



NATIONAL  
GEOGRAPHIC

READING EXPEDITIONS™

国家地理

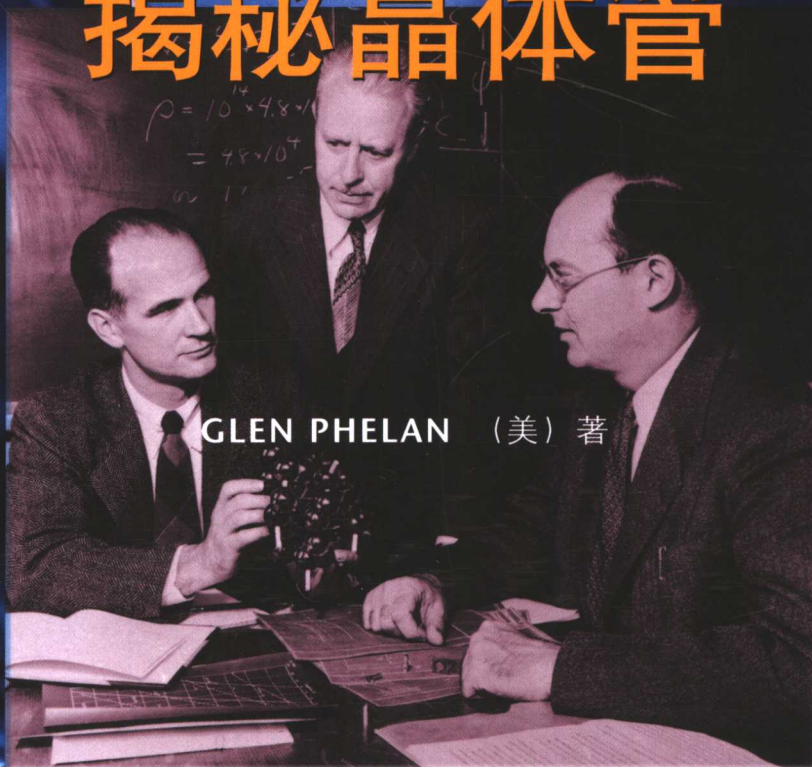
科学探索丛书

SCIENTISTS IN THEIR TIMES

站在时代前沿的科学家

# Building Tiny Transistors

## 揭秘晶体管



GLEN PHELAN (美) 著

外语教学与研究出版社

FOREIGN LANGUAGE TEACHING AND RESEARCH PRESS

英文注释

京权图字: 01 - 2005 - 2576

Copyright © (2004) National Geographic Society. All Rights Reserved.

Copyright © (2005) (English-Chinese bilingual) National Geographic Society. All Rights Reserved.

国家地理科学探索丛书(英文注释版)由美国北极星传媒有限公司策划并授权外语教学与研究出版社在中华人民共和国境内(不包括香港、澳门特别行政区及台湾省)独家出版、发行。

### 图书在版编目(CIP)数据

揭秘晶体管 = Building Tiny Transistors / (美) 费伦 (Phelan, G.) 著. —北京: 外语教学与研究出版社, 2005.4

(国家地理科学探索丛书: 注释版. 站在时代前沿的科学家)

ISBN 7 - 5600 - 4857 - 9

I. 揭… II. 费… III. 英语—语言读物 IV. H319.4

中国版本图书馆 CIP 数据核字(2005)第 046412 号

出 版 人: 李朋义

责任编辑: 咸珊珊 王霖霖

美术编辑: 孙莉明

出版发行: 外语教学与研究出版社

社 址: 北京市西三环北路 19 号 (100089)

网 址: <http://www.fltrp.com>

印 刷: 北京画中画印刷有限公司

开 本: 740×975 1/16

印 张: 2.5

版 次: 2005 年 6 月第 1 版 2005 年 6 月第 1 次印刷

书 号: ISBN 7 - 5600 - 4857 - 9

定 价: 5.90 元

\* \* \*

如有印刷、装订质量问题出版社负责调换

制售盗版必究 举报查实奖励

版权保护办公室举报电话: (010)88817519

---

## 致读者

---

**如**果你希望在享受英语阅读乐趣的同时又能增长知识、开拓视野，由外语教学与研究出版社与美国国家地理学会合作出版的“国家地理科学探索丛书”（英文注释版）正是你的选择。

“国家地理科学探索丛书”（英文注释版）第二辑分为8个系列，共46本，内容涉及自然科学和社会研究，除对本套丛书第一辑已包含的“生命科学”、“物理科学”、“地球科学”和“文明的进程”4个系列进行了补充外，又推出了4个新的系列——“生活中的科学”、“科学背后的数学”、“专题研究”以及“站在时代前沿的科学家”。

这套丛书秉承《国家地理》杂志图文并茂的特色，在书中配有大量精彩的图片，文字地道易懂、深入浅出，将科学性和趣味性完美结合，称得上是一套精致的小百科全书。特别值得一提的是本套丛书在提高青少年读者英语阅读能力的同时，还注重培养他们的科学探索精神、动手能力、逻辑思维能力和沟通能力。

