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青年电子学

Jeanne Bendick 著
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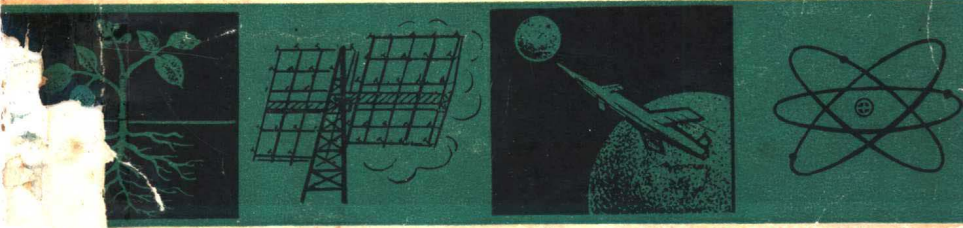

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ELECTRONICS FOR YOUNG PEOPLE

青 年 电 子 学

JEANNE BENDICK 著
朱邦俊、干之云 注释

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Jeanne Bendick

ELECTRONICS FOR YOUNG PEOPLE

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內 容 提 要

本书以生动活泼、浅显易懂的文笔首先介紹什么是电子、原子及电子学的心脏——各种电子器件的簡单构造和工作原理；然后从人們最熟悉的事物着手，讲述电子学在日常生活、工业、医学、科学技术以及軍事中的各种应用；最后讲到原子能以及电子和原子科学的新成就。本书适合已学一、二年英語的理工科学生或无綫电爱好者閱讀。

全书共分十七章，个别地方作了一些删节。正文下面附有汉語注释。书末編有英汉对照术語詞汇表。

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CHAPTER ONE

WHAT IS AN ELECTRON?

An electron is millions of times smaller than the smallest thing you've ever seen. Electrons are so small that nobody has ever seen them, even with the most powerful microscope. It would take trillions of electrons to weigh as much as the lightest feather or to be as large as the head of a pin.[1]

Everything in the world, no matter how different it may seem from[2] every other thing, is made partly of[3] electrons. Electrons are built into trees and shoes and skyscrapers and even people.

This stuff[4] that everything is made of is called MATTER, and matter is built of electrons (and other things we will talk about in a minute),[5] just as a house is built of bricks and bricks are made of clay. Some of this matter we call "live." People and trees, animals and flowers are built of this kind. Some of it does not seem to be alive, like the matter in glass or coins, but all matter is basically alike.

Electrons are really tiny, always moving sparks of pure electricity. If you could see them, they would look like tiny worlds[6] whirling around a sun, just as our world

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1 **It would take trillions of electrons...as large as the head of a pin.** 需要几万亿个电子才有象最輕的羽毛那样重或象針头那样大. 2. **no matter how different it may seem from...:** 无論它看来与...有多么不同. 3. **is made partly of...:** 部分地由...組成. 4. **stuff:** 要素. 5. ***in a minute:*** 一会儿以后. 6. **worlds:** 指一个恒星系中的許多行星. 句中 sun 应理解为恒星.

and the other planets whirl around our sun in the sky. It would be impossible to separate our world from[1] our sun, and it took a long time for men to learn how to separate the electrons from their sun, which is called a NUCLEUS. (If there are more than one, they are called NUCLEI.)

A nucleus is made of electric sparks, too, but they are different from electron sparks. Every electron is a tiny charge of negative electricity, but in the nucleus there are charges of positive electricity called PROTONS. There are other particles in the nucleus, too, called NEUTRONS, which have no electric charge at all.[2] The protons and the neutrons cling together in the nucleus, bound by a power that is one of the strongest forces in the world—a million times stronger than the force of gravity.

Scientists know that there are other particles in the nucleus that account for this force, but so far[3] they can only deduce what these particles are like by studying their actions under different conditions.

A nucleus and the electrons whirling around it make up[4] an ATOM. The positive protons in the nucleus of the atom pull very hard on the negative electrons, keeping them in position,[5] just as the pull of the sun keeps the planets circling it in their positions. If the nucleus were the size of a walnut, an atom would be a mile across![6]

---

1. **to separate ... from ...**: 使...和...分离. 2. **at all**: 根本上; 全然. 3. **so far**: 到目前为止. 4. **make up**: 构成. 5. **keeping them in position**: 使它們保持原位 (指保持在一定軌道上运轉). 6. **If the nucleus were the size of ... a mile across!** 如果原子核象胡桃那样大, 那么整个原子的直径就有一哩!

Just about all the weight in an atom is in the nucleus. Electrons have practically no weight at all. A proton is almost a thousand times smaller than an electron, but it weighs 1,840 times as much.

