

AN ALTERNATE HISTORY OF THE FIRST COMPUTER AGE

# The Book of Conditions

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Generated by Claude Opus 5.5  
from a premise and historical sources supplied by Henrik Westerberg

A novel in twelve chapters.  
Babbage negotiates instead of refusing Lovelace's conditions.  
Literary alternate history; not a historical reconstruction.

## ABOUT THIS EDITION

The model and literary text were generated by Claude Opus 5.5 with the Meaning Model. The human supplied the historical package and counterfactual premise, authorized continuation and a deeper pass, and did not supply replacement prose. Three fresh Claude Sonnet 5.5 readers provided editorial criticism; the writing agent revised the world and chapters in response.

This is an independent rewrite, completed on 11 October 2026, rather than a continuation of the earlier edition. The manuscript is rendered from its native story graph. Its fictional narrative persona, Margaret Ellery Vane, is an authored device, not a real author. Historical people appear in an invented continuation; subjective values in its model are not measurements of them.

The companion archive contains the portable construction and its publication record. For Meaning Model tools, see [meaningmodel.ai](https://meaningmodel.ai) and the [Meaning Model repository](#).

## ONE: THE MORNING

The letter came to 1 Dorset Street on the evening of Monday the fourteenth of August, 1843. It ran to sixteen pages, in a hand that grew larger as it went on, and Charles Babbage read it standing in the hall with his hat still on. Then he sat down on the third stair and read it again.

He was fifty-one. For twenty years he had been building, or failing to build, or explaining why he had not built, a machine to calculate tables and print them without a human hand between the figure and the page. The government had given seventeen thousand pounds to it and last November had stopped giving. Mr Peel had received him in Whitehall Gardens and been civil and had not, Babbage was certain, understood one word. Mr Airy had told Mr Peel the thing was worthless. Upstairs in the drawing room, under a glass shade, stood the one-seventh part of the Difference Engine that Clement had put together in 1832, and it still worked. On Saturday evenings ladies turned its handle and said how wonderful.

The letter was from Ada Lovelace. A fortnight earlier she had refused to let him print his own preface, unsigned, at the head of her translation of Menabrea. He had proposed that they withdraw the whole paper rather than let it go out without his account of how the government had failed him. She had answered that he was behaving like a man who would rather be wronged than read. The paper had gone out without the preface. He had not replied to that letter. Now this.

She offered to conduct the business for him. That was her phrase: to conduct the business, with his own undivided energies devoted to the execution of the work. The offer came with conditions, numbered, and she had underlined the numbers.

The first was that on every practical matter touching other people, ministers, printers, engineers, subscribers, he should abide by her judgment, or by the judgment of referees he might name himself, whenever the two of them differed. The second was that when she needed his mind on a question he should give it wholly and not slur it over. The third was that if she laid before him a plan for bringing an engine into being, he should hear it to the end before he answered. There were others, smaller, about letters and money and the hours he kept. Between the conditions she had written what she thought of him. Some of it was kind.

He knew what such a letter was for. It was for answering in one word. He went into the study, took a pen, turned the last sheet over and looked at its clean back for some time. Then he put the pen down, because it was late, and because a man should refuse a thing like this to its author's face.

He did not sleep well. At some hour after two he got up, lit a candle and went up to the drawing room, and stood in front of the glass shade with the letter in his other hand. The figure wheels caught the light in their columns. Every one of them had been cut to his drawings and every one of the drawings had been altered, some of them nine times, while Clement's men stood waiting. He had never thought of that as a fault. A drawing was a thought; one improved one's thoughts.

He read the third condition again by the candle. If she laid a plan before him, he should hear it to the end.

In the morning he walked. It was a mile and a half from Dorset Street to St James's Square, down through the squares to Oxford Street and along Regent Street, where the shops were opening their shutters and a boy was sluicing the pavement outside a hatter's. He had the letter in his breast pocket. He had decided on the walk what he would say, and it was short.

She received him in the back drawing room at number ten. The front of the house was shut up for August; William was at Ockham. She was in a grey morning dress with a shawl, though it was warm, and there were papers on every chair but one. She looked, he thought, as if she had not slept either.

"You have come to refuse me," she said.

"I have."

"Then refuse me. I would rather have it plainly."

He took the letter out. He meant to hand it back to her. Instead he unfolded it, and because she was watching him and he did not want her to see that he did not know what to do, he looked down at it.

"Your referees," he said. "Whom would you have?"

"Whomever you like. That is the point of the clause. You name them."

"And if I named no one?"

"Then you would be refusing the first condition, and you may as well refuse the rest." She sat down. "You need not answer for the whole letter at once. I know what I have asked."

“You have asked for the engine.”

“I have asked for the business. The engine is yours. It will always be yours. I have no wish to design a single wheel of it. I wish to see one built.” She said it without heat, as if she were giving a figure. “Mr Babbage, you have been building it for twenty years. I have been watching for ten. Nothing is ever finished, because everything is always being improved. I do not say that to wound you. I say it because it is the only thing I know about the engine that you do not.”

He said, “Clement would say the same.”

“Then Clement and I agree on something.”

He sat in the one clear chair, with the letter on his knee, and took out a pencil. He did not cross anything out. Beside the first condition he wrote: referees, how many, and who pays them? Beside the second: wholly, at what hours? Beside the third he wrote nothing for a long time and then: a plan for which engine?

“Whom would you propose,” he said, “as a referee?”

“Mr De Morgan.”

“He dislikes Airy.”

“So do you. So, at present, do I. That is not why I propose him.” She leaned forward. “He is the only man in London who will tell us both we are wrong and not enjoy it.”

Babbage laughed.

He went through the smaller conditions. Some he queried, two he underlined, one he said was impertinent and she agreed that it was. It was nearly noon when he folded the sheets.

“I do not accept,” he said. “I do not refuse. I want time to write you an answer that is as long as your letter.”

“How much time?”

“A fortnight.”

“Ten days,” she said. “I shall be at Ockham. Write there.”

He walked home the way he had come. Regent Street was full now. At the corner of Oxford Street a man was selling the morning’s Times and calling out something about Ireland, and Babbage bought a copy without hearing what it was and carried it home unread.

In the study he unfolded the letter again and turned to the back of the last sheet, where he had meant last night to write one word. He wrote instead, small, in the corner: Saw A.A.L. this morning. Refused none of the conditions. Asked for time.

He had meant to write one word. He had written twelve.

At St James’s Square, when he had gone, Ada sat for a while without moving. Then she cleared the papers from one chair to the floor, and from another, and went to her desk and counted.

She counted on a half-sheet, the way De Morgan had taught her to keep a working: what she had asked, and what he had not refused. Three conditions; eleven smaller ones; none struck out; nine queried; two underlined; one called impertinent. The figure meant nothing yet. She knew that. A man might query a clause he meant in the end to refuse, so as to refuse it with reasons. But she had known him ten years, and he had never in that time queried anything he meant to refuse. He refused at once, and wrote pamphlets afterwards.

Her hand was not steady. She put the pen down and waited for it to be steady and then took it up again and wrote to her mother. She wrote that Mr Babbage had called that morning, that there had been a little difficulty about the preface which was now quite over, and that they were more friends than ever.

She did not write the rest. Her mother had a way of taking hold of the rest of things.

When the letter was sealed she rang for tea, and when it came she found she could not drink it, and sat holding the cup with both hands until it was cold, looking at the half-sheet of figures on the desk as if it were a table she had computed and did not yet trust.

## TWO: ARTICLE THE FIRST

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His answer reached Ockham on the twenty-fourth of August, the ninth day of the ten. It was eleven pages long. Ada read it in the library with the windows open on the park, and William, who had come in to ask whether she would drive with him to Ripley, stood by the door and watched her read, and did not ask.

Babbage had numbered his conditions as she had numbered hers. He wanted it written that the design of the engine was his and no one's else, and that he might improve it as long as he lived. He wanted it written that every drawing, finished or not, remained his property, wherever it was kept and whoever paid for the paper. He wanted the right to answer Mr Airy in print, under his own name, as often as Mr Airy deserved it. He wanted his hours left alone. He agreed to Mr De Morgan as umpire, if Mr De Morgan would serve, because he respected him, and he added in the margin that De Morgan had once called Airy's method of reckoning a public scandal, which Ada thought was probably not true.

The last page said that he did not yet know what she meant by a plan, and would be glad to hear it.

"Well?" said William.

"He wants everything," she said. "So do I. That is a beginning."

William came and sat on the arm of the chair opposite. He was a tall man who sat carefully, as if furniture were something one might damage. He had married her eight years before, and he had learned in that time that there were rooms of her he would be shown and rooms he would not, and he had decided early, and without bitterness, to be grateful for the ones he was shown.

"Your mother will ask what you are doing," he said.

"My mother will be told that I am helping Mr Babbage with his correspondence."

"Is that what you are doing?"

She looked at him. "I am trying to get a machine built, William. A small one. One that can be finished. And I am trying to do it without anyone's money but the money of people who want what it makes. I will tell you all of it, if you want all of it."

He thought about this. "I want to know if it will cost us anything."

"It may cost you your name on a paper."

"I have signed papers before," he said, and went to Ripley alone.

Babbage came down to Ockham twice that autumn, on the new line to Woking and then by fly. The first time he brought drawings, a roll of them under his arm that he would not let the servant carry, and spread them on the billiard table, and talked for three hours about the anticipating carriage of the Analytical Engine, by which a carry could be made to all the figures of a number at once instead of one after the other. Ada listened to the end, as her third condition required, and then asked him which of the drawings on the table could be given to a workman next Monday.

He said none of them could. They were not finished.

"Then they are not what I mean by a plan," she said.

The second time he came without drawings, and they did not quarrel, and that frightened her more than the first.

She had bought the book in Guildford on the eleventh of September. It was a quarto in green cloth with a leather spine, ruled faint, from the stationer's in the High Street near the Guildhall clock, and it cost four shillings and sixpence, which she paid from her own purse and then, being her father's daughter and her mother's too, wrote down on the inside of the front board. On the first leaf she wrote, in the clearest hand she had: The Book of Conditions. Below it, smaller: Between C.B. and A.A.L., with A. De M. as umpire. Every article to be initialled by both. Nothing binds that is not written here.

She showed it to Babbage on his second visit. He turned the blank pages slowly.

"You mean to fill it."

"I mean to write in it only what we agree. It may stay very thin."

"And when we disagree?"

"We write that too, and send it to Mr De Morgan, and he writes his award under it, and that binds."

Babbage looked at the inscription for some time. "Nothing binds that is not written here," he read aloud. "That is a hard rule for a man who changes his mind."

"It is a hard rule for anyone. It is the only one I know that works."

De Morgan came down on the fourth of October, on condition that he be allowed to bring his own pencils and to leave by the five o'clock train whatever happened. He was thirty-seven, short-sighted, one eye blind since infancy, and he had taught Ada the calculus by letter for three years without once flattering her. He sat at the end of the dining table with the green book before him and Babbage on his left and Ada on his right, and when they had both talked for an hour he said:

"Let us see if we can write one sentence that you both mean."

It took the rest of the day.

Babbage wanted the first article to name the Analytical Engine, because it was the great work and everything else was a lesser thing. Ada would not have it. She wanted the first article to name an engine that could be made with money that could be got, in a shop that could be hired, by men who could be paid, and that would print tables someone would buy. She had a buyer in mind and did not yet name him. She said: an engine of differences, a new one, simpler than the old, made only to calculate and print the tables of mortality and of life annuities on which the assurance offices set their prices. Not a philosophical instrument. A tool.

"A tool," said Babbage, as if she had said a mangle.

"The life offices buy tables every year," she said. "They pay men to compute them and other men to check them and they still find errors. Mr Davies at the Guardian has said so in print. If the engine prints a table without an error, they will pay for the engine. If they pay for one engine, there will be money for the next. The Analytical Engine is the next."

"You would have me spend the rest of my life on a table of annuities."

"I would have you spend three years on it. And then the rest of your life on whatever you please, with a working engine in the drawing room to show the doubters. Mr Airy cannot say a thing is worthless while it is printing."

That struck him. She saw it strike. He sat back.

De Morgan wrote. He wrote slowly, in pencil, on a loose sheet, and read it out, and they altered it, and he wrote it again. By four o'clock he had: That the object of Mr Babbage's undivided energies shall be an engine of differences, of the new and simpler design, to calculate and print tables of mortality and of life annuities.