本套丛书既适合学生自学，又可用于课堂教学。丛书各个系列均配有一本教师用书，内容包括背景知识介绍、技能训练提示、评估测试、多项选择题及答案等详尽的教学指导，是对课堂教学的极好补充。



NATIONAL  
GEOGRAPHIC

国家地理

科学探索丛书

英文注释

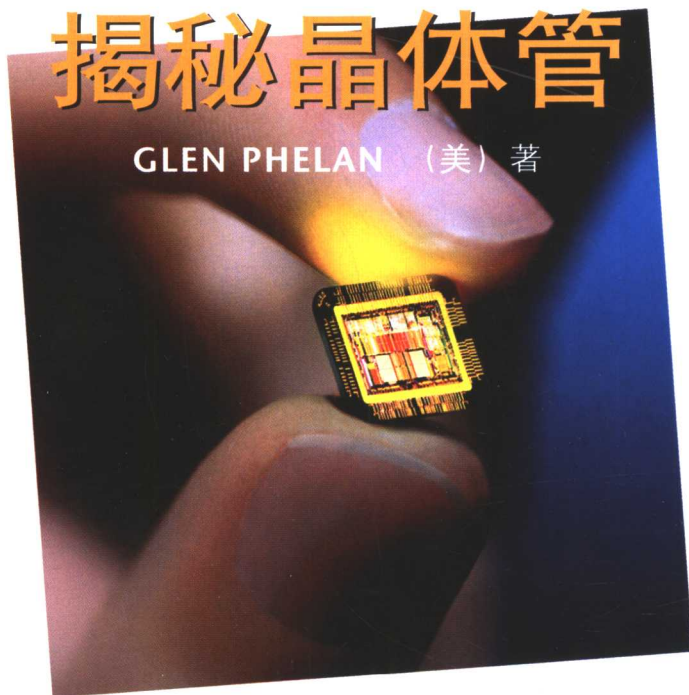
SCIENTISTS IN THEIR TIMES

站在时代前沿的科学家

