters convey a message, and to give the idea that they are the mere random sketches of children.

"Having once recognized, however, that the symbols stood for letters, and having applied the rules which guide us in all forms of secret writ-

ings, the solution was easy enough. The first message submitted to me was so short that it was impossible for me to do more than to say, with some confidence, that the symbol λ stood for E. As you are aware, E is the most common letter in the English alphabet, and it predominates to so marked an extent that even in a short sentence one would expect to find it most often. Out of fifteen symbols in the first message, four were the same, so it was reasonable to set this down as E. It is true that in some cases the figure was bearing a flag, and in some cases not, but it was probable, from the way in which the flags were distributed, that they were used to break the sentence up into words. I accepted this as a hypothesis, and noted that E was represented by λ .

"But now came the real difficulty of the inquiry. The order of the English letters after E is by no means well marked, and any preponderance which may be shown in an average of a printed sheet may be reversed in a single short sentence. Speaking roughly, T, A, O, I, N, S, H, R, D, and L are the numerical order in which letters occur; but T, A, O, and I are very nearly abreast of each other, and it would be an endless task to try each combination until a meaning was arrived at. I therefore waited for fresh material. In my second interview with Mr. Hilton Cubitt he was able to give me two other short sentences and one message, which appeared—since there was no flag—to be a single word. Here are the symbols. Now, in the single word I have already got the two E's coming second and fourth in a word of five letters. It might be 'sever,' or 'lever,' or 'never.' There can be no question that the latter as a reply to an appeal is far the most probable, and the circumstances pointed to its being a reply written by the lady. Accepting it as correct, we are now able to say that the symbols λ λ stand respectively for N, V, and R.

"Even now I was in considerable difficulty, but a happy thought put me in possession of several other letters. It occurred to me that if these appeals came, as I expected, from someone who had been intimate with the lady in her early life, a combination which contained two E's with three letters between might very well stand for the name 'ELSIE.' On examination I found that such a combination formed the termination of the message which was three times repeated. It was certainly some appeal to 'Elsie.' In this way I had got my L, S, and I. But what appeal could it be? There were only four letters in the word which preceded 'Elsie,' and it ended in E. Surely the word must be 'COME.' I tried all other four letters ending in E, but could find none to fit the case. So now I was in possession of C, O, and M, and I was in a position to attack the first message once more, dividing it into words and

putting dots for each symbol which was still unknown. So treated, it worked out in this fashion:

. M . ERE . . E SL NE .

"Now the first letter *can* only be A, which is a most useful discovery, since it occurs no fewer than three times in this short sentence, and the H is also apparent in the second word. Now it becomes:

AM HERE A E SLANE .

Or, filling in the obvious vacancies in the name:

AM HERE ABE SLANEY .

I had so many letters now that I could proceed with considerable confidence to the second message, which worked out in this fashion:

A . ELRI . ES .

Here I could only make sense by putting T and G for the missing letters, and supposing that the name was that of some house or inn at which the writer was staying."

Inspector Martin and I had listened with the utmost interest to the full and clear account of how my friend had produced results which had led to so complete a command over our difficulties.

"What did you do then, sir?" asked the inspector.

"I had every reason to suppose that this Abe Slaney was an American, since Abe is an American contraction, and since a letter from America had been the starting-point of all the trouble. I had also every cause to think that there was some criminal secret in the matter. The lady's allusions to her past, and her refusal to take her husband into her confidence, both pointed in that direction. I therefore cabled to my friend, Wilson Hargreave, of the New York Police Bureau, who has more than once made use of my knowledge of London crime. I asked him whether the name of Abe Slaney was known to him. Here is his reply: "The most dangerous crook in Chicago." On the very evening upon which I had his answer, Hilton Cubitt sent me the last message from Slaney. Working with known letters, it took this form:

ELSIE . RE . ARE TO MEET THY GO .

The addition of a P and a D completed a message which showed me

that the rascal was proceeding from persuasion to threats, and my knowledge of the crooks of Chicago prepared me to find that he might very rapidly put his words into action. I at once came to Norfolk with my friend and colleague, Dr. Watson, but, unhappily, only in time to find that the worst had already occurred."

"It is a privilege to be associated with you in the handling of a case," said the inspector, warmly. "You will excuse me, however, if I speak frankly to you. You are only answerable to yourself, but I have to answer to my superiors. If this Abe Slaney, living at Elrige's, is indeed the murderer, and if he has made his escape while I am seated here, I should certainly get into serious trouble."