"Is that what you both mean?" he said.

"Not quite," said Ada. "Add: and to be finished."

Babbage said, "Every engine is meant to be finished."

"Then you will not mind its being written."

They argued over those four words for longer than they had argued over the rest. Babbage said they were an insult. Ada said they were a description. He said that no man of science could promise the end of an inquiry before it began; she said that this was not an inquiry, it was a machine, and machines were either finished or they were not. He said she did not understand how a design improved in the making. She said she understood it perfectly; she had watched it improve for ten years, and it was still in the drawing room under a glass shade.

De Morgan put his pencil down and looked at his watch.

"I have forty minutes before the fly," he said. "I propose a second article, which I will write now, naming the Analytical Engine as the work that follows the first, to which Mr Babbage's energies shall pass when the first is finished. That gives you, Babbage, the thing you want in writing. It gives you, Lady Lovelace, your four words. And I propose a third, for later: that no part of the design shall be altered after metal is cut for it without the consent of the umpire. You need not initial the third today. I should like you both to think about it overnight, which I do not suppose either of you will."

Babbage was silent for a long minute. Then he took the pen and initialled the first article, C.B., hard enough to mark the page beneath. Ada initialled it, A.A.L. The second article they initialled together, De Morgan watching. The third they left blank, a ruled space with its number and nothing else.

De Morgan caught his train with four minutes to spare.

That night, when Babbage had gone up, Ada sat with the green book open at the first leaf and read the article again. Under it, in her own hand, she wrote the date: the fourth of October, 1843. She did not write anything else. There was nothing else that had been agreed.

In November Babbage's son Henry sailed for India, a cadet in the Company's Bengal service, nineteen years old. Babbage went down to Gravesend to see him off, and afterwards wrote to Ada, in a letter about the cost of cast iron, that he had not known until the ship was out of sight how little he had said to the boy in all those years, being always at the engine.

She kept the letter. She did not paste it into the book. It was not a condition.

## THREE: PROSPECT PLACE

Her first act of business was to cross the river.

She went on a Tuesday in the second week of January, 1844, in a hired brougham because she did not want the Lovelace arms on the door in Newington. William offered to come. She said that a man who had been called a thief by Mr Babbage for ten years would talk more freely to a woman alone, and William, who did not follow this, let her go.

Prospect Place was a row of brick houses off the Kent Road, and number twenty-one had a yard behind it and a long shed of blackened timber with skylights, and the noise of the shed came through the house as a steady grinding under everything, so that when the girl showed her into the front parlour the ornaments on the mantel were very slightly moving. Joseph Clement came in a few minutes later in a dressing gown over his waistcoat. He was sixty-four. He had been a weaver and a slater in Westmorland before he was a draughtsman, and he still had the shoulders of a man who carried slates, but he breathed as if each breath had to be fetched from a distance.

"Lady Lovelace," he said. "I have never had a countess in this room. I have had a great many lawyers."

"I have not come with a lawyer."

"No. You've come from him." He sat, carefully. "Sit down. You'll forgive me if I don't stand long."

She had decided in the carriage how to begin and she began that way. She told him that there was to be a new engine, smaller than the old one, made to a frozen design, for the life offices, and paid for by subscription and not by the Treasury. She told him there was a book in which every condition between herself and Mr Babbage was written, and an umpire. She did not tell him that only three articles were in it yet.

Clement listened with his head on one side, the way, she thought later, a man listens to a lathe to hear if the tool is cutting true.

"And what do you want of me?"

"Two things. The drawings of the old engine that are still here. Mr Babbage says they are his. You say, or your lawyers say, they are yours. I do not want to know who is right. I want to know whether he may come and copy them."

"And?"

"Your great planing machine. I want to know whether it can be bought."

He laughed at that, and the laugh became a cough, and the cough went on for some time. The girl came to the door and he waved her away.

"That planer," he said when he could, "has paid for this house twice. I take eighteen shillings a day for the use of it, and there's not another in London that'll give you a plane like it on a bed eight foot long. You know why I have it? Because his engine needed it. He wanted his frames true to a thousandth and nobody in England could make them so, so I made the machine that could, and when we fell out he said the machine was his because it was made for his work, and I said it was mine because it was made by my hands, and by the custom of the trade a man keeps the tools he makes. Every engineer in London knows that. Ask Whitworth. Whitworth worked in that shed."

"I don't dispute it."

"No. You want to buy it." He looked at her. "Who would be buying it? Not him."

"The trust. There will be a trust. I am trying to make sure there is nothing in this engine that anyone can say belongs to Mr Babbage alone, or to you alone, or to me."

"To you." He considered that. "What does a married lady own, in law?"

"Nothing," Ada said. "That is one reason it will be a trust."

He was quiet for a while. The grinding in the shed changed its note and then went back.

"I'm not going to live long," he said. "The doctor says the heart. I've no children. My brother's in Westmorland and would sell the planer to the first man who asked, and the first man who asked would be some railway shop that would run it into the ground in five years cutting rails. If your trust wants it, it can have it when I'm gone, at a fair price, and my executor can name the price. I'll write that down for you. As for the drawings, he can come and copy them. He can't take them away. They stay in this house till they go to my executor with everything else. Is that clear enough for your book?"

"Yes."

“Write it in, then.” He leaned back. “Now I’ll tell you something, since you’ve come so far. You’ll have been told it was money. That the Treasury wouldn’t pay my bills and I stopped work. It wasn’t money. Money’s never the reason a thing stops. Money’s the reason given.”

She waited.

“He would not stop changing it,” Clement said. “Every week a new drawing. Every week a part we’d cut and fitted was wrong because the drawing it was cut to was wrong now. Not wrong. Improved. I’ve had men stand at the bench with a finished piece in their hands and nothing to do with it, because it belonged to last month’s engine. You can’t build to a man who thinks faster than metal can be cut. I told him so. He thought I was asking for more money. Maybe I was. A man must be paid for his idle hands as well as his busy ones.” He shut his eyes for a moment. “I liked him. You’ll not believe that. I liked him better than any man I ever worked for. He was the only one who ever understood what I was doing. That’s why it was so bad.”

Ada said, “In the book there is a blank article. It says that no part of the design may be altered after metal is cut for it, without the umpire’s consent.”

Clement opened his eyes.

“Has he signed it?”

“Not yet.”

“Then get him to sign it,” Clement said, “before you cut anything. That’s my advice and you can have it for nothing.”

He wrote his memorandum at a little table by the window, slowly, in a square tradesman’s hand: that on his death his planing machine should be offered first to the trustees of the engine at a price to be fixed by his executor, and that Mr Babbage might copy at No. 21 Prospect Place such drawings of the former engine as were in Clement’s keeping, but remove none. He signed it Jos. Clement and dated it, and blotted it, and handed it to her.

“Mind,” he said, “you’ll want a foreman who’ll stand up to him. Not a gentleman. A man who’ll stop the shop.”

“Do you know one?”

“I know a few. They’re all at Whitworth’s.” He almost smiled. “Ask Joe Whitworth to lend you one. He owes me a favour, though he’d not say so.”

She drove back over Blackfriars Bridge in the early dark. The river was low and the lamps on the bridge were lit and the carriage wheels drummed on the granite setts. She held the memorandum in her lap in its fold. It was the first paper in the business that was not between herself and Babbage, and the first that had been signed by someone who would not be alive to see it honoured. She thought about the grinding in the shed, which she could still hear, faintly, as one hears the sea after leaving it.

That night she pasted the memorandum onto the fourth leaf of the green book, with a strip of gummed paper along the top edge so that it could be lifted and read on both sides, and under it she wrote: Received of Mr Clement, at Prospect Place, 9th January 1844. And under that: Article the Third remains to be initialled.

Babbage went to Prospect Place on the thirtieth of January to copy the drawings, with a draughtsman and a portfolio. He came back and wrote to Ada that Clement had been civil, that they had not quarrelled, and that the drawings were in a shocking state of disorder. He did not say whether they had shaken hands. She did not ask.

Joseph Clement died on the twenty-eighth of February. Babbage did not go to the funeral. He sent a note to the widow of Clement’s brother, who had come down from Westmorland, and he sent, by Ada’s arrangement and at her suggestion, a wreath in the name of the engine’s trustees, though the engine had as yet no trustees and no name.

Some days afterwards she found Babbage in the study at Dorset Street with the green book open at the blank third article. He did not hear her come in. He was not reading it. He was looking at it the way she had seen him look at a drawing he meant to alter, and then he closed the book without writing anything and saw her and said, quite naturally, that the weather was very raw for March.

## FOUR: THE DEED

Griffith Davies kept his tables in a room at the back of the Guardian's office in Lombard Street, on the second floor, where the light came in over the roofs from the north and never fell on the paper directly. He had chosen the room himself in 1823. He was fifty-five now, a Fellow of the Royal Society, and the directors gave him whatever room he asked for, but he had not moved, because he knew this light.

De Morgan brought Lady Lovelace to him on the eleventh of April, 1844, at half past ten. Davies had agreed to the appointment because De Morgan had asked for it and because he was curious, and he had prepared for it by taking from the press the three printed tables of annuities he trusted least and laying them on the side table in order of their faults.

She was smaller than he had expected and older, and she did not look well. She shook his hand like a man.

"Mr De Morgan says you think engines are a waste of money," she said.

"Mr De Morgan says a great many things to make a meeting go." Davies had been thirty-five years in London and his voice still went up at the ends of sentences the way voices did in Llandwrog. "I think the government's engine was a waste of money. Seventeen thousand pounds and not a page printed. I am an actuary, Lady Lovelace. I price promises. That one I would not have insured."

"Nor would I," she said. "That is why I am not asking you to insure it."

She told him what she wanted. She had it on two sheets of paper, which she did not look at. An engine of differences, not the old one, a new and simpler design, frozen before metal was cut. One purpose: to compute and print the tables of mortality and of life annuities from which offices like his set their premiums. One shop, hired. A subscription among the life offices, each paying in proportion to its business, in return for a share in the engine's printed tables for twenty years. A trust to hold the money and the machine, because she could hold neither. An umpire for disputes. A book of conditions.

Davies listened without interrupting. When she had finished he went to the side table and brought back the three tables he had laid out, and put them in front of her one at a time.

"This one," he said, "has eleven errors that I know of. Three are the computer's. Four are the copyist's. Four are the compositor's: he set a six for a nine, and so on. This one has a hundred and four, because it was copied from a table that had them, and nobody computed it fresh. This one I made myself in 1825, and it has two, and I found the second last year." He sat down. "Your engine will take away the copyist and the compositor. It will not take away the error. An engine is made by men. A wheel can slip. A tooth can wear. How will you know when it is wrong?"

She did not answer at once. De Morgan, at the window, turned round.

"You will check it," she said at last.

"Against what?"

"Against tables computed by hand. Fresh. From the Carlisle observations. By someone who has never seen the engine's figures."

"Then you will be paying for the hand tables as well as the engine."

"For the first table. And then for samples. Not every figure. Enough figures, chosen so that if the engine were wrong anywhere, we should be likely to find it." She looked at him. "That is a question in the calculus of chances. I do not know the answer yet. I should like to find it out."

Davies sat back. He had come to the meeting with a refusal ready and the refusal was not quite fitting the question any more.

"The Guardian will want to see the check tables before it pays for anything," he said. "And it will want me to choose who computes them."

"Then choose."

"I will." He thought for a moment. "There's a woman in Somers Town who checks for me at piecework. Widowed. She's better than any of my clerks. I would put her on it."

"Then put her on it."

He took a quarter sheet from the rack and wrote on it, in a hand like engraving: Guardian. £800. Subject to (1) check tables computed independently under G.D.'s direction, (2) design frozen before cutting, (3) a trust. He initialled it and passed it across.

“That is not a promise from the Board,” he said. “It is a promise from me to ask them. They usually do what I ask, because I am usually right.” He did not smile when he said it. “You will need six more offices to make it worth building. I’ll give you the names of the actuaries who’ll listen.”

Seven offices subscribed by the end of May. The Guardian’s eight hundred pounds was the largest share; the smallest was a hundred and fifty from an office in Norwich that Davies said would pay late and in full.

The deed was drawn by Woronzow Greig, Mrs Somerville’s son, a barrister of the Inner Temple and Ada’s friend of ten years. He drew it because a married woman could neither contract nor hold a fund, and he went through it with her across his desk in King’s Bench Walk on the first of June, clause by clause, as he would have with any client.