# Building Tiny Transistors

## 揭秘晶体管

GLEN PHELAN (美) 著

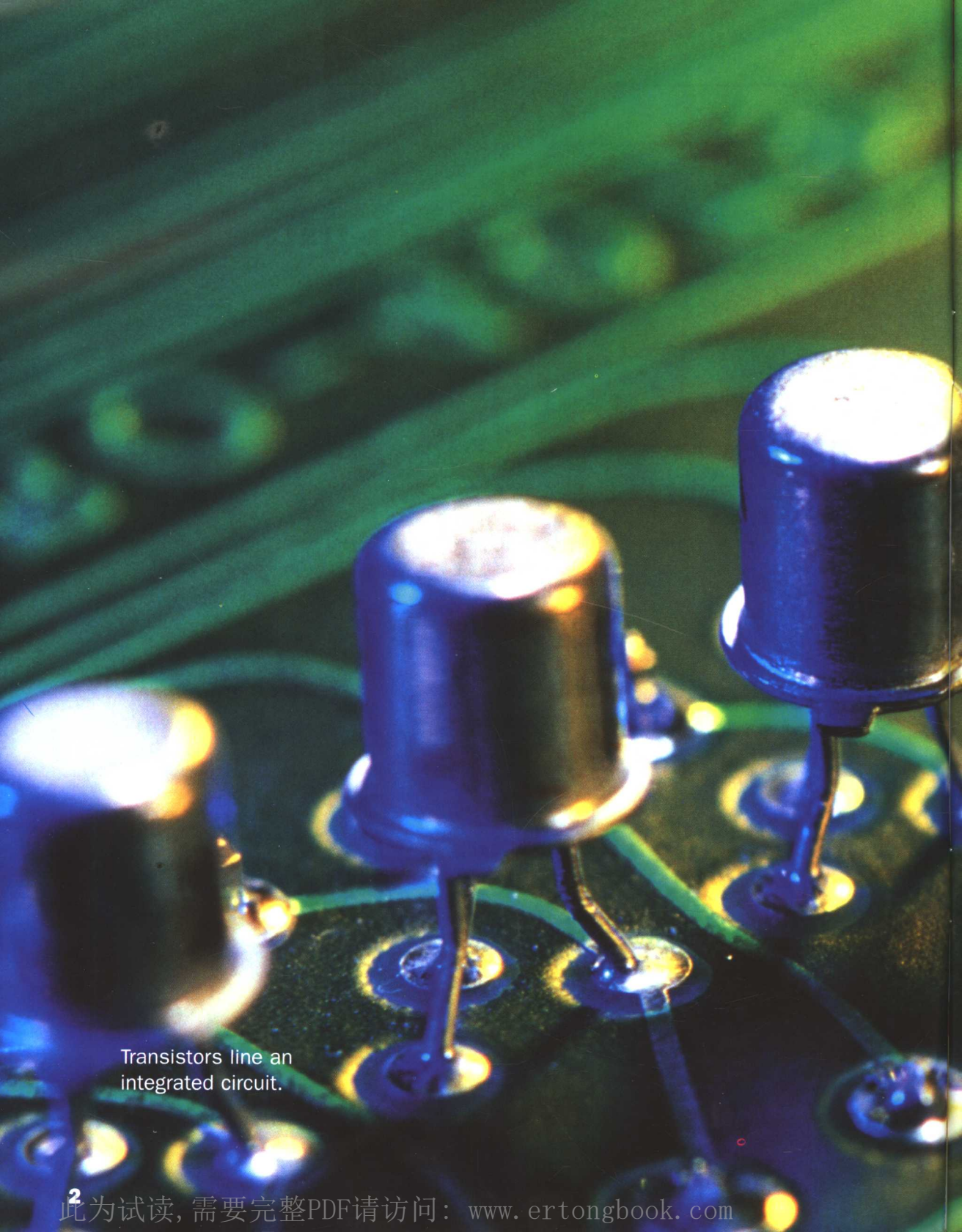


外语教学与研究出版社

FOREIGN LANGUAGE TEACHING AND RESEARCH PRESS

北京 BEIJING





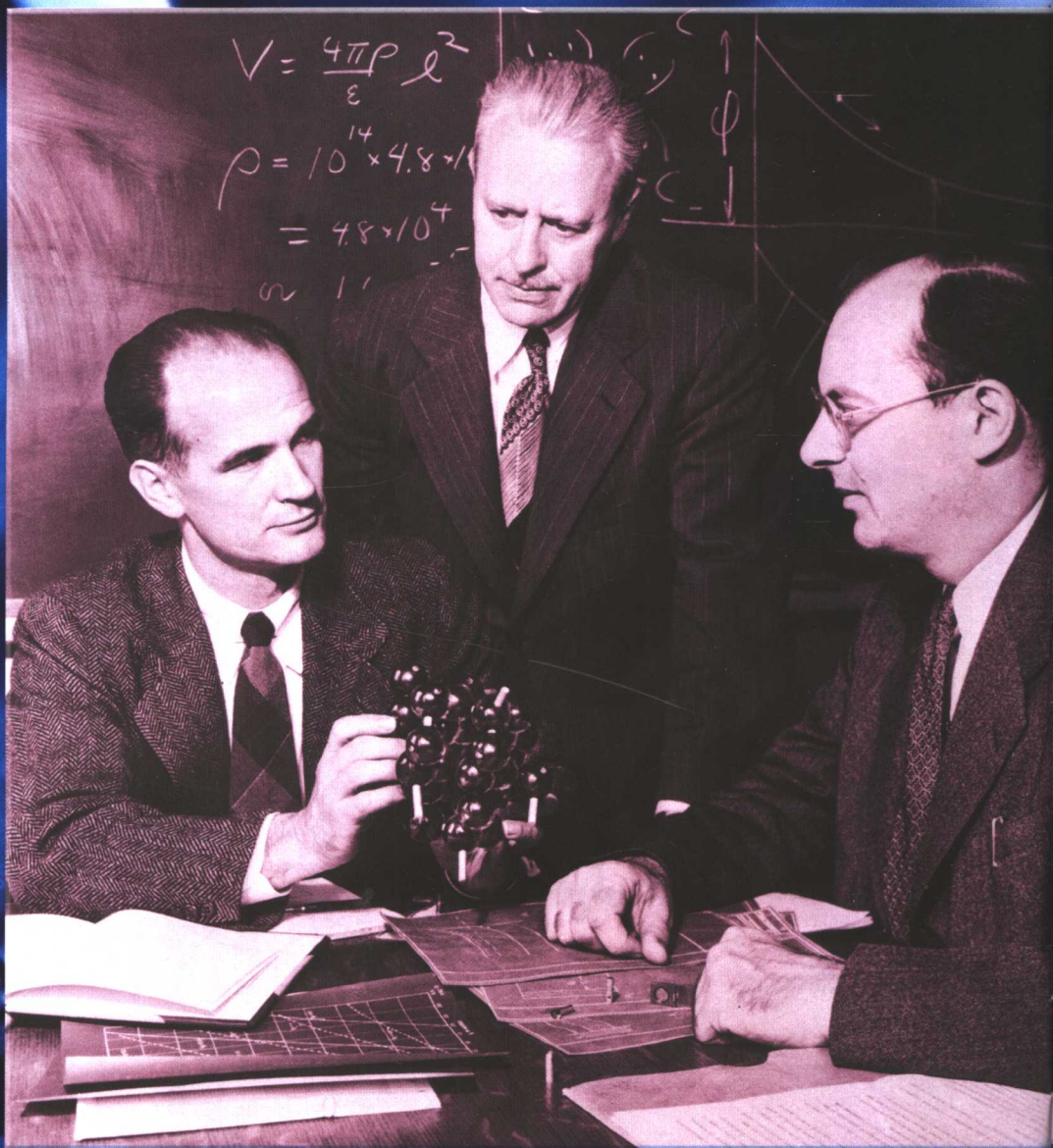
Transistors line an  
integrated circuit.