"You need not be uneasy. He will not try to escape."

"How do you know?"

"To fly would be a confession of guilt."

"Then let us go to arrest him."

"I expect him here every instant."

"But why should he come?"

"Because I have written and asked him."

"But this is incredible, Mr. Holmes! Why should he come because you have asked him? Would not such a request rather rouse his suspicions and cause him to fly?"

"I think I have known how to frame the letter," said Sherlock Holmes. "In fact, if I am not very much mistaken, here is the gentleman himself coming up the drive."

A man was striding up the path which led to the door. He was a tall, handsome, swarthy fellow, clad in a suit of gray flannel, with a Panama hat, a bristling black beard, and a great, aggressive hooked nose, and flourishing a cane as he walked. He swaggered up the path as if the place belonged to him, and we heard his loud, confident peal at the bell.

"I think, gentlemen," said Holmes, quietly, "that we had best take up our position behind the door. Every precaution is necessary when dealing with such a fellow. You will need your handcuffs, Inspector. You can leave the talking to me."

We waited in silence for a minute—one of those minutes which one can never forget. Then the door opened and the man stepped in. In an instant Holmes clapped a pistol to his head, and Martin slipped the handcuffs over his wrists. It was all done so swiftly and deftly that the fellow was helpless before he knew that he was attacked. He glared from one to the other of us with a pair of blazing black eyes. Then he burst into a bitter laugh.

"Well, gentlemen, you have the drop on me this time. I seem to have

knocked up against something hard. But I came here in answer to a letter from Mrs. Hilton Cubitt. Don't tell me that she is in this? Don't tell me that she helped to set a trap for me?"

"Mrs. Hilton Cubitt was seriously injured, and is at death's door."

The man gave a hoarse cry of grief, which rang through the house.

"You're crazy!" he cried, fiercely. "It was he that was hurt, not she. Who would have hurt little Elsie? I may have threatened her—God forgive me!—but I would not have touched a hair of her pretty head. Take it back—you! Say that she is not hurt!"

"She was found, badly wounded, by the side of her dead husband."

He sank with a deep groan on to the settee, and buried his face in his manacled hands. For five minutes he was silent. Then he raised his face once more, and spoke with the cold composure of despair.

"I have nothing to hide from you, gentlemen," said he. "If I shot the man he had his shot at me, and there's no murder in that. But if you think I could have hurt that woman, then you don't know either me or her. I tell you, there was never a man in this world loved a woman more than I loved her. I had a right to her. She was pledged to me years ago. Who was this Englishman that he should come between us? I tell you that I had the first right to her, and that I was only claiming my own."

"She broke away from your influence when she found the man that you are," said Holmes, sternly. "She fled from America to avoid you, and she married an honourable gentleman in England. You dogged her and followed her and made her life a misery to her, in order to induce her to abandon the husband whom she loved and respected in order to fly with you, whom she feared and hated. You have ended by bringing about the death of a noble man and driving his wife to suicide. That is your record in this business, Mr. Abe Slaney, and you will answer for it to the law."

"If Elsie dies, I care nothing what becomes of me," said the American. He opened one of his hands, and looked at a note crumpled up in his palm. "See here, mister," he cried, with a gleam of suspicion in his eyes, "you're not trying to scare me over this, are you? If the lady is hurt as bad as you say, who was it that wrote this note?" He tossed it forward on to the table.

"I wrote it, to bring you here."

"You wrote it? There was no one on earth outside the Joint who knew the secret of the dancing men. How came you to write it?"

"What one man can invent another can discover," said Holmes.

"There is a cab coming to convey you to Norwich, Mr. Slaney. But, meanwhile, you have time to make some small reparation for the injury you have wrought. Are you aware that Mrs. Hilton Cubitt has herself

lain under grave suspicion of the murder of her husband, and that it was only my presence here, and the knowledge which I happened to possess, which has saved her from the accusation? The least that you owe her is to make it clear to the whole world that she was in no way, directly or indirectly, responsible for his tragic end."

"I ask nothing better," said the American. "I guess the very best case I can make for myself is the absolute naked truth."

"It is my duty to warn you that it will be used against you," cried the inspector, with the magnificent fair play of the British criminal law.

Slaney shrugged his shoulders.