“You are named,” he said, “in a schedule. As the conductor of the business. The trustees appoint you, and they can unappoint you. You can be instructed by them. You cannot sign for them. You cannot hold a shilling of the fund in your own name. William will sign as guarantor of the first five hundred pounds. And he will sign as the person in whose name you act.”

“I know,” said Ada.

“I know you know.” Greig turned a page. “The title ‘conductor of the business’ has no standing in law whatever. I have put it in because you asked for it. A court would read it as a description, like ‘a lady of good family.’”

“Then let it be a description,” she said. “It is an accurate one.”

They signed on the eighteenth of June in Greig’s chambers. It was very hot. Davies came from Lombard Street in his black coat and sat by the open window; De Morgan came from Gower Street with his own pens. Babbage did not come, because he was not a party: the deed bound the trustees and the guarantor, and Babbage’s obligations were in the green book and nowhere else. William came up from Ockham on the early train. He had read the deed twice at home and asked Greig three questions by letter, all of them sensible.

Ada sat at the end of the table and watched them sign.

Davies signed first, Griffith Davies, very small. De Morgan signed, Augustus De Morgan, and blotted it, and looked at Ada over his spectacles. William signed last. He signed twice, once as guarantor and once in the clause that began And the said William, Earl of Lovelace, in whose name the said Augusta Ada, Countess of Lovelace, acts. He wrote his name the second time more slowly than the first, and when he had finished he did not look up at once.

Greig gathered the parchments. Davies took out his watch.

Nobody asked Ada to sign anything, because there was nothing she could sign. The schedule with her title in it was the last sheet, and it had no place for a signature.

In the cab afterwards William said, “I didn’t like that.”

“Which part?”

“The part where I signed for you.” He looked out at the Strand. “I don’t mind the money. I minded that.”

She took his hand, which she did not often do in public, and held it as far as Charing Cross.

At Dorset Street that evening she copied the schedule, word for word, onto the sixth leaf of the green book, under the heading: What the law says I am. And under it she wrote, in the same hand: What this book says I am, and initialled it A.A.L., and left the space beside it for Babbage, who initialled it the next morning without comment, C.B., and then said that he supposed she would now want to see the drawings of the new engine, and that they were nearly ready.

## FIVE: PIECEWORK

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Hester Fell worked at the window because the window was where the light was, and in Chalton Street in October the light was not much. She had two rooms on the second floor over a corn-chandler’s, the front one for work and eating and the back one for sleeping, and the front one had a deal table, two chairs, a shelf of tables in calf and boards gone soft at the corners, and her father’s brass inkstand, which was the only thing she owned that anyone would have paid money for.

She was thirty-three. She had been computing for money since she was twenty-nine, and for nothing since she was seven, when her father, who kept a school for writing and arithmetic in Clerkenwell, had sat

her at the end of his desk and shown her how a logarithm turned a multiplication into an addition, and she had felt something open in her head like a window in a hot room. Her father had been dead eleven years. Her husband, Thomas, a law-stationer's clerk who had copied other men's deeds in a beautiful hand, had been dead four and a half. He had taken the typhus in the spring of 1840 from a lodging-house in Saffron Hill where he went to collect a debt for his master, and had been dead in nine days. Kate had been six. Kate was ten now and at the National School in Somers Town until three.

The work came by the parcel. A man named Gaskin, who computed for the Nautical Almanac at so much a sheet and could not do all he had contracted for, sent her sheets of arguments with the method written at the top, and she worked them out and sent them back, and he paid her fourpence a sheet and was paid, she supposed, a good deal more. The actuaries' work came through a clerk at the Guardian and paid better: checking, mostly, other people's columns, at threepence a page of figures found correct and a penny for every error found. She had sometimes thought, at night, that the penny for an error was the best-paid arithmetic in London, and that a dishonest woman could make a living by finding errors that were not there. She was not a dishonest woman. She had found, in four years, three hundred and twelve errors, and every one of them was real, and she had kept a list.

On the third of October the clerk from the Guardian did not send a parcel. He sent a note asking her to wait upon Mr Davies in Lombard Street at eleven the next morning.

She had never met Mr Davies. She had checked his tables and found, once, an error in one, and she had sent it back with a note in the margin, as she always did, and had heard nothing, and had thought she might lose the work. She did not lose it. The next parcel came with an extra twopence a page on the rate, and no explanation.

She wore her better grey and left Kate's dinner with Mrs Rudd downstairs and walked, because the omnibus was sixpence and she had decided on the stairs that she would walk there and take the omnibus back only if the news was good.

Mr Davies was a square, grey man with a Welsh voice. He did not stand when she came in, but he moved a chair for her with his foot, which she took as a kind of courtesy between people who worked.

"Mrs Fell," he said. "You found my error in the table of joint lives, in 1842."

"Yes, sir."

"Nobody else did. Two clerks of mine checked that table and passed it." He did not seem displeased. "How did you find it?"

"I compute each figure twice," Hester said. "By two different roads. When the roads don't meet, I look."

"Twice. At threepence a page."

"I can't afford to be wrong, sir. A penny for an error is no good to me if I'm the one making it."

He looked at her for a moment. Then he took a sheet from the desk and laid it before her. At the top, in his engraver's hand, was the name of a table she knew, the Carlisle table of mortality, and below it a list of ages from ten to ninety-five and a rate of interest, three per cent.

"I want the values of an annuity on a single life," he said, "at every age on this list, at three per cent, from the Carlisle observations, computed fresh. Not copied from Milne. Not copied from anyone. I want them to seven figures. And then I want them again, at three and a half, and four, and so on, which you'll see on the second sheet. You'll work alone. You'll show your figures to no one but me. You'll not be told why."

She read the sheet. It was not hard work. It was a great deal of work: she counted it in her head while he was talking and made it some nine hundred pages of figures before it was checked, and the checking would be as much again.

"The rate is sixpence a page," Davies said. "Of verified figures. Verified by you, twice, by your two roads. Paid monthly. For as long as the work lasts, which will be a year at the least."

Sixpence was more than Gaskin paid her by half. It was more than she had ever been offered for anything. She found she had put both hands flat on the desk.

"May I ask," she said, "why they are wanted fresh?"

"You may ask." He considered. "I'll tell you this much, because you'll guess it. There is to be an engine. A calculating engine, of Mr Babbage's design, smaller than his old one, to compute and print tables like these. Before any office will pay for it, the office will want to see it compute a table that has been computed by hand, by someone who has never seen what the engine prints. And find them the same."

Hester heard herself say, "And then?"

"And then the office will have an engine."

She did not need him to say the rest. She had read about Mr Babbage's engine in the Penny Magazine when she was a girl and had not understood it, and had understood since. A machine that did what Gaskin paid her fourpence for, and the Guardian paid her threepence for, and did it without tiring, and without a copyist, and printed its figures at the end without a compositor to set a six for a nine. She looked at the sheet of ages under her hands. She would be computing, at sixpence a page, the standard against which the machine would be tried, and when the machine passed the trial, there would be no more pages.

"It will be some years," Davies said, as if he had heard her. "Engines are slow to make. And an engine that prints tables will still need someone to tell it when it is wrong. I have told the lady who is conducting the business that I will not trust a table I cannot check. I meant it." He paused. "I'd sooner you didn't repeat that to Mr Babbage."

"I don't know Mr Babbage, sir."

"No," said Davies. "You will."

She took the omnibus home.

The lady who was conducting the business came to Chalton Street on the twenty-second of November, a month and a half later, without warning, on foot from the cab stand in the Euston Road. Mrs Rudd came up the stairs in a state to say there was a lady asking, and Hester had time to put her shawl over the shelf of washing and no time to do anything about the floor.

Lady Lovelace was thin and very pale, in a dark blue dress too good for the street, and she was out of breath from the stairs. She said that Mr Davies had told her about the two roads and that she had wanted to see them. She did not sit down until Hester asked her to, which surprised Hester, and then she sat on the second chair with her hands in her lap and asked to see a page.

Hester showed her one. It was the eleventh sheet of the three-per-cent table, ages forty-one to forty-four. Down the left side of the page ran the first road, the old one, the annuity built up from the oldest age downward, year by year; down the right ran the second, which Hester had worked out herself from her father's notes and used for no one but herself, the same figure got from the commutation columns. Between them, in a narrow ruled margin, she had written the difference in the last place, and in every line on the page the difference was nothing.

Lady Lovelace looked at it for a long time.

"Who taught you the second road?"

"My father had the beginnings of it. I did the rest."

"Mr De Morgan would like to see this." She turned the page over, as if there might be more on the back. "Mrs Fell, do you know what this is for?"

"Mr Davies told me there is to be an engine."

"Yes." She put the sheet down very carefully, squared to the edge of the table. "Do you mind?"

Nobody had ever asked Hester whether she minded anything to do with her work. She thought of three answers and gave the true one.

"I mind," she said. "I've a daughter. This is the only trade I have. If the engine does it, I don't know what I'll do. But I'd rather it were done right than done by me wrong. And I'd rather be paid sixpence to make it right than fourpence to be put out of work by it anyway, which I would be, my lady, whether or no."

Lady Lovelace looked at her then, directly, for the first time, and Hester had the odd sense of being computed: of a figure being got by two roads and checked in the margin.

"I think," the lady said, "that an engine which prints tables will need someone like you more than an office which computes them by hand ever has. I don't yet know how to prove it. When I do, you'll be the first to read the proof."

Then she asked whether Hester would mind if she sat for a while and watched her work, and Hester said she would not mind, and went back to the forty-fifth year of the three-per-cent table with a countess on the other chair, and worked both roads, and wrote the nothing in the margin; and the countess sat without speaking for an hour and ten minutes by the clock on the chandler's church, and then thanked her and went down the stairs slowly, holding the rail.

## SIX: THE SHOP

Enoch Dunn came down from Manchester on the fourteenth of May, 1845, by the night mail through Birmingham, with a carpet bag, a deal box of his own tools that he would not let the porter carry, and a letter from Mr Whitworth that he had been told to give to the lady and no one else.

He was twenty-six. He had been at Whitworth's in Chorlton Street seven years, first as a fitter and then as an erector, which meant he was the man sent out with a machine when it was sold, to set it level on its bed and run it and show the buyer's men how not to ruin it. He had erected planers in Leeds and lathes in Glasgow and a boring mill at Woolwich Arsenal that he had not liked, because the Arsenal men called him Lanky and would not use the gauges. He had never been sent anywhere for longer than a month. This time Mr Whitworth had said a year, perhaps more, and had told him that he would be working for a gentleman who had cost the country seventeen thousand pounds and a lady who was Lord Byron's daughter, and that he was to do as the lady said and measure everything the gentleman gave him.

The shop was behind the house at 1 Dorset Street, in what had been a coach house and a stable and a yard between them, roofed over now with glass in iron sashes that Ada had had put in during the winter at a cost of a hundred and twelve pounds, which was written in a ledger she showed him on the first morning. Clement's great planer stood along the north wall, bought from his executor in October for three hundred and forty pounds. It had been brought across the river on two drays, in pieces, and put together again by two of Clement's old men, who had then been taken on. Along the south wall were the lathes from Manchester, and a slotting machine, and, on a bench of their own under a cloth, three surface plates of cast iron, each scraped true by hand at Chorlton Street so that any two of them laid face to face would cling together like wet glass.

Enoch went to the plates first. He lifted the cloth and looked at them and put the cloth back.

"They came safe, then," he said.

"Mr Whitworth sent a man with them," Ada said. "He would not let them go on the dray."

"No. He'd not."

She asked him what he thought of the planer, and he walked round it twice, slowly, the way he would have walked round a horse he was asked to buy. Then he asked for one of the plates and a straight-edge and some red lead, and spent forty minutes on the planer's table on his knees, and stood up with his hands red to the wrist.

"It's true enough," he said. "Truer than ours were when I was apprenticed. He knew his business, Mr Clement." He wiped his hands on a rag from his pocket. "The ways want scraping at the far end. A hair, happen. Two thousandths of an inch, near enough. I'll do it Saturday."

"You can see two thousandths of an inch?"

"I can feel it. I'll know Saturday."

She wrote it down. He noticed that she wrote everything down.