# Contents

## 目 录

<b>Introduction</b> .....	<b>5</b>
引言	
<b>Chapter 1</b> <i>The First Computers</i> .....	<b>8</b>
第一章 最初的计算机	
<b>Chapter 2</b> <i>De Forest Paves the Way</i> .....	<b>12</b>
第二章 开拓者德福雷斯特	
<b>Chapter 3</b> <i>ENIAC: The First Electronic Computer</i> .....	<b>18</b>
第三章 埃尼阿克：第一台电子计算机	
<b>Chapter 4</b> <i>The Dream Team</i> .....	<b>22</b>
第四章 梦幻组合	
<b>Chapter 5</b> <i>A New Era</i> .....	<b>28</b>
第五章 新纪元	
<b>Chapter 6</b> <i>Transistors Today</i> .....	<b>34</b>
第六章 今日晶体管技术	
<b>Gallery of Scientists</b> .....	<b>38</b>
科学家画廊	





## William Shockley<sup>1</sup>, Walter Brattain<sup>2</sup>, and John Bardeen<sup>3</sup> The Dream Team

1. William Shockley 威廉·肖克莱 (美国工程师和教师)
2. Walter Brattain 沃尔特·布拉顿 (美国物理学家)
3. John Bardeen 约翰·巴丁 (美国物理学家)

# Introduction

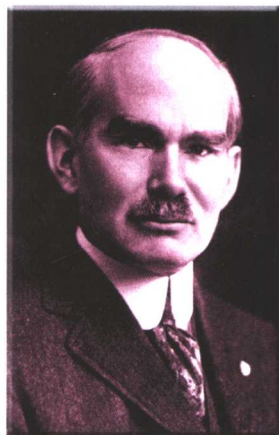
## 引言

*On December 16, 1947, two scientists huddled<sup>1</sup> over a strange-looking device<sup>2</sup> in a research lab. They passed a weak electric signal<sup>3</sup> through it. Then something wonderful happened. The signal coming out was much stronger than the signal going in. The men had invented a transistor. It was the day the future began.*

Transistors are part of every electronic device you use—from cell phones<sup>4</sup> to computers. Did only two people invent the transistor? No. The work of many people led the way. Here you will meet some of these people.

The story of the transistor is an inspiring<sup>5</sup> tale. It's full of brilliant<sup>6</sup> insight<sup>7</sup>, happy accidents, and hard work. But it is also the story of fierce<sup>8</sup> competition and clashing<sup>9</sup> egos<sup>10</sup>. Science is like that sometimes. After all, scientists are people, too.

How has the transistor changed our lives? To begin to answer this question, let's go back to the 1940s. This was a time before the transistor—before the computer age began.



**Lee De Forest<sup>13</sup>**  
a life of successes  
and failures



**Grace Hopper<sup>11</sup>**  
known as Amazing<sup>12</sup> Grace

- |                   |                   |       |
|-------------------|-------------------|-------|
| 1. huddle         | v.                | 聚在一起  |
| 2. device         | n.                | 装置    |
| 3. signal         | n.                | 信号    |
| 4. cell phone     |                   | 手机    |
| 5. inspiring      | adj.              | 鼓舞人心的 |
| 6. brilliant      | adj.              | 卓越的   |
| 7. insight        | n.                | 洞察力   |
| 8. fierce         | adj.              | 激烈的   |
| 9. clashing       | adj.              | 冲突的   |
| 10. ego           | n.                | 自我    |
| 11. Grace Hopper  | 格雷斯·霍珀 (美国计算机科学家) |       |
| 12. amazing       | adj.              | 令人吃惊的 |
| 13. Lee De Forest | 李·德福雷斯特 (美国发明家)   |       |



## Life in the 1940s

In the first half of the 1940s, the United States was at war. Every evening, families gathered<sup>1</sup> around radios to hear the latest news about World War II battles far away. Television had been invented, but few people had TVs. So the main sources<sup>2</sup> of news were radios and newspapers.

While soldiers fought, people at home pitched in<sup>3</sup> to help the war effort. Scientists pitched in, too. They put aside their normal research and worked instead on projects<sup>4</sup> that helped win the war.

Then, in 1945, the war ended. Soldiers were coming home, and everyone looked forward to a better way of life. They wanted to buy things. They wanted new cars, new homes, and new washing machines.

The pace<sup>5</sup> of life picked up, but compared to today, it was slow. There were fewer choices. There were no portable<sup>6</sup> radios or CD players. And if you wanted to copy a school report, you used a copy machine, right? Wrong. They hadn't been invented yet. Instead, you put carbon paper<sup>7</sup> between two sheets of paper and put them all in your typewriter<sup>8</sup>.

Where were computers? There were a few. But they didn't look like today's machines. The transistor would change all that. Still, computers had already come a long way.

- |                 |             |       |
|-----------------|-------------|-------|
| 1. gather       | <i>v.</i>   | 聚集    |
| 2. source       | <i>n.</i>   | 来源    |
| 3. pitch in     |             | 协力    |
| 4. project      | <i>n.</i>   | 科研项目  |
| 5. pace         | <i>n.</i>   | 节奏    |
| 6. portable     | <i>adj.</i> | 便于携带的 |
| 7. carbon paper |             | 复写纸   |
| 8. typewriter   | <i>n.</i>   | 打字机   |



A family listens to the radio in the 1940s.