"I'll chance that," said he. "First of all, I want you gentlemen to understand that I have known this lady since she was a child. There were seven of us in a gang in Chicago, and Elsie's father was the boss of the Joint. He was a clever man, was old Patrick. It was he who invented that writing, which would pass as a child's scrawl unless you just happened to have the key to it. Well, Elsie learned some of our ways, but she couldn't stand the business, and she had a bit of honest money of her own, so she gave us all the slip and got away to London. She had been engaged to me, and she would have married me, I believe, if I had taken over another profession, but she would have nothing to do with anything on the cross. It was only after her marriage to this Englishman that I was able to find out where she was. I wrote to her, but got no answer. After that I came over, and, as letters were no use, I put my messages where she could read them.

"Well, I have been here a month now. I lived in that farm, where I had a room down below, and could get in and out every night, and no one the wiser. I tried all I could to coax Elsie away. I knew that she read the messages, for once she wrote an answer under one of them. Then my temper got the better of me, and I began to threaten her. She sent me a letter then, imploring me to go away, and saying that it would break her heart if any scandal should come upon her husband. She said that she would come down when her husband was asleep at three in the morning, and speak with me through the end window, if I would go away afterwards and leave her in peace. She came down and brought money with her, trying to bribe me to go. This made me mad, and I caught her arm and tried to pull her through the window. At that moment in rushed the husband with his revolver in his hand. Elsie had sunk down upon the floor, and we were face to face. I was heeled also, and I held up my gun to scare him off and let me get away. He fired and missed me. I pulled off almost at the same instant, and down he dropped. I made away across the garden, and as I went I heard the window shut behind me. That's God's truth, gentlemen, every word of it,

and I heard no more about it until that lad came riding up with a note which made me walk in here, like a jay, and give myself into your hands."

A cab had driven up whilst the American had been talking. Two uniformed policemen sat inside. Inspector Martin rose and touched his prisoner on the shoulder.

"It is time for us to go."

"Can I see her first?"

"No, she is not conscious. Mr. Sherlock Holmes, I only hope that, if ever again I have an important case, I shall have the good fortune to have you by my side."

We stood at the window and watched the cab drive away. As I turned back, my eye caught the pellet of paper which the prisoner had tossed upon the table. It was the note with which Holmes had decoyed him.

"See if you can read it, Watson," said he, with a smile.

It contained no word, but this little line of dancing men:

♫♫♫XYYXXYYXXYYXXYYXX

"If you use the code which I have explained," said Holmes, "you will find that it simply means 'Come here at once.' I was convinced that it was an invitation which he would not refuse, since he could never imagine that it could come from anyone but the lady. And so, my dear Watson, we have ended by turning the dancing men to good when they have so often been the agents of evil, and I think that I have fulfilled my promise of giving you something unusual for your notebook. Thirty-four is our train, and I fancy we should be back in Baker Street for dinner."

Only one word of epilogue. The American, Abe Slaney, was condemned to death at the winter assizes at Norwich, but his penalty was changed to penal servitude in consideration of mitigating circumstances, and the certainty that Hilton Cubitt had fired the first shot. Of Mrs. Hilton Cubitt I only know that I have heard she recovered entirely, and that she still remains a widow, devoting her whole life to the care of the poor and to the administration of her husband's estate.

The Shadow

The 1930s crime fighter The Shadow confronted several ciphers during his crime fighting career. Two of them appear in “The Chain of Death.”