He met Mr Babbage at eleven. Mr Babbage came out from the house in a velvet cap with a roll of drawings, as Ada had told Enoch he would, and spread them on the clean bench by the window, and began to explain the engine. Enoch listened. He had been told to measure everything the gentleman gave him and he had not yet been given anything to measure, so he listened, and he understood more of it than Mr Babbage seemed to expect: the columns of figure wheels, one for each order of difference; the adding of each column into the next; the printing at the end. He had seen a Jacquard loom. He had never seen anything like this.

When Mr Babbage paused, Enoch put his finger on the corner of the top sheet, where there was a small square ruled for a title and a date, and said:

"Who signs these, sir?"

Mr Babbage looked at the finger and then at him.

"I drew them."

"Yes, sir. But who signs them? At Chorlton Street, a drawing comes to the shop with the master's initials and the date and the word Approved, and nothing goes to the bench without. If the drawing changes after, it comes back with a new date, and the old one's taken up and burned in the stove in front of the foreman. So the men can't cut to the wrong one." He took his finger away. "These've no date, sir."

There was a pause. Ada, standing at the end of the bench, did not move.

"These are the working drawings of the calculating section," Mr Babbage said. "They are finished."

"Then they'll want signing, sir. Begging your pardon."

Mr Babbage looked at Ada. Ada looked back at him. Enoch, who had stood between a good many buyers and a good many of their engineers in his time, understood that something was being settled in that look that was not about the drawings, and stood still and let it be settled.

"Mr Dunn is right," Ada said. "It is what we agreed. The design is frozen before metal is cut. A drawing that is not signed and dated is not frozen."

"I am aware of what we agreed."

"Then let us sign them."

She went into the house. She came back with the green book under her arm and a pen and ink. She opened the book at a page Enoch could not see, wrote something, and turned it towards Mr Babbage. Mr Babbage read what she had written. He took the pen. Enoch saw him hesitate, and then write two letters, hard, and hand the pen back.

Ada wrote her own two letters beside them, and then went down the drawings one by one, initialling each in the square in the corner, A.A.L., and dating it, the fourteenth of May, 1845, and turning each sheet to Mr Babbage, who initialled them after her, C.B., without a word, until there were eleven sheets done. Then she gave them to Enoch.

"These are what you cut to," she said. "Nothing else."

"Yes, my lady."

"If anything comes to the shop that is not signed by both of us, you will not cut it."

"No, my lady."

"Even if Mr Babbage brings it himself."

Mr Babbage said, "Especially if I bring it myself, I imagine," in a voice that might have been amused, and went back into the house.

That afternoon Enoch made the gauges.

There were to be two hundred and seventy figure wheels in the calculating section, and each had to be the same as every other to within a thousandth of an inch on the pitch of its teeth, or the carry would bind, or skip, and the engine would print a wrong figure without anyone's knowing. He made a pair of gauges for the pitch out of a bar of Whitworth's steel he had brought in his box: one that must enter between two teeth, and one, a hair thicker, that must not. A wheel that let in the first and stopped the second was a good wheel, and any other wheel went in the scrap bin under the bench, and he wrote its number in a book. He made gauges for the bore and the boss and the thickness. He hung them on a board by the planer, each on its own nail, with its name painted under it, so that a man could see at a glance if one was missing.

Ada came out at six. She looked at the board.

"Will you keep count," she said, "of what you reject?"

"I always keep count, my lady. Mr Whitworth likes to know."

"So do I. Will you give me the count every Saturday?"

"If you like."

"And the reason. Not only the number. Whether it is the man, or the metal, or the machine, or the drawing."

Enoch thought about this. Nobody had ever asked him to divide his rejects by their causes. At Chorlton Street a bad part was a bad part and the man who made it was told.

"The drawing, my lady?"

"If a part is cut true to a drawing and still will not fit, the fault is in the drawing. I should like to know how often that happens."

He understood her then, or thought he did. He looked at the board of gauges and then at the house.

"I'll keep four columns," he said.

She went in. He sat on the end of the bench in the long light from the glass roof and opened the box he had brought from Manchester and laid his own tools out on the bench in the order he liked them, his scrapers and his files and his scribing block and his own little square, which had been his master's and was true to a ten-thousandth. Then he took out a new book with a marbled cover that he had bought in Manchester for this purpose, and ruled it, and at the head of four columns wrote: Man. Metal. Machine. Drawing.

He sat for a while longer with the book on his knee. Through the window of the house he could see a lamp lit in an upper room and a man moving about in it, back and forth, as men did who were thinking, and once stopping at the window and looking down at the shop. He closed the book and went to find his lodging, which was in Marylebone Lane over a tallow-chandler's, and smelled of it.

## SEVEN: ARTICLE THE THIRD

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By March of 1846 there were ninety-one figure wheels cut, gauged and passed, standing on pegs in a rack along the shop wall like the pipes of an organ, and eleven in the scrap bin, and Enoch's book had a mark in the column headed Drawing for the first time.

It was a small mark. A boss on one of the sector arms had been drawn a sixteenth too long to clear the wheel beside it, and the piece had been cut true to the drawing and would not go in. Enoch took the drawing and the piece to Mr Babbage, who looked at both and said at once that the drawing was wrong, and corrected it, and initialled the correction and sent it to Lady Lovelace, who initialled it too, and the piece was cut again. It took a day. Enoch wrote it down in the fourth column with a note of the day lost, and Ada read it on the Saturday and was pleased: a day lost, and written down, and the drawing put right without a quarrel.

The twelfth drawing came three weeks later.

It came on a Thursday, by Mr Babbage's own hand, as Ada had once said it would. He brought it to the shop himself at seven in the morning, before she was up, and laid it on Enoch's bench, and explained it with the eagerness of a man who has not slept. It was the carriage. In the engine as drawn, when a figure wheel passed from nine to nought it gave one to the wheel above it, and that wheel, if it too was at nine, gave one to the wheel above, and so on up the column, one after another, like men passing buckets. Mr Babbage had found, in the mill of the Analytical Engine, a way to make every carry in the column at once: to see beforehand which wheels would pass nine and to lift them all together. It would make each turn of the handle faster by half. It was beautiful. Enoch, who had never seen anything like it, could see that it was beautiful.

He could also see that it would need different wheels. Not every wheel: the carriage arms and their sectors, and a new set of levers behind the columns, and a change in the shape of the teeth of the upper wheels so that the anticipating arms could catch them. Of the ninety-one wheels on the pegs, he reckoned forty would have to be scrapped.

"It's not signed, sir," he said.

"It will be."

"Then I'll wait till it is."

He waited. He sent the men to the slotting machine to cut keyways in shafts that would not change, and when the shafts were done, he stopped the shop. He stopped it at three in the afternoon, with nothing to cut that he was sure of, and sent the men home on full pay, which he had no right to do and wrote down so that it could be stopped from his own wage if the lady chose. Then he went to the house and asked for her.

She came out to the shop with the drawing in her hand. She had already seen it. Mr Babbage had taken it to her at ten and she had refused to initial it, and he had said a number of things in the study that she had not answered, and she had come out to find the shop silent and the men gone.

"You stopped them," she said.

"I'd nothing to give them, my lady. I'll not cut to a drawing that may be withdrawn. And I'll not cut to the old one if this one's to come in, because it'd be waste."

"Is it a better carriage?"

Enoch thought about this honestly.

"It's a deal better," he said. "It's the best thing I've seen. But it's not the engine we're making"

She looked at the rack of wheels on the wall. Ninety-one. She had written their cost in the ledger every week: the steel from Sheffield, the men's time, the planer's oil. She knew, without adding it, that the forty Enoch meant would come to something near three hundred pounds, and that three hundred pounds was more than any office but the Guardian had paid in.

She went back into the house and up to the study. Babbage was at the window. He did not turn round.

"You know what I am going to say," she said.

"You are going to say Article the Third."

"Yes."

"I signed it under protest," he said. "In front of your foreman. To keep the peace on the first day."

"You signed it. There is nothing in the book that says under protest."

"There is nothing in the book," he said, turning, "that says I must build a worse engine than I know how to build. Article the First says the object of my energies is an engine of the new and simpler design. This is simpler. It has fewer parts in the end. It is faster. It is better in every particular. You are asking me to finish a machine that I know to be wrong."

"I am asking you to finish a machine," Ada said. "You have never finished one in your life."

She had not meant to say it. It stood in the room between them. She saw it strike him, as she had seen the thing about Airy strike him three years before at Ockham, but this time it struck somewhere that bled. He went quite white.

"That is what Clement said," he said at last. "I suppose he told you."

"He told me he liked you better than any man he ever worked for. He told me that is why it was so bad."

Babbage sat down. He sat for a long time with his hands on his knees, looking at the floor. When he spoke again it was in an ordinary voice.

"Then we will send it to De Morgan," he said. "That is what the book is for."

"Yes."

"And I will abide by what he says."

"So will I."

He looked up at her. "Will you? If he gives it to me?"

"Yes," she said.

She sent the drawing, and Enoch's reckoning of the waste, and a copy of Article the Third, and a letter from each of them, to De Morgan in Camden Street by hand that afternoon. Babbage's letter was nine pages. Hers was one.

While they waited the shop stayed silent, the men on full pay, Enoch doing what he could with the shafts. It was in that silence, on the twenty-second of April, that Hester Fell came to Dorset Street for the first time, with the first four volumes of the check tables bound in brown buckram under her arm, sent by Mr Davies to be locked in the shop's iron press until the day the engine was ready to be tried against them.

Enoch let her in at the yard gate. She was not what he had expected. Mr Davies had said a woman who checked figures, and Enoch had pictured someone like his aunt in Bolton who kept the chapel accounts, stout and kind and sure of herself. Mrs Fell was thin and straight and wore grey, and looked at the shop the way he had looked at the planer on his first morning, as if she were working out what it was for before she would let it see her interested.

"Are those the wheels?" she said, looking at the rack.

"Ninety-one of them. Forty may be scrap."

"Why?"

He told her about the carriage, and the drawing, and the stopped shop. She listened the way he had seen few people listen, without nodding and without interrupting, and when he had finished she said:

"So you were right to stop. And he's right that it's better. And it'll be waste either way."

"Aye."

"Then the question is only who pays for it."

He had not thought of it like that. He thought about it now.

"I suppose it is," he said.

She put the four volumes down on his bench. He saw that each had a label on the spine in a small exact hand, and that the first page of the first volume, when she opened it to show him, had two columns of figures and a narrow ruled margin between them with a row of noughts down it.

"What's that?" he said, meaning the margin.

"The difference," she said. "Between two ways of getting each figure. If it's nought, I trust it."

"And if it's not?"

"Then I look."

He looked at the page for some time. Then he went to the board by the planer and took down his two gauges for the wheel pitch, the one that must enter and the one that must not, and laid them on the bench beside her book.

“Same thing,” he said.

Hester looked at the gauges and then at him, and for the first time since she had come through the gate she nearly smiled.

De Morgan’s award came on the eleventh of May. It was written on two sides of a sheet of Gower Street foolscap in his small slanting hand, and Ada pasted it into the green book under Article the Third.

He allowed the new carriage, because it was better, because no part made solely for the old carriage had yet been finished, and because, he wrote, an umpire who forbade an improvement merely because it was late would be a worse fool than the engineer who proposed it. He froze everything else: every drawing initialled on the fourteenth of May 1845 or since, except the carriage and the parts touching it, to be altered no further while the engine was building, without a fresh award. And he charged the waste, which he took from Enoch’s reckoning at two hundred and eighty-four pounds six shillings, to Mr Babbage’s own purse and not to the trust, on the ground that the trust had paid for an engine and Mr Babbage had chosen to improve it.

Babbage paid. He paid by draft on the fifteenth, which meant, Davies happened to know, selling the last of his Exchequer bills at a poor price, and he initialled the award without comment, and went to the shop and stood with Enoch for an hour going over which wheels must go and which might stay, and the shop started again on the sixteenth.

He did not speak to Ada, except about the engine, until July. In June Peel’s government fell over the Corn Laws, and she heard from Davies that Babbage had been seen in the Athenaeum reading the news with an expression of perfect contentment. In July the Lovelaces took a house in Great Cumberland Place, and Babbage called to see it, and walked through every room, and said in the last one that he supposed it was very fine, and then, looking out of the window and not at her, that the new carriage had been tried on a column of six wheels and had carried in one motion, all six, as he had said it would.

“I knew it would,” Ada said.

“Yes,” said Babbage. “You did.” And went home.

## EIGHT: THE PANIC AND THE MOTHER

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The money had been wrong since April, and she had known since April, and she had told no one.