Before computers,  
people used typewriters.



A telephone from the 1940s



## The First Computers 最初的计算机

*Computers were not always the electronic wonders we know today. In fact, there was a time when they weren't even electronic. The first computers were around long before electricity<sup>1</sup> was even discovered.*

Abacus<sup>2</sup>

- |                |           |    |
|----------------|-----------|----|
| 1. electricity | <i>n.</i> | 电  |
| 2. abacus      | <i>n.</i> | 算盘 |



## Computing<sup>1</sup> by Hand

The first computer was the abacus. It was invented long long ago and is still used today. The abacus didn't have a screen, or a mouse, or even buttons<sup>2</sup> to push. But it *is* a computer. That's because it helped people compute, or solve<sup>3</sup>, math problems. By moving sliding<sup>4</sup> beads<sup>5</sup> on a rack<sup>6</sup>, the user could solve math problems or keep track of<sup>7</sup> items<sup>8</sup> bought or sold.

The next big breakthrough<sup>9</sup> in the computing machine came centuries later. In 1642, a young Frenchman, Blaise Pascal<sup>10</sup>, invented a calculator<sup>11</sup>. This machine would

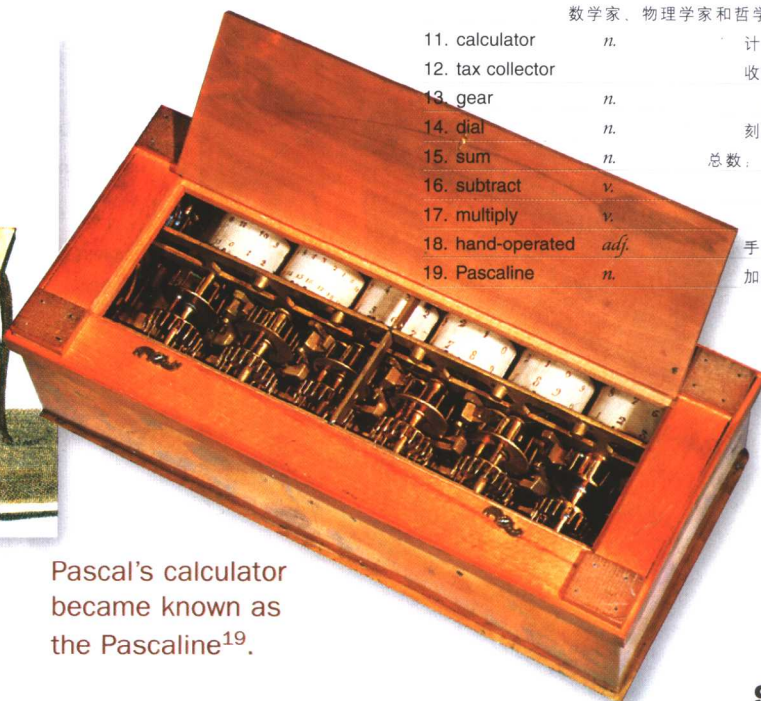
help his father, a tax collector<sup>12</sup>. A box of gears<sup>13</sup> and dials<sup>14</sup>, it could add sums<sup>15</sup> up to ten million.

Pascal's calculator could only add. Over the years, however, other people made calculators that could add, subtract<sup>16</sup>, multiply<sup>17</sup>, and divide. These machines were all hand-operated<sup>18</sup> by turning wheels, dials, and gears.

1. compute	v.	计算
2. button	n.	按钮
3. solve	v.	解答
4. sliding	adj.	滑动的
5. bead	n.	(有孔的) 小珠
6. rack	n.	架子
7. keep track of		记录
8. item	n.	项目
9. breakthrough	n.	重大成就
10. Blaise Pascal		布莱兹·帕斯卡 (法国数学家、物理学家和哲学家)
11. calculator	n.	计算器
12. tax collector		收税员
13. gear	n.	齿轮
14. dial	n.	刻度盘
15. sum	n.	总数; 总和
16. subtract	v.	减
17. multiply	v.	乘
18. hand-operated	adj.	手动的
19. Pascaline	n.	加法器