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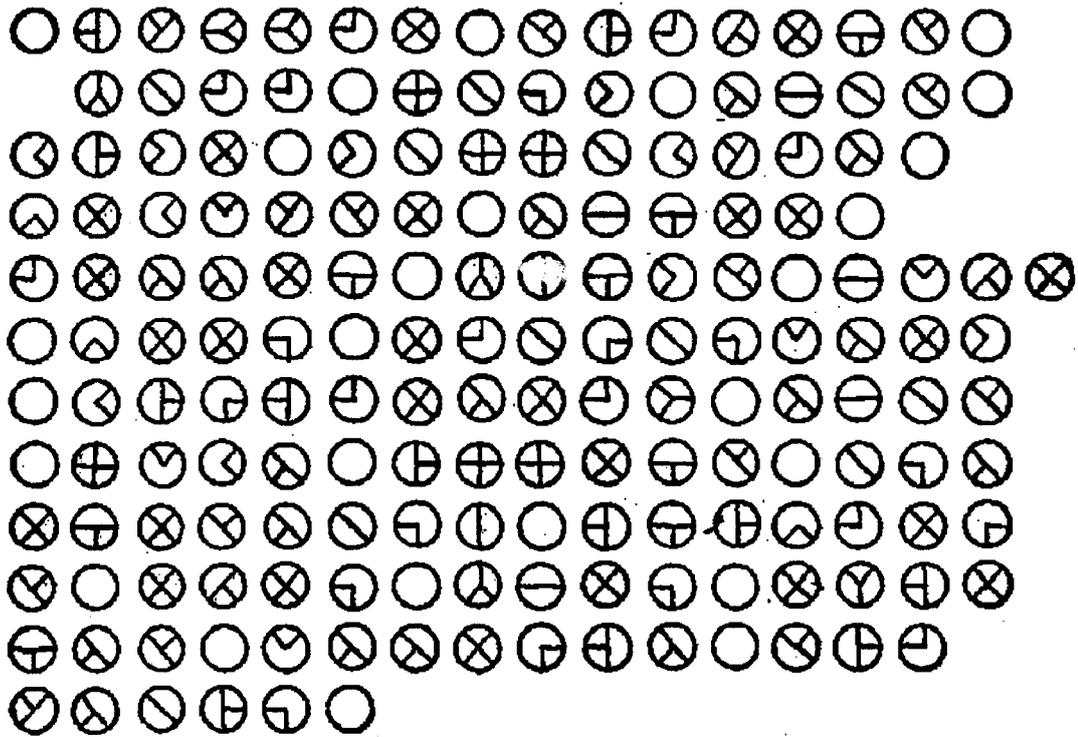
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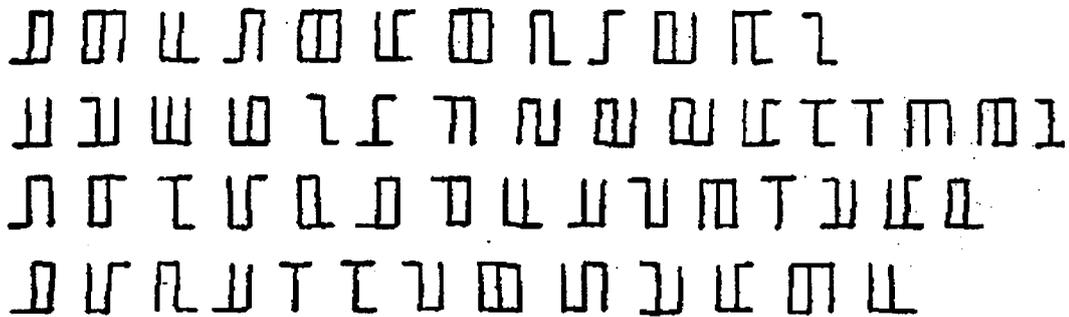
Like the multiple-headed Hydra of ancient times, so works this new, modern organization of crime, a

CHAIN OF DEATH



This done, Joquill began another peculiar inscription, formed with a succession of

block-like characters in several lines:



Joquill placed the sheets together; he folded them and put them in an envelope. From memory, he made duplicates of each sheet, folded these pairs together and put them into a second envelope.

The lawyer addressed the envelopes and placed stamps upon them. Rising, he strolled to the door of the outer office, unlocked it

and walked from his own room. He nodded to two clients who were seated on a bench and remarked that he would soon be back to interview them.

Stepping into the corridor, Joquill continued toward the elevators. There, he posted his letters in the mail chute. Wearing the ghost of a smile, the gray-haired attorney



MYNHEER HANSEL VAART,
code expert and friend of one
of the principals in the story,
whose help is obtained in solv-
ing the cypher messages.

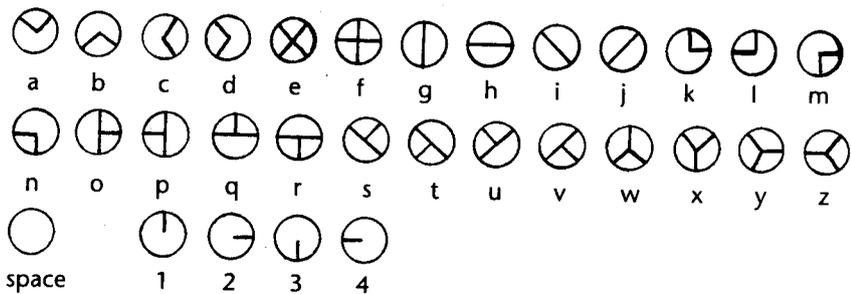
Codes, Ciphers, & Other Cryptic & Clandestine Communication