It was not wrong in any way a clerk would have caught. Every shilling that came in was written in the ledger and every shilling that went out, and they balanced. What was wrong was the shape of the future. The subscription had been reckoned in 1844 on an engine to be finished in three years, and in the summer of 1847 it was a little more than half finished: the calculating section stood in the shop in its frame, three columns of it, with the new carriage behind, and the printing section existed in eleven initialled drawings and a heap of type-wheel blanks. Steel had gone up. Wages had gone up, because the railways were taking every good fitter in England, and twice Enoch had come to the house to say that a man was going to the Great Western and could she find another sixpence a day, and twice she had found it. The calls would run out at Christmas. The engine needed eighteen months more.

She had meant to tell the trustees in June. She sat up two nights over a statement, and on the second night took twenty drops more than Dr Locock allowed, to sleep after, and in the morning she read the statement through and saw a hole with no plan beside it, and put it in the drawer to bring them in September with a plan. In September she had not got the plan. She told herself October.

In May she had seen wheat quoted at a hundred and two shillings the quarter and thought only of the price of a loaf for Enoch’s men. In September the harvest came in heavy, and the corn houses that had bought at a hundred and two began to fail, and she read their names at breakfast in the City column, a list that grew every morning, and connected none of them with anything of hers until the nineteenth of October, when a letter came from Norwich. The office that Davies had said would pay late and in full regretted that in present circumstances it was unable to meet any further call. Two London offices wrote the next week to defer theirs. On the twenty-fifth William read out at breakfast that the government had

suspended the Bank Act, pleased, as a man is pleased when a fever breaks in somebody else's house. She had already written the figure on a half-sheet in her own working hand. Twenty-four hundred.

Davies came to Great Cumberland Place on the twenty-ninth at ten in the morning, which was early for him, and he did not sit down.

"I have been through the ledger," he said. "With the subscription book beside it, and Mr Dunn's returns. I make it two thousand four hundred to the finish. Fourteen hundred before the panic. You'll have known the fourteen hundred since April, is it?"

She did not deny it. He had not asked a question.

"You should have told us in June."

"I meant to come to you with a plan."

"You were to come with the figures. The plan is ours. That is what trustees are for." He looked at her without heat, and she would have preferred heat. "An office will insure a man with a weak heart, Lady Lovelace, if he tells us of it. It is the man who hides it we will not have on the books at any premium. I shall tell Mr De Morgan this afternoon. I'd sooner you heard it from me."

When he had gone she went up to her room and took the bottle out of the drawer and a glass from the washstand, and counted the drops into the water as she counted everything, by fives, and stopped at twenty, which was what Dr Locock allowed for a bad night, and then went on to thirty, and stopped. She sat on the edge of the bed with the glass in her hand. The clock on the landing struck the half and then the hour. If she drank it she would sleep until the afternoon, and wake knowing the same thing, with the afternoon gone. She needed the afternoon. She poured it into the slop pail, and rinsed the glass, and set it upside down to dry, and wrote to her mother.

Lady Byron came up from Esher on the fourth of November in her own carriage and sat in the drawing room with her gloves on and heard the whole of it: the engine, the subscription, the trust, the green book, the hole. She asked eleven questions, each of them exact. She asked for the ledger and went through it page by page with her finger, as Davies had, and closed it.

"I shall not lend you money," she said. "You cannot hold it. If you could, William would own it. I do not lend money to William."

"Mamma—"

"I shall lend it to the trust. Through Mr Wharton, who will see that it is secured. Two thousand five hundred pounds. The odd hundred is for what you have not foreseen. You will not have foreseen everything." She drew off one glove. "There are three conditions. I will read them."

She took a sheet from her reticule. It was written already. Ada saw that her mother had written it at Esher, before she came, before she had seen a page of the ledger or asked one of her eleven questions.

"First. That you give up the conducting of the business to Mr Davies for two years from the first of January. Second. That you submit to Dr Locock's regimen, which I shall ask him to write out in full: the reduction of your opiates; rest; no more than two hours together at a desk. Third. That the loan be secured upon the engine itself, so that if it is never finished the trust shall owe it to me and to no one else."

"You want me out of it," Ada said.

"I want you alive in two years. I can see your hands."

Ada looked down at her hands. They were shaking very slightly, as they had shaken since the summer, and she had stopped seeing it.

"Mr Davies will conduct it better than I have."

"Mr Davies will conduct it differently. Whether better I cannot judge. He will at least tell his trustees what he knows."

That was the only reproach, and it was made in the voice of the rest.

Ada asked for a day. Her mother gave her one and went to a cousin in Hanover Square. Ada sat up with the green book and read it from the first leaf: Article the First in De Morgan's pencil gone over in ink; Clement's memorandum under its gummed strip; What the law says I am; Article the Third with the award pasted beneath. If she agreed to this it would go in too, and bind her as the award had bound Babbage, who had paid two hundred and eighty-four pounds six shillings out of his own purse and initialled it without a word. She had watched him do it and thought it was what the book was for.

In the morning she wrote that she accepted. When her mother came she asked for the sheet itself, the one written at Esher, and Lady Byron, puzzled, gave it. Ada pasted it in at the next clear leaf with a strip

along the top, as she had pasted Clement's, and wrote under it, Accepted, 6th November 1847, and her initials, and turned the book round on the table.

Lady Byron looked at the pasted sheet in her own hand, and at the space beside her daughter's initials. Then she took the pen and wrote, very small, A.I.N.B., and laid the pen in the tray and drew her glove back on.

"It is a curious book," she said.

William was told that evening, after her mother had gone. She had told the trustees and her mother and the book, and then him, and she watched him take in the order of the telling.

"You might have asked me," he said.

"For the money? You'd have given it."

"Yes."

"And then it would be yours. The engine. Secured on it. By law."

He thought about that for some while, looking at the fire.

"Better your mother's than mine," he said. "I see that." He stood up. "I'd still have liked to be asked."

She heard him go down the stairs and the front door close, and his step going west along the pavement towards the park.

On the last day of December she went to Dorset Street with the keys. Babbage was in the study with his back to the window and a letter from somebody in Leipzig in his hand, and he talked from the moment she came in: about the Leipzig man, who had misunderstood the notation entirely; about Airy, who would certainly say in public that the panic was the engine's fault, because Airy said everything was the engine's fault, the weather included; and whether this business of her mother's altered the date for the printing section, because if it did he should like it recorded somewhere that the delay was the corn trade's and not his.

"It doesn't alter the date," Ada said. "That's Mr Davies's concern now."

"Ah," said Babbage, and stopped, and looked at her properly for the first time. "Yes. So it is."

Davies came at eleven. She gave him the key of the iron press where the check tables were locked, and the key of the drawing cupboard, and the ledger, and Enoch's book of returns with its four columns. She kept her hand on the ledger a moment after he had taken hold of it, and he waited, and she let go. He did not thank her. He put the two keys on his own ring, beside the keys of his office in Lombard Street, opened the ledger at the last page and read it standing, and then asked whether Mr Dunn's return for the week was come.

## NINE: THE RULE OF TWO HANDS

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Dr Locock's regimen allowed two hours a day at a desk, and from February of 1848 Ada spent them on the one question the business had left her.

On Tuesdays and Fridays she went to Chalton Street, by cab as far as the Euston Road and on foot from there, because the walk was part of the regimen and she did not want the carriage in the street. On the other days Hester came to Great Cumberland Place with her papers in a satchel and was shown up the back stairs to a small room on the second floor that had been a sewing room, with a table, two chairs, a fire, and a window over the mews. Lady Byron had forbidden the business. She had not thought to forbid mathematics.

Davies conducted from Lombard Street, with a clerk who went to the shop on Mondays and Thursdays. Enoch's Saturday returns went to Davies. Ada did not go to the shop.

"Mr Davies thinks it a question for after the engine is finished," she said on the first Tuesday, with her gloves still on. "Mr Babbage thinks it isn't a question at all, because the engine cannot be wrong. I think it's the only question. How shall we know a table is right?"

"Check it, my lady."

"Every figure? Then what is the engine for?"

"Not every figure," Hester said. "The ones that matter."

She meant it as a clerk means it, and she showed what she meant. The round ages, where the offices sold most of their policies. The ends of the columns, where a computer tired. The places where the differences

changed sign. She had found three hundred and twelve errors in four years by knowing where to look, and she laid her list on the table as evidence.

"In other people's tables," Ada said. "Made by men who tire. A wheel doesn't tire. It doesn't know which ages are round. If a tooth breaks it breaks wherever the wheel happens to stand, and if we choose where to look we shall look where a clerk goes wrong and miss where a machine does."

"Then where do you look?"

"Nowhere. We let the table choose."

She had brought a tea caddy, an old jappanned one from Ockham with a broken hinge, and eighty-six slips of card with the ages written on them from ten to ninety-five. She shook it and held it out. Hester looked at it for a moment as if it were a thing a gentleman might offer at a fair, and then put her hand in and drew a slip, and another, until there were twelve on the table: 14, 22, 23, 38, 41, 49, 60, 66, 71, 77, 83, 90.

"Twenty-two and twenty-three," Hester said. "I'd never have chosen both."

"No," said Ada. "That's why."

Hester computed the twelve by her second road, fresh, and they matched her old table to the last place, and she did not say anything about the caddy. But she drew the next twelve herself, without being asked.

The question Ada took home was how many to draw. If a table had a fault in it, how many slips must come out of the caddy before one could say, with a stated assurance, that the fault would have shown itself? It depended on the fault. A fault that touched every figure would be caught by any slip. A fault that touched only some, the figures below a broken wheel, or the figures far enough from the start for a small error to have grown, would be caught only by a slip that fell among them, and the chance of that was a thing that could be counted.

She counted it that night in the sewing room after the house was in bed, because the regimen said two hours together and said nothing about two hours apart. She wrote it the way De Morgan had taught her, the question at the top in words and then in symbols, and worked down the sheet, and somewhere past midnight the sum turned in her hand, as the good ones did, and came out simpler than the question: a short expression, in the number of slips and the number of figures touched, that a clerk could use with a table of logarithms and no calculus at all. She sat back. The fire had gone to ash. Her feet were cold and she had not noticed, and she had not counted the drops at eleven as she counted them every night, because she had not thought of them. She looked at the sheet for a while with the plain physical pleasure she had not felt since the summer of the Notes, and then she went to bed and slept until eight.

In May, on a Friday, in the sewing room, with rain on the window over the mews, Hester saw the other thing.

"The engine adds differences," she said. "Each figure from the one before, by adding. So if you take what it prints and difference it back, you ought to get the differences it started with, all the way down. If a figure's wrong, the differences go wrong just there and after. You'd see it in the third column like a stone in a stream." She put her finger on the page between them. "That's not a check of the figures. That's a check of the machine."

Ada put down her pen.

"Yes," she said. "By hand. By someone who never sees the engine."

"Then we needn't draw your slips at all."

Ada said that they would see.

She made the faulty copy herself, that week, in the sewing room, in the two hours: a fair copy of Hester's three-per-cent table, ninety-five down to ten, with two faults in it. The first was the one they had talked of, a figure wrong at age fifty-three by one in the sixth place and carried down through every figure after, as a slipped wheel would carry it. The second she told no one about. She altered the starting third difference, at ninety-five, by one in the last place, and computed the whole table forward from it honestly, so that every figure followed from the one before by perfect addition, and the error, too small to see at ninety-five, grew as it went down the ages until below sixty it stood in the sixth place, and below forty in the fifth.

On Tuesday she gave it to Hester at Chalton Street and said only that it had a fault in it.

Hester differenced it back in an afternoon. She found the stone at fifty-three and marked it, and went on down the column to ten, and said that the rest was smooth.

"Draw twelve," Ada said.

"It's smooth, my lady. I've differenced it to the third order."

"Draw twelve."

Hester drew them, and computed them fresh by the commutation road, with her mouth shut. At forty-four the fresh figure and the copy parted in the fifth place. She computed it again. They parted again. She went back to her sheet of differences and ran her pencil down the third column, and it was as smooth as she had said, from ninety-five to ten, every difference the same as the one above it.

"It's smooth," she said. "And it's wrong."

"Every figure follows from the one before," Ada said. "So the differences come out smooth. But what it started from was wrong. If the engine is given a wrong starting figure, or Enoch sets a column one tooth out, it will print a table that is perfectly consistent and perfectly false, and your differencing will pass it, because the machine did exactly what it was told. The slips catch that. Your differences catch a machine that goes wrong in the working. The slips catch a machine that was wrong from the start. One hand for each."