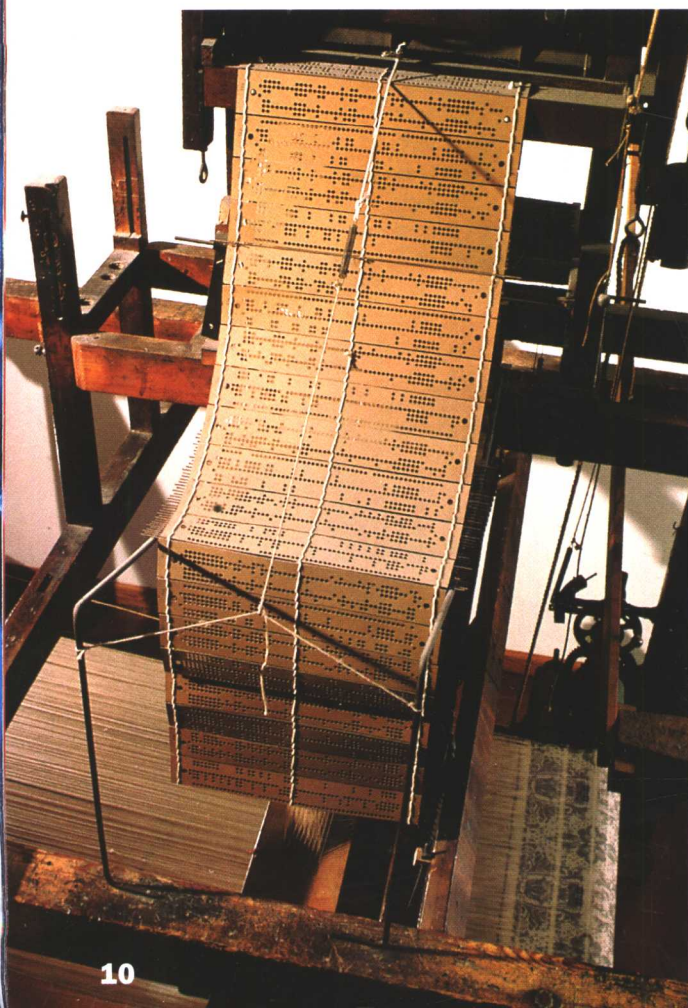
Blaise Pascal



Pascal's calculator became known as the Pascaline<sup>19</sup>.

## A Steam Computer

By the early 1800s, steam engines<sup>1</sup> changed the way many things worked. Steam became an important source of power<sup>2</sup> for trains, ships, and machines in cotton mills<sup>3</sup>. In the 1820s, an English math professor<sup>4</sup> named Charles Babbage<sup>5</sup> had an idea. Why not use steam to power a computing machine?



Babbage designed<sup>6</sup> a steam-powered computer. It had more than 50,000 parts. What was special about his design, however, was that this computer used punched cards<sup>7</sup>. A pattern<sup>8</sup> of holes was punched into each card. This pattern would tell the computer what to do. This idea gave birth to computer languages and computer programmers<sup>9</sup>.

## Creating a Code

Babbage never finished building his computer. One reason was that the parts could not be made precisely<sup>10</sup> enough. Even though he never finished, he did provide an important idea for others to build on. Using patterns on punched cards, he showed that it was possible to create a code to tell computers what to do.

- |                    |                     |         |
|--------------------|---------------------|---------|
| 1. steam engine    |                     | 蒸汽机     |
| 2. power           | <i>n.</i>           | 动力      |
| 3. mill            | <i>n.</i>           | 工厂      |
| 4. professor       | <i>n.</i>           | (大学) 教授 |
| 5. Charles Babbage | 查尔斯·巴贝奇 (英国数学家和发明家) |         |
| 6. design          | <i>v.</i>           | 设计      |
| 7. punched card    |                     | 穿孔卡     |
| 8. pattern         | <i>n.</i>           | 图案      |
| 9. programmer      | <i>n.</i>           | 程序编制员   |
| 10. precisely      | <i>adv.</i>         | 精确地     |
| 11. Jacquard loom  |                     | 提花机     |
| 12. guide          | <i>v.</i>           | 引导      |
| 13. weave          | <i>v.</i>           | 织       |

Charles Babbage was inspired by the Jacquard loom<sup>11</sup>. It used punched cards like the ones shown here to guide<sup>12</sup> the weaving<sup>13</sup> of patterned cloth.



## Counting Faster

In the 1880s, inventor Herman Hollerith<sup>1</sup> had a problem. He wanted to speed up the computing of the United States census<sup>2</sup>. The census is a count of the population that is made every ten years. But in 1880 the census took almost seven years to compute. With the growing population, the next census might take ten years. A faster way was needed.

Hollerith invented a machine that read punched cards. The cards stored census data<sup>3</sup>. Each punch on a card stood for a number. Combinations<sup>4</sup> of two punches stood for letters. With the punch card reader, a rough<sup>5</sup> count of the 1890 census took only six weeks to compute!

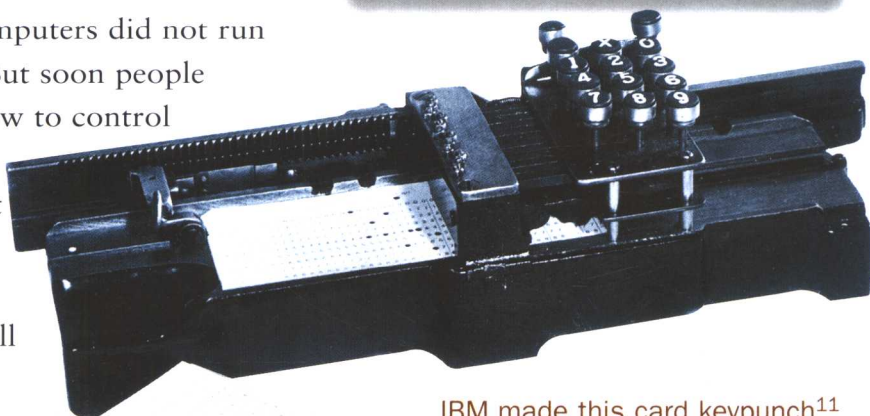
These early computers did not run on electricity. But soon people would learn how to control the flow<sup>6</sup> of electricity. That would lead to the world of electronics. It all began with the invention of a special kind

of tube and a high-energy inventor from Iowa<sup>7</sup>.