The Shadow

The Shadow's Ciphers

In the 1930s a popular superhero was a mysterious man named the Shadow. A Shadow novelette, *Chain of Death*, contained what was called a "directional code," although it actually functioned more like a cipher than a code:

The Shadow's *Chain of Death* cipher

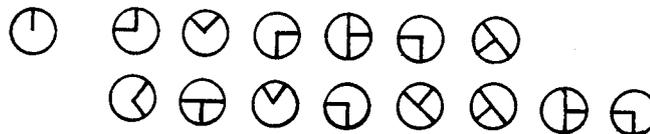


The extra symbols at the base of the alphabet make this code different. The lines inside each circle function like an arrow and tell the recipient how to hold the paper. Symbol 1 means hold the sheet normally, top and bottom positioned as usual, and read the message in a regular left-to-right manner. Symbol 2 indicates a turn 90° to the right, and symbol 3 directs the reader to invert the paper. Symbol 4 signifies a turn 90° to the left. There is also a version "B" in which symbol 2 and 4 represent a 90° turn to the left and right, respectively.

These extra symbols can appear before or in the middle of a line of text. These turns make the cipher difficult to analyze by principles of frequency.

The following example reveals the Shadow's true identity:

The Shadow's real identity:
Lamont Cranston



As directed by holding the page in the regular straightup way, the substituted symbols spell the Shadow's best-known identity, the crimefighter Lamont Cranston.

Later in *Chain of Death*, the Shadow encountered another type of encryption based upon paired symbols and spaces.

Chain of Death cipher

	a-e	f-j	k-o	p-t	u-y	z, space
	U U	Γ U	0 U	C U	U U	
	U U	Γ U	0 U	C U	U U	L U
	U U	Γ U	0 U	C U	U U	L U
	U U	Γ U	0 U	C U	U U	
	U U	Γ U	0 U	C U	U U	

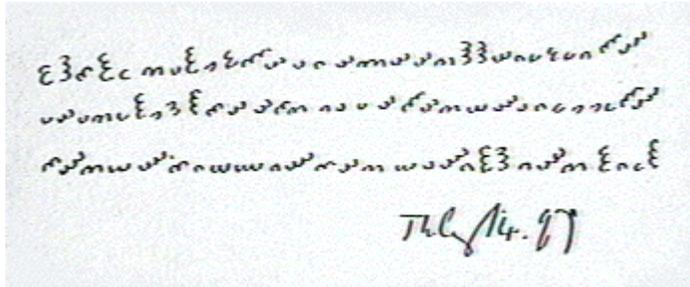
Each alphabet letter is represented by a symbol pair. To begin a communication, it is best to have a starting half-symbol such as \perp . To it is joined the left half-symbol of the first message letter. After a space, the right half-symbol of the first message letter is set in place. The left half of the second message character is connected to the previous half symbol, then a space, the right symbol, and so forth. The following example spells out the word *code*:



The divisions created by the split figures discourage an interceptor from easily matching figures and suspected alphabet characters. Odd symbols can also be added to serve as nulls.

The Dorabella Cipher

In 1897, the English composer Edward Elgar (1857 – 1934; composer of the *Enigma Variations*) included a still unsolved cipher in a letter to a young friend Dora Penny.



<http://www.geocities.com/Vienna/4056/cipher.html>

The Kryptos Sculpture



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In 1990, sculptor James Sanborn installed the Kryptos sculpture at the Central Intelligence Agency. The sculpture contains four encrypted messages. Three of the four have been solved.

Well, as it turns out ... not quite. The sculptor James Sanborn, for aesthetic reasons, left a letter out of part 2 of the sculpture thinking that the missing letter would pose no problem to cryptanalysis of that portion of the sculpture. But, it did. It turns out that the missing letter led to a mistaken cryptanalysis. Part 2's alleged plaintext was incorrect. Sanborn, who hadn't paid attention to the plaintext messages that had been decrypted, discovered the error in 2006 and announced it.

See the sculpture at <https://www.cia.gov/cia/information/tour/kryptos.html>

Track the cryptanalysis at <http://www.elonka.com/kryptos/>

The Beale Ciphers

In 1885, a pamphlet titled “The Beale Papers” was published in Lynchburg, Virginia. The pamphlet contains three ciphers that it claims have information that would lead to a large buried treasure in Bedford County. The pamphlet might well be a hoax, but the story and challenge of the ciphers has intrigued cryptologists since the pamphlet’s publication.