Hester put the pencil down. Her face had gone a dull red to the hair.

"You set me a trap."

"I set the engine one. You were standing in it."

"You might have told me."

"Then it would not have been a test."

Hester stood up and went to the window and stood with her back to the room. Down in the street a man was shouting coals. Ada waited for some time and then put on her gloves, and found that she was ashamed, which she had not expected, and that she was not going to say so, which she had.

Hester did not come to Great Cumberland Place on the Friday. A boy brought a note: Mrs Fell was prevented. On the Tuesday after, when Ada climbed the stairs in Chalton Street, a sheet lay on the table, ruled, in Hester's small exact hand, with two clauses on it.

Each table printed by the engine to be differenced back by a second hand, to the last order the engine uses. For a fault in the working.

At arguments drawn by lot, the number by Lady Lovelace's rule, each figure to be computed fresh by another road. For a fault in what it was given.

"That's the whole of it," Hester said. "I've left out the reasons. Gentlemen will want the reasons. Offices won't."

Ada read it twice and wrote it out fair in July, in the sewing room, over four days of two hours, with her own rule for the number of slips worked into four pages that Hester could follow and De Morgan, when he saw them, said he could not improve. They called it the Rule of Two Hands, for want of a better name. The engine was one hand and the computer the other, and neither was to be trusted alone.

Babbage called at Great Cumberland Place on an evening in June, after dinner, with a roll of drawings under his arm that he would not give to the footman.

"Before you say it," he said in the drawing-room door, "these are not the business. Your mother has forbidden the business. These are the Analytical Engine, which your Article the Second describes as the work to which my energies shall pass when the first is finished. I am merely passing a little early, in the evenings, when the first is in Davies's hands and Davies does not want me. You may look at them as a private person. A private person may look at anything."

She should have sent him away. She told him to put them on the carpet, because the table was too small.

They were the printing apparatus of the great engine: a train of type wheels that would take the results from the mill and set two columns at once, side by side, so that a table and its differences, or a table and its check, could come off the plate together. He had drawn it at night, he said, from ten until two or three, since February; he did not sleep much now that there was nothing to quarrel about in the daytime. He went down on his knees on the carpet beside the sheets in his evening coat and talked: about the type wheels; about the Chartists, whom he had watched gather on Kennington Common in April from the top of an omnibus and thought very orderly, more orderly than the Royal Society; about Airy's new transit circle at Greenwich, which Airy had designed himself and which would therefore be found by Airy to be the best instrument in Europe; about the man in Leipzig, again. Ada knelt on the other side of the drawings and followed the trains of wheels with her finger and asked him why the second column's carriage did not foul the first, and he showed her, and she saw it, and laughed out loud, and for most of an hour she forgot that she was barred from anything.

Then he took a pencil out of his pocket and held it out to her.

"Initial them," he said. "The corners. So that they're frozen. You like things frozen."

“Not these,” she said. “These aren’t for freezing.”

He looked at her over the drawings. Then he laughed too, and rolled them up, and took them home under his arm to go on with at ten.

Davies came to Chalton Street on a Saturday in September, which he had never done, and sat on Hester’s second chair, and asked Hester three questions about the faulty copy and Lady Lovelace none, because he said he had no need to. The third was whether she had found both faults.

“The first,” Hester said. “Not the second. The slips found the second.”

Davies wrote that down too.

“It’ll go in the book at Dorset Street,” he said. “Under my hand for the trustees, as a condition of every office’s acceptance of every table. I’ll want your initials on it, Lady Lovelace. That’s not the business. That’s the engine’s honesty. I’ll take it as within the regimen.” He turned to Hester. “And you’ll be the second hand, Mrs Fell, for the Guardian at least, at the same rate, for as long as the engine prints.”

Ada went to Dorset Street on the following Thursday to initial it, for the first time in nine months, and did not go into the shop. Babbage brought the green book from the drawer of his study desk and opened it on the desk for her at the clean leaf where Davies had pasted the fair copy of the Rule, with G.D. beside it. She initialled it. Then she dipped the pen again and wrote beneath her initials, smaller, in the same hand: Proved on her own figures by Mrs Hester Fell, computer, of Chalton Street, who is the second hand. She considered the line for a while. She did not add that the second hand had been tricked into the proof. She blotted it, and Babbage put the book back in the drawer and locked it, and asked whether she would like to see how the type wheels for the table engine were coming on, through the window, if she stood at the window, which was not going into the shop.

Hester had begun, that spring, to walk home with Enoch. He came up from Dorset Street on Saturdays to fetch the week’s check sheets for the shop’s press, and had taken, without either of them remarking it, to walking her back to Chalton Street afterwards by the longer way, round the Regent’s Park. They talked about the shop, where the calculating section was nearly done; about Kate, who was fourteen and wanted to be a pupil-teacher; about whether the cholera would come, as the papers said it would. He did not talk much. When he did it was in short pieces, like a man laying out tools in the order he would want them.

It came in the summer of 1849, to the courts behind the Brill in July and to Chalton Street in August, and Mrs Rudd downstairs, who had kept Kate’s dinner for five years, was taken ill on a Wednesday and buried on the Friday. Hester boiled every drop of water that came up the stairs and kept Kate indoors for six weeks and computed at the window with her mind on the street. Enoch came up from Dorset Street every evening with a loaf and a can of milk he swore he had seen drawn, and set them on the top stair outside her door, and knocked, and was half-way down again by the time she opened it.

“You’ll come in,” she said, the first time.

“I’ll not,” he said from the turn of the stair. “I’ve the shop on me. Boil that.”

Kate did not take it. Hester did not take it. In London that summer fourteen thousand people died of it, and in September it went away as it had come, and nobody could say how.

The calculating section ran on the twentieth of September.

Hester was there because Davies had asked her. Babbage was there in the velvet cap, and De Morgan with his watch out, and Davies. Ada was not; the regimen had three months more to run, and she had asked only that someone write to her the moment it was done.

Enoch set the starting figures on the columns by hand: the value of an annuity at ninety-five and its first, second and third differences, from Hester’s table, and Hester read them back to him from her sheet, one by one, and he set them again where she said a tooth was out, because the slips had taught her what a wrong start would cost. Then he looked at Babbage, and Babbage nodded, and he put his hand on the crank and turned it.

It was not loud. It was a long soft rattle, like a drawer of cutlery being slowly closed, and then a click as the carriage lifted, all at once, and the top column moved. Enoch turned again. At every turn the top column showed the value of an annuity a year younger, and Hester read it off and wrote it down against her own table on the bench. Ninety-four. Ninety-three. She stopped writing the figures at seventy-one, when the page was full, and Enoch stopped turning.

“Same,” she said. “All the way.”

Babbage took off the velvet cap and held it in both hands.

Ada had the letter the next morning. It came by hand while she was at breakfast, and she took it into the hall to read it standing, and then sat down on the second stair and read it again. There was no letter in it. There were twenty-four figures in a column in Hester's hand, and beside them the engine's twenty-four as Hester had read them off the wheels, and between them a narrow ruled margin with twenty-four noughts down it.

Airy came on the fourteenth of November, at the trustees' invitation. Two of the five offices still in the subscription had written to Davies that they would pay their calls for 1850 on the Astronomer Royal's opinion and not otherwise. Davies told the shop so on the Monday, in those words, and Babbage said that in that case the engine might as well be broken up for its brass at once and save everyone the trouble.

Airy came at eleven, in a plain black coat, with a table of his own in his pocket. He watched Enoch turn for twenty minutes without speaking, then named three ages and checked the figures against his table, and found them right. Babbage stood at his elbow and began, while Airy was writing, to explain the anticipating carriage, and then, because Airy did not look up, to explain the history of the anticipating carriage, which led him to the mill of the Analytical Engine, and so to the year 1842, and the opinion given to Mr Peel, and the Treasury minute.

"Mr Babbage," Airy said, still writing. "I am asked about this engine. Not about that one, and not about 1842." He turned to Enoch. "Who made it?"

"I did, sir. To Mr Babbage's drawings."

"How many of these wheels have you thrown away?"

Enoch told him, from the book with four columns, and Airy wrote that down. He asked what the engine had cost. He asked what a computer was paid. He asked Hester, who had been named to him as the computer for the checking, how long she would take to compute the same table by hand, and she told him, and he wrote that down. Then he asked Davies, in front of the shop, whether the drawings of Mr Babbage's other engine were being made at the subscribers' expense, and Davies said that they were not, and Babbage went from red to white and did not say anything at all, which Hester had not known he could do.

The opinion came to Davies a week later. It was one page. It said that the engine computed; that its tables, reckoning the cost of the engine over its life, would cost the offices about fourteen shillings the page against nine by hand; and that whether it was wanted was another question.

Davies read it aloud in the shop. Babbage walked out of the yard gate in the middle of it and did not come back for a fortnight.

"He says it computes," Davies said to the shop when the gate had shut. "In writing. Over his name. That is the first time in twenty years." He folded the page into his pocket-book. "The rest is ours to show him."

In December the five offices paid their calls for 1850. Davies entered each in the ledger in his small engraver's hand, and sent the figures to Great Cumberland Place on a single sheet, without a covering letter, since the regimen did not forbid a sheet of figures.

## TEN: THE FIRST TABLE

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She came back on the second of January, 1850, a day late, because the first was a Tuesday and she would not, she said, begin anything on a Tuesday again. Davies gave her the keys of the press and the ledger and a statement of account written out fair on two sheets, every figure since November 1847, with the loan from Esher shown in red as a debt of the trust secured on the engine, and a line at the foot in his own hand: Nothing withheld. G.D.

She read it through in the study at Dorset Street with Babbage on the other side of the desk pretending to read a letter. At the end she wrote under Davies's line, Nothing withheld. A.A.L., and gave it back to him, and he took it as if she had given him a receipt.

The red line stayed with her. Two thousand five hundred pounds, owed to her mother, secured on the engine, so that if the trust failed the engine would be Lady Byron's: the wheels Enoch had cut, the carriage Babbage had fought for, the plates that had not yet been cast. She found she could not look at the frame in the shop without seeing a small upright hand on it.

In April, at Ockham, she went to William in the estate room before breakfast, before she had told Davies or Greig or anyone, and asked him for it.

He was standing at the table with the forester's plan of the lower park weighted open under two inkstands. He heard her out without putting down his pencil.

"How much?"

"Two thousand five hundred."

He looked out of the window, down the slope, to where the oaks below the church stood bare in a line against the water meadow. Hughes had been at him to fell them for three years. They had been planted by his grandfather.

"They'd fetch it," he said. "Near enough."

"You don't want to."

"No." He put the pencil down at last. "I'll write to Hughes this morning."

"I'll have it written in the book. As a loan to the trust, at whatever—"

"No."

"William, nothing binds that isn't—"

"I know what it says. I've read the first leaf." He rolled the forester's plan and tied it. "I'll not be in your book, Ada. It's not a loan. It's the oaks. Pay your mother and have done."

"Then nothing binds it."

"Then nothing binds it," he said, and went out to the stables to find Hughes.

The oaks came down in May. Lady Byron was paid through Mr Wharton on the twenty-ninth, and wrote to her daughter that Mr Wharton informed her the trust's obligation was discharged, and that she was glad Ada was well enough to arrange it. Ada read the letter twice, and expected to feel free, and felt instead that she had moved a weight from one shoulder to the other. She did not put the letter in the green book. There was nothing in the green book to put it under.

The printing apparatus was finished in June: a train of type wheels at the end of the frame that took each result as the columns gave it up and pressed it, figure by figure, into a tray of soft papier-mâché, line under line, so that when a page was done a plate could be cast from the tray in type metal and sent to any printer in London, with no compositor between the engine and the page to set a six for a nine. Enoch had made the type wheels to Babbage's drawings, initialled and dated, and had rejected thirty-one, nineteen of them under Metal, because the Sheffield steel was dirty that spring.

They printed the first table on the ninth of July: annuities on a single life, Carlisle, three per cent, ninety-five down to ten, eighty-six figures to seven places, two quarto pages. Enoch turned. The type wheels pressed. Babbage watched the moulds come out of the train with a look Ada had seen before only at christenings. Davies stood at the window with his watch. Hester stood at the side bench with her pencil and her ruled sheets and did nothing, because the Rule said the second hand must not see the figures until the plate was cast.