- |                                     |             |                       |
|-------------------------------------|-------------|-----------------------|
| 1. Herman Hollerith                 |             | 赫尔曼·霍勒里思 (美国发明家)      |
| 2. census                           | <i>n.</i>   | 人口普查                  |
| 3. datum                            | <i>n.</i>   | ( <i>pl.</i> data) 数据 |
| 4. combination                      | <i>n.</i>   | 组合                    |
| 5. rough                            | <i>adj.</i> | 粗略的                   |
| 6. flow                             | <i>n.</i>   | 流动                    |
| 7. Iowa                             |             | 艾奥瓦州                  |
| 8. Tabulating Machine Company       |             | 制表格机公司                |
| 9. giant                            | <i>adj.</i> | 超群的, 伟大的              |
| 10. International Business Machines |             | 国际商业机器公司              |
| 11. keypunch                        | <i>n.</i>   | 键盘穿孔机                 |

## Fun Fact

Hollerith used his punch card reader in the business world. He founded the Tabulating Machine Company<sup>8</sup>. This grew to be the giant<sup>9</sup> company now known as International Business Machines<sup>10</sup>, or IBM.



IBM made this card keypunch<sup>11</sup> machine in 1901.

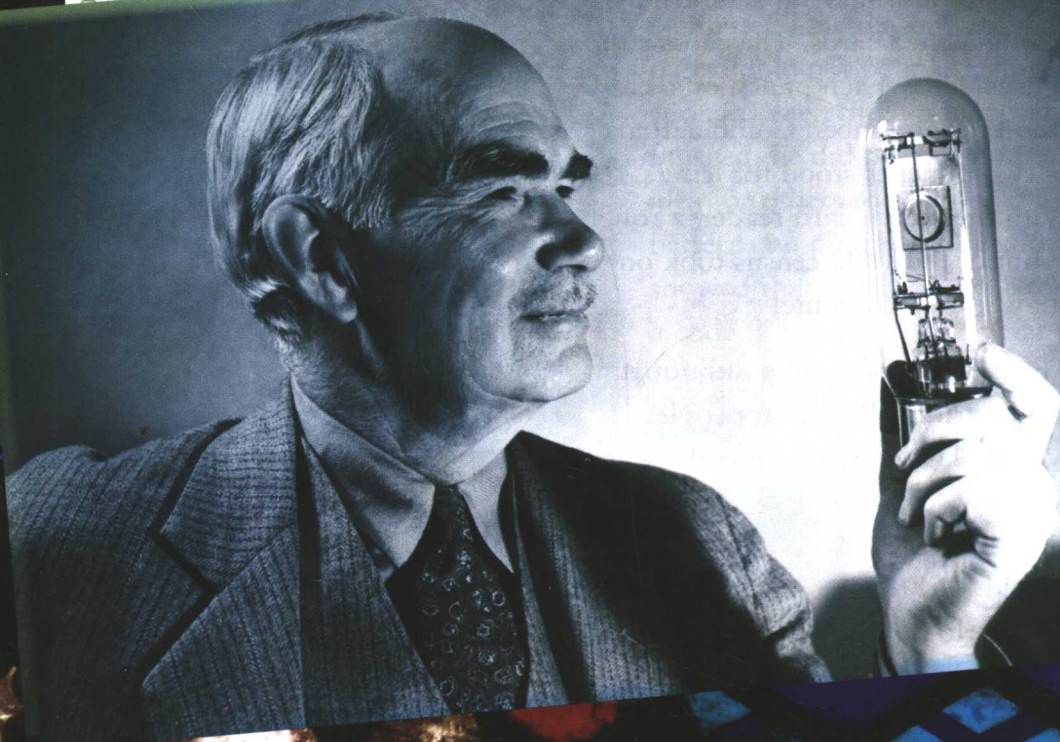


### De Forest Paves the Way 开拓者德福雷斯特

*Lee De Forest's life was filled with more failures than successes. Like many inventors, he tried lots of new and sometimes crazy things before he made his first important discovery. But Lee De Forest's invention opened the door to the world of electronics and computers. His vacuum tube<sup>1</sup> made it all possible.*

1. vacuum tube

真空管，电子管



Lee De Forest holds his most famous invention, the vacuum tube.

## A Drive to Invent

As a boy in the 1880s, Lee De Forest was bright, energetic<sup>1</sup>, and creative<sup>2</sup>. He was also ambitious<sup>3</sup>. In school, he was always inventing things to sell or enter in contests<sup>4</sup>. He wanted to make money to help pay for his education. He was also hoping to become rich and famous. None of his early inventions were very successful. But that didn't discourage<sup>5</sup> him.