Pig Pen Ciphers

The cipher appearing in “The Gold Bug,” for example, does not have a memorable key. Unless the symbols have been designed with a pattern that facilitates memorization, it is usually difficult to remember substitutions that use strange symbols. One cipher that uses symbols but it easily memorized is the Pig Pen Cipher. It was used by the Freemasons in the Eighteenth Century, in the United States Civil War, and (more recently) by the Boy Scouts. The description that follows is taken from *Codes, Ciphers and Secret Writing* by Martin Gardner. Notice that the symbols are cells of two 3×3 pens of nine cells each (in one collection of cells, the cells are empty, and in the other collection of cells each cell contains a dot) and two collections of four cells formed by \times s (again, in one collection of cells, the cells are empty, and in the other collection of cells each cell contains a dot).

Different cryptographers use slightly different versions of the twenty-six cells, but the basic idea is the same. The various versions of this cipher each use two collections of 9 cells with some way to distinguish between the two collections and two collections of 4 cells with some way to distinguish between the two collections and some memorable way of placing the letters of the plaintext alphabet in the cells.

The pattern that aids in remembering the key can be used in cryptanalysis.

A similar cipher was used by the Rosicrucians. It uses three 3×3 pens of nine cells. Again, different cryptographers use slightly different versions, but here is one version of the key.

abc	def	ghi
jkl	mno	pqr
stu	vwx	yz

The left-hand letter in each cell correspond to having one dot on the left side of the cell. The middle letter in each cell corresponds to having one dot in the center of the cell. And, the right-hand letter in each cell corresponds to having one dot on the right side of the cell. For example,

a is replaced by $\cdot _ |$, n is replaced by $\boxed{\cdot}$, and u is replaced by $_ \cdot |$.

Norse becomes $\boxed{\cdot} \boxed{\cdot} | \cdot _ \cdot | \boxed{\quad}$

The various versions of this cipher each use three collections of 9 cells with some way to distinguish among the three collections and some memorable way of placing the letters of the plaintext alphabet in the cells.

The pattern that aids in remembering the key can be used in cryptanalysis.

Exercises

1. Cryptanalyze the following message:

⊙|⌈|□|⌊|•|•| ⌈|□|□|⌈|⌊|⌊ [••|⌈|⌊|□| ⊙|⌈|□|□|⌊|⌈
⌈|□|□|⌈|⌊| •|⌊|⌊|⌈|⌈|⌈ □|□|⌊|⌊|⌊|⌊ □|⌈|□|□|□|⌊|⌊
⌈|□|⌊|⌈|⌈|⌈ ⌈|⌊|⌈|⌊|□|□ •|□|□|⌊|⌈|⌈|⌈ ⌈|□|□|•|□|□
□|⌊|⌈|⌈|⌈|⌈ □|⌈|⌈|□|□|⌈ ⊙|□|⌊|•|□|⌈|⌈ ⌈|⌈|□|□|⌊|□|□
⌈|•|□|□|⌊|⌊ ⌊|⌈|□|□|⌊|⌈ □|⌊|□|□|□|□|⌊|⌊ □|⌈|⌊|⌊|⌈|⌈
⌈|⌊|⌊|□|⌈|⌈ ⊙|⌊|□|□|⌈|□|□ ⌊|•|⌈|□|⌈|⌈ •|□|⌈|⌈|⌊|⌊ ⌊

2. Cryptanalyze the following message:

4̇2̇6̇4̇2̇ 2̇1̇3̇5̇7̇ 5̇3̇3̇2̇4̇ 4̇3̇6̇7̇4̇ 4̇1̇6̇1̇3̇ 5̇2̇5̇6̇1̇
1̇1̇2̇1̇6̇ 1̇6̇3̇4̇2̇ 3̇3̇3̇1̇1̇ 1̇2̇4̇1̇7̇ 6̇5̇4̇1̇3̇ 5̇7̇3̇6̇5̇
2̇7̇3̇3̇1̇ 4̇1̇2̇6̇1̇ 3̇4̇6̇3̇4̇ 2̇3̇5̇1̇3̇ 6̇1̇3̇5̇1̇ 1̇3̇4̇2̇3̇
7̇5̇3̇2̇6̇ 4̇1̇6̇1̇5̇ 7̇5̇4̇6̇4̇ 2̇1̇5̇6̇3̇ 4̇4̇3̇5̇6̇ 1̇1̇3̇3̇4̇
2̇5̇