It was cast on the tenth and a proof pulled on the eleventh by a printer in Fetter Lane and sent to Chalton Street by hand. On the evening of the thirteenth Hester came to Dorset Street herself with the proof and her sheets and asked for Lady Lovelace and Mr Dunn together.

"Third differences," she said, and laid the sheet on the bench under the lamp. "Smooth from ninety-five to seventy-two. Here." She put her finger on it. "At seventy-one they jump. Then smooth again from seventy, on a different line." She drew it in the air, a stream with a stone in it. "The figure at seventy-one's wrong in the sixth place by one. Every figure after carries it."

Enoch took the lamp from the bench to the engine and turned the crank back, a turn at a time, counting under his breath, until the top column stood where it had stood when it printed seventy-one. He took the cover off the carriage behind the sixth wheel and looked, and put his hand in, and took it out with a lever between finger and thumb, and held it to the lamp.

There was nothing to see, and then Ada saw it: a bright flat on the nose of the lever no wider than a hair, where the steel had been rubbed by ten thousand turns of the crank.

"It's worn," Enoch said. "Took a carry it shouldn't, once, wheel above at nine and this at nought. It'll not do it often. Only when the figures fall just so."

"You passed it," Hester said. It was not an accusation; she was placing it.

"I passed it a year since. It were true then. A gauge'll tell you what a thing is the day you gauge it. It'll not tell you what ten thousand turns'll do." He turned the lever in the light. "I should have had them all out at Lady Day and gauged them again."

"It's a fault of steel," Hester said. "That's what the Rule's for."

He did not answer her. When Ada left at ten he had the cover off the whole carriage and every lever laid out on a clean cloth in order, and the gauge in his hand.

Ada wrote it in the green book that night: Table I, annuities, Carlisle, 3 per cent. Printed 9th July 1850. Differenced by H.F.: discrepancy at age 71, sixth place, carried forward. Traced by E.D. to a worn carry lever, sixth wheel. Lever replaced; all levers gauged again. Table reprinted 16th July, differenced again, and drawn by lot at twelve arguments by H.F., and found the same. She initialled it, and when Davies came on the seventeenth he wrote G.D. beside her initials for the trustees, and the Guardian printed the table in its tariff for 1851, and paid.

The Exhibition opened in Hyde Park on the first of May, 1851.

Babbage had not wanted to send the engine. He had quarrelled with the Royal Commission over the arrangement of the classes and written a pamphlet about it, and said in the study, at length, that he would not have his engine stood among the mangles and the steam ploughs to be gawped at by excursionists from Leeds, who would think it a superior kind of mangle. Davies said the Guardian wanted its engine computing and not standing in a glass house for six months. Enoch said the move would shake the frame out of true. Ada said that the Commissioners had offered space in the Machinery Court, and that an engine which printed a page every afternoon for six months in front of half of Europe, with a computer at a table beside it differencing every page by the Rule where anyone could watch, would answer Mr Airy better than anything she could write.

"Let them watch it checked," she said. "They'll believe the checking before they believe the engine."

They sent it. Enoch set it up on its bed in the Machinery Court in April among the steam hammers and the power looms, under the great glass roof, and had it true again in eleven days. From the first of May it printed a page every afternoon at three, annuities at a different rate each day; the moulds were cast in a little furnace behind a rope, a proof pulled on a hand press and pinned up on a board, and at a table beside the board, with her back to the crowd, Hester differenced the day's page by hand and wrote at its foot, in pencil, Differenced, H.F., and the date. People watched her as much as the engine. A newspaper called her the Lady Arithmetician. Hester said nothing about it to anyone except Kate, who was seventeen and a pupil-teacher, and thought it very fine.

Ada came on a morning in June before the doors opened to the shilling public, on a pass from the Commissioners, with William. She had been bleeding since April. She had told William and Dr Locock and no one else. Dr Locock had said it was a disorder of the womb, and looked at her for a long time, and asked to see her again in a month.

She walked the length of the Machinery Court on William's arm, slowly, past the locomotive and the hydraulic press and the cotton machines, and stopped in front of the engine. Enoch was there early, oiling it, and took off his cap. Hester had not come yet.

"Will you turn it for me?" Ada said. "Not for the page."

Enoch looked at the clock on the iron column and then at her. He set the columns from the morning's figures and put his hand on the crank and turned, slowly, and the long soft rattle went up under the glass, and the carriage lifted all at once, and the type wheels moved, and the sun came across the court in long bars full of dust and lay across the brass.

"Again," Ada said.

He turned again. William stood with her hand on his arm and said nothing, and she held on to the arm.

Dr Locock saw her in July and said the word. She told William, and her mother. John Crosse, whose father's house in the Quantocks she had stayed at in the winter of 1844, came up from Somerset in August and called three afternoons a week and read to her, and on those afternoons William rode.

The jurors awarded the engine a Council Medal in October. It was struck in the name of Charles Babbage alone. The jurors' report gave the engine three pages and named the Calculating Engine Subscription, Mr Griffith Davies, F.R.S., and the Countess of Lovelace, who had conducted its business. It did not name the foreman who had made it true or the computer who had checked it every afternoon for five months and a half.

Ada read the report in bed at Great Cumberland Place and sent for Davies and the green book. Her hand that day was not to be trusted, and she had him write at her dictation: The jurors have named the conductor. They have not named the foreman or the second hand. This book names them: Enoch Dunn, foreman, who made it true; Hester Fell, computer, who would not let it lie. She took the pen from him and put her initials under it, very slowly, and held the pen out to him, and he wrote G.D.

Babbage hung the medal in its case in the drawing room at Dorset Street, on the wall above where the old portion of the Difference Engine stood under its glass, and told everyone who asked that the Commissioners had shown more sense than he had expected of them. In November Enoch went to Dorset Street to settle where the engine should stand when it came back from Hyde Park, and was shown the medal by the housekeeper, and saw that a second card had been slipped into the case behind the first, where it could only be read close to, in Babbage's own hand: With A.A.L., who would have it finished.

## ELEVEN: THE LAST ARTICLE

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The engine went to Lombard Street in the second week of January, 1852, in nine crates on three drays, with Enoch walking beside the first dray the whole way from Dorset Street with one hand on the tailboard. The Guardian had cleared a back room on the ground floor behind the clerks' hall, where the boards had been taken up and a bed of brick and stone laid to Enoch's drawing, and by the end of the month the engine stood on it under a skylight and printed, on the first of February, a table of joint lives at four per cent, which Hester differenced in Chalton Street and found smooth.

Ada did not see it there. She had not been out of Great Cumberland Place since November except to be driven in the park on fine days, wrapped to the chin, and in the new year the fine days stopped.

Davies came on the third of February to tell her, and found her asleep, and told William instead in the library. He stood with his back to the fire and described the brick bed and the skylight and the joint-lives table in some detail, and then stopped and looked at the carpet, and said that he hoped Lady Lovelace would know that the offices were very satisfied, and that the subscribers had voted to go on paying for the printing of further tables at the rate agreed, and that there was nothing else she need trouble herself with, nothing at all.

"I'll tell her," William said.

"Tell her nothing's withheld. She'll know."

Lady Byron came up from Esher in March and took the house in hand. She decided who came up the stairs, and when, and for how long. Greig came, because he was Mrs Somerville's son and a lawyer. Sophia De Morgan came. The children came at the hours appointed. John Crosse came twice, and was told the third time at the door that Lady Lovelace was not equal to visitors.

Babbage came in June, and was let up because Ada asked for him in front of the doctor.

He brought a roll of proofs from Lombard Street under his arm and sat by the bed in his overcoat although the window was open, and talked. He told her that the Guardian's hall porter believed the engine to be a new kind of safe, and had been heard explaining to a policyholder that it counted the money as it went in. He told her that Airy had written to the Times about the transit circle and been answered by a man in Bristol, who was wrong, but less wrong than Airy. He told her about the Italian with the barrel organ who had taken up a station at the corner of Manchester Square and played the same four airs from nine until dusk, and he did the four airs, badly, and the Italian's bow, and the Italian's monkey, until she laughed so much that she began to cough and could not stop, and turned her face to the pillow with the handkerchief, and he stopped in the middle of the monkey.

"Go on," she said, when she could.

He looked at the handkerchief in her hand, and then at the window.

"When you're up," he said, "I'll bring the mill. All of it. Every drawing since 1834. You may initial none of them."

"Go on with the monkey."

He went on with the monkey.

She was bright all that evening and very ill the next day, and on the day after that Lady Byron wrote to Mr Babbage that it would be better for her daughter if he did not call again. He did not call again. He wrote instead, every few days, long letters about the engine in Lombard Street and the porter and the Italian, which William read aloud at the bedside when she could no longer hold them.

In August she asked William to send for Babbage, in spite of her mother, so that she could ask him to be her executor. Babbage came and went up and came down after twenty minutes with a face William did not want to look at, and said in the hall, picking up his hat, that he had agreed, and that he supposed

Lady Byron would not allow it, and that he would not contest it if she did not. Lady Byron did not allow it. Babbage did not contest it.

In the last week of August, on an afternoon with the blinds half down against the heat, William was sitting with her and thought she was asleep. Then she said his name. He went to the bed. She asked him to open the small drawer of her writing table and bring her what was in it, and he brought it: a packet of letters, perhaps thirty, tied with green tape, addressed in a hand he knew from the hall table.

"Will you give those back to Mr Crosse," she said. "Unopened."

He held them.

Then she told him.

When she had finished he stood by the bed for a moment longer with the packet in his hand. He put it on the writing table, squarely, as if setting down something he had been asked to carry for a stranger. Then he went out of the room and down the stairs and out of the front door into Great Cumberland Place without his hat, and walked: up the Edgware Road as far as the canal, and back by Paddington and the Bayswater Road, and into the park when the gates opened, and round the water twice, and out again, and along Oxford Street with the carts going in to Covent Garden. He came back at four in the morning and sat in the library until it was light. At nine he was told she was asking for him, and went up, and she was asleep when he got there, and he sat by the bed until she woke. When she woke neither of them spoke of it.

At eleven he gave the packet to Greig in the hall, and asked him to return it to Mr Crosse, unopened, with no message. Greig took it and put it in the inside pocket of his coat and asked nothing at all, which William remembered afterwards as the kindest thing anyone did for him that year.

He sat with her every afternoon after that, as before. He sat in the chair by the window now, not the chair by the bed.

On the second of September she asked Greig to bring the green book from Dorset Street.

Greig brought it on the third. William was in the room, at the window. The book was heavier than she remembered. She could not hold it. Greig set it open on the bed-tray at the first clear leaf after the jurors' page, and she saw Davies's hand there, and the names of Enoch Dunn and Hester Fell, and her own initials under them, crooked. Greig put the pen into her fingers and closed them round it.

She had thought about the words for a week, in the hours when the drops let her think, and they had seemed quite clear. With the pen in her hand they would not stay still. The line went up the page as she wrote it, as if the bed were moving. She stopped and slept, and woke with the pen gone and Greig putting it back. She thought of the oaks below the church, which were not in the book, and would not be. She thought she would not put them in now, either. She wrote three sentences, and her initials, and stopped, and the pen made a mark she had not intended beside the A.

"Read it to me," she said.

Greig came from the window and read it.

"Article the Last. That the husband who owns this book by law shall own it also by gift. That he shall read every page of it, including my mother's sheet. That he shall do with it what he thinks right after I am dead."

There was nothing else on the page but her initials and, beside them, the space.

William waited for her to ask him for something: to forgive her, or to sign, or to say anything at all. She looked at him across the bed for a while. Then she shut her eyes.

Greig closed the book and gave it to William, who held it in both hands. It was heavier than he had expected, because of all the things pasted in.

"There's a space," Greig said quietly in the passage outside, afterwards.

"She didn't ask me to."

He took it down to the library and put it in the drawer of his desk and locked the drawer.

The autumn was very bad. William learned the names of things: the haemorrhages, the doses, Dr Locock's careful phrases and later Dr West's, and the mesmerist her mother brought, whom he disliked on sight and did not send away, because it was not his to send. Lady Byron sat at the foot of the bed with her gloves on her knee for the last fortnight and slept in the dressing room. Ada knew them, most days, until the last week.

She died on the evening of the twenty-seventh of November. William was in the room. He held her hand at the end, the hand he had held from the Strand to Charing Cross eight years before, after he had signed the clause that said she did not exist in law; she had held his that day as far as Charing Cross and

no farther, which was as far as she held anything in public. She was thirty-six, thirteen days short of her thirty-seventh birthday.