When De Forest went to college, he became very interested in radio. At that time—in the 1890s—it was called “wireless telegraphy<sup>6</sup>.” Radio as we know it hadn't been invented yet. Scientists were just beginning to try to send radio waves<sup>7</sup> through the air. De Forest continued to study radio waves, and he earned<sup>8</sup> an advanced degree<sup>9</sup> based on his study.

The background shows a stained<sup>18</sup> glass window. This style was popular in the early 1900s, when De Forest began his career<sup>19</sup>.

## The First Amplifier<sup>10</sup>

Then, in 1906, De Forest was tinkering<sup>11</sup> with some wireless telegraph equipment<sup>12</sup>. He used a light bulb with a metal plate inside. This experiment had been done years before by Thomas Edison. But De Forest then put a squiggly<sup>13</sup> piece of wire called a grid<sup>14</sup> inside the bulb. He found that the grid acted like a switch<sup>15</sup>. The grid could turn electricity on or off. This was important.

The big breakthrough came when De Forest fed a weak electric signal into the bulb. The grid made that signal stronger. De Forest was astonished<sup>16</sup>! The bulb had become an amplifier. He knew that he had invented something really useful at last.

This invention made it possible to amplify, or boost<sup>17</sup>, and send sound waves. Now voices and music could be sent through the air. Radio, television, and the computer were soon to follow.

1. energetic	<i>adj.</i>	精力充沛的	8. earn	<i>v.</i>	获得	14. grid	<i>n.</i>	栅极
2. creative	<i>adj.</i>	有创造力的	9. advanced degree		高级学位	15. switch	<i>n.</i>	开关
3. ambitious	<i>adj.</i>	有抱负的	10. amplifier	<i>n.</i>	放大器	16. astonish	<i>v.</i>	使惊讶
4. contest	<i>n.</i>	竞赛	11. tinker	<i>v.</i>	很不熟练地修补	17. boost	<i>v.</i>	增强
5. discourage	<i>v.</i>	使泄气	12. equipment	<i>n.</i>	设备	18. stained	<i>adj.</i>	染色的
6. wireless telegraphy		无线电报	13. squiggly	<i>adj.</i>	成波形曲线的	19. career	<i>n.</i>	事业
7. radio wave		无线电波						

## The Sound of Music

De Forest was very excited about this new invention. He wanted to show the world what he had done. So he arranged<sup>1</sup> to do the first live broadcast<sup>2</sup> from the opera<sup>3</sup> house in New York City. He planned to broadcast the famous opera singer Enrico Caruso<sup>4</sup>.

First he set up a strange-looking transmitter<sup>5</sup> in the attic<sup>6</sup> of the opera house. Then he needed an antenna<sup>7</sup> to send signals. He ended up tying two long fishing poles<sup>8</sup> to the flagpole on the roof. He was ready to broadcast.

On January 13, 1910, hundreds of people waited at listening posts around New York City. They all were wired<sup>9</sup> to earphones. Then they heard the voice of Caruso in their earphones. Music had traveled for miles through the air.

## Boosting Phone Calls

De Forest's invention came to be called the vacuum tube. It looked a lot like a lightbulb, but it made electric signals stronger. It amplified the signals.

In 1912, he showed it to the American Telephone and Telegraph Company<sup>10</sup> (AT&T). This was just

what the phone company needed. Until now, a call from New York could only go as far as Denver<sup>11</sup>. It needed a boost to get all the way to the Pacific Coast. The amplifier would boost its signals. With vacuum tubes, calls could go from coast to coast.

In July 1914, the president of AT&T made the first call from coast to coast. He phoned from New York to San Francisco<sup>12</sup>. The signal was boosted along the way by vacuum tubes. The boosters were in Pennsylvania<sup>13</sup>, Nebraska<sup>14</sup>, and Utah<sup>15</sup>.

The vacuum tube was a success. Soon, phone lines linked all parts of the nation, and the telephone became a common item in most homes.

- |  |    |                       |
|--|----|-----------------------|
| 1. arrange                                   | v. | 安排                    |
| 2. live broadcast                            |    | 现场广播                  |
| 3. opera                                     | n. | 歌剧                    |
| 4. Enrico Caruso                             |    | 恩里科·卡鲁索 (意大利歌剧男高音歌唱家) |
| 5. transmitter                               | n. | 发射机                   |
| 6. attic                                     | n. | 阁楼                    |
| 7. antenna                                   | n. | 天线                    |
| 8. fishing pole                              |    | 钓鱼竿                   |
| 9. wire                                      | v. | 给……安装电线               |
| 10. American Telephone and Telegraph Company |    | 美国电话电报公司              |
| 11. Denver                                   |    | 丹佛                    |
| 12. San Francisco                            |    | 旧金山                   |
| 13. Pennsylvania                             |    | 宾夕法尼亚州                |
| 14. Nebraska                                 |    | 内布拉斯加州                |
| 15. Utah                                     |    | 犹他州                   |