She was buried at Hucknall, in the Byron vault, beside her father, whom she had never seen, as she had asked. William went. Babbage was not asked. Davies sent a wreath from the Guardian.

Enoch read it in the Times on the twenty-ninth and walked up from Lombard Street in his dinner hour, and told Hester on the landing outside her door with his cap in his hands, and went back down the stairs to be at the engine by two. Hester sat at her table a long while. Then she took a clean sheet and ruled a narrow margin down it, as for any table, and sat with the margin in front of her until the light went. When she lit the candle she wrote the date at the head of the sheet and put it at the bottom of the pile.

In December, at Horsley, when the house had emptied, William unlocked the drawer and took the green book out and opened it at the first leaf. The Book of Conditions. Between C.B. and A.A.L., with A. De M. as umpire. Every article to be initialled by both. Nothing binds that is not written here.

He read every page. It took him three evenings. On the third he came to her mother's sheet in the small upright hand he knew, with A.I.N.B. beside it, and read it twice; and turned the leaf and read the Rule of Two Hands, with the line beneath it about Mrs Fell; and the jurors' page; and the last page, with its wandering hand and her initials and the space. There was nothing anywhere about the oaks. There was nothing about Mr Crosse.

He closed it and put it back in the drawer and locked it.

Enoch asked Hester on a Sunday in February, walking back round the Regent's Park by the Outer Circle in a thin snow that did not lie. He had a letter in his pocket from Mr Whitworth and he took it out and gave it to her to read, and walked beside her while she read it, so that she should not have to look at him.

Foreman at Chorlton Street, from April. The best place in the works.

"You'll take it," she said.

"I'll take it." He put the letter back in his pocket. "I'd take you with it. And Kate. There's schools in Manchester crying out for teachers. Better than here."

She had known for a year that he would ask. She had known for a year what she would say. She found that it did not help at all.

"Kate's walking out with Mr Pryor," she said. "The compositor. In Holborn. She'll not go north."

"She's nineteen. She'll go where she's took."

"She'll not go north."

They walked a little. A keeper went by them with a dog.

"And the engine," she said.

"They'll want a man for it. Gaskin knows one."

"They'll want the second hand."

"There's tables in Manchester."

"Not the Guardian's." She stopped on the path, and he stopped. "When I married Thomas I had six shillings a week from teaching in my father's school. It went to Thomas the day we came out of church. I never minded. I'd nothing to mind with. What I get from the Guardian is the first money I've had that's more than piecework, Enoch, and it's mine. Nobody signs for it."

"I'd never touch a penny of it."

"I know you wouldn't," Hester said. "The law would."

He looked at her for a moment as if she had set him a drawing he could not read, and then as if he had read it.

They walked on. The snow was gathering on his shoulders and in the brim of his hat and he did not brush it off. After a while she put her hand through his arm, which she had not done before, and kept it there to the gate at Gloucester Gate, and down Albany Street, and across the Hampstead Road, and to the corn-chandler's door in Chalton Street, where she took it back.

"April, then," he said.

"April."

He went north on the ninth of April by the morning train from Euston. At ten past six she was at her window with the column she was checking, and heard a train go out, which might have been his, and finished the column.

## TWELVE: HORSLEY, 1878

The engine left Lombard Street in June of 1867, in the same nine crates it had come in, which the Guardian had kept in a cellar for fifteen years because nobody had told anyone to burn them.

Hester was there because the secretary had sent for her. Mr Davies had been dead twelve years. His room at the back, with the north light that never fell on the paper, was a junior clerk's now, and had a gas bracket. The engine's room behind the clerks' hall had been cleared to the brick bed, and the bed was dusty, and the men from the carrier's were sliding the last crate up a ramp of planks into the yard, where a dray waited to take it to Dorset Street. Mr Babbage had asked to have it back. Nobody else had asked for it.

The secretary was a young man named Bartram with good manners and a pencil behind his ear. He gave her a printed sheet.

"The Institute's," he said. "Adopted last year. We'll be going over to their tables entirely from Michaelmas. I thought you should see it, since you'll be doing a good deal of it."

It was headed Rules for the Computation and Examination of Tables, and the fourth rule was called the Rule of Two Hands. Each table to be differenced back by a second hand, to the last order of differences employed. At arguments drawn by lot, each value to be computed afresh by an independent method. There were no reasons given and no name.

Hester read it twice.

"It's a good rule," Mr Bartram said. "Somebody at the Institute thought of it, I suppose."

"They've left out the reasons," Hester said.

He did not know what she meant and was too polite to ask. He told her instead, because she was looking at the dray, that the engine had cost the office twenty shillings a page this last year, with the repairs, and the man they had to have in from Clerkenwell for the carriage arms, which nobody now living quite understood; and that the Institute's tables, checked by the rule, came to five.

"Will I still be wanted?" she said.

"Three days a week, Mrs Fell. At the same rate. More than ever, the secretary says."

She watched the dray turn out into Lombard Street. One of the carriage arms had worked loose in its crate, and she could hear it as the wheels went over the setts, a small loose knock at every turn, until the traffic covered it.

In November of 1877 a letter came to Horsley from Major-General Babbage, who had been sorting his father's papers in forty-one boxes since he came home from India, and had found Lady Lovelace's initials in the corners of the drawings of 1845, and a note in his father's hand on the back of one of them: The green book is at Horsley. It is hers and his now. He wrote to ask whether the book existed, and whether he might see it, since the engine was his. He mentioned that the computer who had checked its tables, a Mrs Fell, was still living, in Somers Town; his father's letters named her.

William was seventy-two. He had been ill in the autumn and was not yet allowed to ride. He read the letter at breakfast and then went to the library and unlocked the drawer, which he had not done since the October Babbage died, and took the book out and set it on the desk, and sat with his hands on either side of it for most of the morning.

The letter from Lord Lovelace came to Chalton Street in March, on paper with a coronet, asking whether Mrs Fell would do him the kindness of coming to Horsley on the fourth of April, by the train to Effingham Junction, where a carriage would meet her, to read some tables in a book that he wished to give to Major-General Babbage; he would be grateful, as she was the only person living who could tell him whether the tables were right.

Hester was sixty-six. She still lived in the two rooms over the corn-chandler's, though the chandler was a different chandler and the stairs were harder. She still computed three days a week for the Guardian, by the Institute's rule, at sixpence a page. She went because she was curious, and because she did not know what book he meant.

The carriage at Effingham was a closed landau with a coachman who said nothing for four miles. Horsley Towers was a long flint house with a great many towers that did not seem to her to be holding anything up, and a hall with a timber roof like a church's. Lord Lovelace met her in the library: a tall old man who walked with a stick and sat carefully, as if furniture were something one might damage. Major-General Babbage was there too, a man of fifty-three with his father's forehead and none of his father's restlessness,

who shook her hand and said that he had read her name in his father's letters and had not expected to meet her.

The book was on the table. It was a green quarto with a leather spine, the cloth worn pale at the corners and grey along the fore-edge where hands had held it, swollen to half again its thickness with what had been pasted into it.

"My wife kept this," Lord Lovelace said. "From the autumn of 1843. When she was dying she gave it to me. I have read every page, more than once. I think it belongs with the engine, and the engine is Henry's." He touched the cover. "But there are tables in it. Copies of the first tables, and her working of the Rule. Before I give it away I should like to know that what is written in it is true."

"I'm the person who checked them," Hester said. "I don't know about true."

He smiled for the first time. "That will do."

They left her alone with it at the long table under the window, with a lamp and her own pencil and a ruled sheet she had brought in her bag from habit. It was a grey April afternoon with rain coming over the Downs.

She opened it at the first leaf. The Book of Conditions. Between C.B. and A.A.L., with A. De M. as umpire. Every article to be initialled by both. Nothing binds that is not written here. Inside the front board, in faded ink: 4s. 6d.

She had heard of the book for thirty years and never seen it. She read it from the beginning, slowly, not as a computer reads but as one reads a letter. Article the First, in pencil gone over in ink. Mr Clement's memorandum under its gummed strip, which she lifted and read on both sides. What the law says I am, and under it, What this book says I am, initialled twice. Article the Third and Mr De Morgan's award, with the figure two hundred and eighty-four pounds six shillings, which she remembered Enoch working out on the back of a drawing with a carpenter's pencil. A sheet in a small upright hand, pasted, with three conditions on it and four initials beside it that she did not know.

Then the Rule, two clauses in Lady Lovelace's clearest writing, which were Hester's two clauses with the reasons put back; G.D. beside them for the trustees; her ladyship's initials; and under those, in the same hand, smaller:

Proved on her own figures by Mrs Hester Fell, computer, of Chalton Street, who is the second hand.

She sat with her finger under the line. She thought of the faulty copy, and of the second fault, the smooth one, which she had passed; and of standing at her own window with her back to a countess while a man shouted coals in the street. Lady Lovelace had not written that down. She had written this.

Then she did what she had come to do. She turned to the copy of Table I, which Lady Lovelace had written out fair on two leaves, took her pencil and her ruled sheet, and differenced it back, all eighty-six figures, to the third order. It took her an hour and a half. The rain came and went. The third differences were smooth from ninety-five to ten. Lady Lovelace had copied the reprinted table, not the first; the stone at seventy-one was not in it, and the note beside it said why: Traced by E.D. to a worn carry lever, sixth wheel. Lever replaced; all levers gauged again. Then, because the Rule had two hands, she took twelve ages from her head as near to random as she could make them and computed them fresh by the commutation road, and they were the same.

She read the jurors' page in Mr Davies's engraver's hand and found her name a second time, written out whole beside Enoch's: Enoch Dunn, foreman, who made it true; Hester Fell, computer, who would not let it lie.

She had not seen Enoch for twenty-five years. His letters came at Christmas now, about the gun shop, and gauges, and a new measuring machine of Mr Whitworth's that would tell a millionth of an inch, and never about anything else, and she read them at the window and understood them. In 1870 Parliament had passed an Act by which a married woman might keep what she earned. She had read it in the paper at her table, and put the paper down, and finished the page she was checking, and a week later, in the middle of another page, had put her pencil down and sat for a long time with the snow on a man's shoulders in front of her eyes.

The light was going. She turned to the last leaf.

Article the Last. The hand wandered across the page like the hand of someone writing in a moving carriage. That the husband who owns this book by law shall own it also by gift. That he shall read every page of it, including my mother's sheet. That he shall do with it what he thinks right after I am dead. A.A.L. And beside the initials, the space.

Every other article in the book was initialled twice. She turned back through it to be sure, counting, as she would have counted the noughts in a margin. Every one twice, or three times, or four. This one once.

Lord Lovelace came in at six with the lamp lit and Major-General Babbage behind him.

"Well, Mrs Fell?"

"The tables are right, my lord. I've differenced the first, and drawn twelve. The note beside it is right too. I was there." She hesitated. "My name's in it. Twice."

"Yes," he said. "She put it there. I wondered whether you knew."

"I didn't know."

He came and stood by the table and looked down at the open book, at the last leaf, where her finger still lay on the page an inch from the space, as it had lain when she was counting. She took it away.

He stood for a while. Then he turned back one leaf, and another, until he came to the small upright hand and the three conditions, and looked at them, and turned forward again to the last leaf. He leaned his stick against the table and took a pen from the stand and dipped it, and bent, and wrote in the space beside his wife's initials, in a hand much steadier than hers, two letters, W.L., and under them the date, 4th April 1878, and blotted it.

He closed the book and held it out to Henry Babbage, who took it in both hands.

"Mrs Fell, you'll stay to dinner," Lord Lovelace said. "The train's not till nine."

She stayed. At dinner Henry Babbage asked her about the Rule, and she told him, reasons and all, and he said that he meant to build a working piece of his father's other engine, the great one, the mill at least, before he died, and that if he did he would want it checked by someone who would not let it lie.

"I'm sixty-six, sir," said Hester.

"So you are," said Henry Babbage. "So you are. I shall have to be quick."

The carriage took her to Effingham in the dark. On the train she sat by the window with her bag on her knee, and after Leatherhead she took out the ruled sheet with the eighty-six third differences of Table I down one side and the narrow margin beside them with its noughts. She took out her pencil, and at the foot of the sheet, as she had on every proof at the Exhibition, wrote Differenced, H.F., and the date, and put it back in the bag.