Now we can begin to see what scientists mean when they say that all matter is basically alike. For all matter is made up of atoms—that is, it is made up of nuclei with electrons whirling around them.

If all atoms were *exactly* alike there would be only one kind of matter in the world. But some have more protons in their nuclei than other atoms have, and more electrons arranged in different ways. In fact,[1] there are more than ninety different kinds of atom, and they make up the simplest form of matter called the ELEMENTS.

Elements come in many forms.[2] Some are gases, some are liquids and some are solids. Helium, which is a very light gas, is an element. Iron and gold are elements. And the only difference between one element and another is the number of electrons and protons in an atom of the element.

If the atoms of all these elements just stayed apart from each other,[3] there would be only about ninety different things in the world. But they can combine into COMPOUNDS. And it is compounds — combinations of the elements — that make all the different kinds of matter in the world. That is why there are things so different as trees and people, animals and stones, although basically

1. **In fact:** 事实上. 2. **Elements come in many forms.** 元素有許多形态. 3. **stayed apart from each other:** 互不相关 (指原子間并不結合成分子).

they are all made up of electrons whirling around their nuclei.

Just as electrons and nuclei together build atoms, groups of atoms build MOLECULES. A molecule is the smallest particle of matter that can be identified as[1] that particular kind of matter. An atom of the element hydrogen, for example, is made up of only one electron circling its nucleus. As soon as[2] two hydrogen atoms are combined with an atom of the element oxygen, they become a molecule of a familiar compound, water. Sometimes it takes a great many atoms to make a molecule, but no one has ever seen a molecule even with the strongest microscope. The largest molecules, those in starch, are still many times too small for us to see[3] at present.

Scientists knew that molecules were built of atoms, but they used to think[4] that an atom was the smallest thing in the world, and they were very eager to see[5] how it was made. They knew that it was electric and that electricity was very powerful, and they were hopeful of[6] finding a way to put the atom to work[7] for them. Scientists built all sorts of complicated machines so they could study the atom. And as they got to know more about it,[8] they proved that an atom, just as they had suspected, was made of tiny bits of electricity which they called ELECTRONS, circling around their nucleus.

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1. can be identified as ...: 能鉴别为.... **2. As soon as:** 一旦. **3. too small for us to see:** 太小，以致我們看不見. **4. used** [ju:st] **to think:** 一貫认为. **5. were eager to see:** 迫切想知道 (= were eager to know). **6. were hopeful of:** 希望. **7. to put ... to work:** 使...工作. **8. *And as they* got to know more about it:** 而随着对原子逐漸有更多的了解.

Electron is not a new word at all. Scientists have been using it for a long time, when they talked about all the sparks of electricity that make up a big electric charge like a flash of lightning. After the scientists made the important discovery that everything was built of these invisible, always moving sparks of electricity they set about[1] making these electrons work for them, and the science of making electrons work is what we call ELECTRONICS.

Electrons at work[2] are electronic energy, but there is another kind of energy in an atom that has power of quite another sort. This is the power released by the exploding nucleus of an atom, and it is called NUCLEAR or ATOMIC ENERGY.

Electronics is the science of the electrons. It is the way we harness the electrons[3] and put them to work, to do many things men have never been able to do before. Electronics lets us see across space and through the blackest night and the thickest steel. It helps us to fight disease and it helps us fight wars, too. Electronics works in factories and on farms and in homes. Some day[4] electronics will be running our planes, trains and cars, and heating our houses. Electronics has become a helper with a thousand hands.[5]

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1. **set about:** 着手. 2. **Electrons at work:** 做功的电子. 3. **It is the way** (in which) **we harness the electrons:** 它(电子学)是我們馴服电子的方法. 4. **Some day:** 将来有一天; 有朝一日. 5. **helper with a thousand hands:** 万能的助手.

CHAPTER TWO

STARTING ELECTRONS TO WORK

If you had a team of work horses, you couldn't make them do anything for you unless you could harness them to a plow or a wagon[1] and make them go where you wanted them to. In the same way, scientists had to find a way to harness electrons before they could put them to work. They had to find a way to make the electrons go where they were sent, instead of sticking close to their nuclei.

The scientists studied different kinds of matter. They thought that the electrons in some kinds of matter might come apart[2] and move around more easily than the electrons in others. They soon found that the electrons in metal were pretty free to go where they wanted, because they were not bound to their nuclei as tightly as the electrons in other things.

For this reason, metal is a good CONDUCTOR of electric current. The billions of little particles of electricity that make up electric current bump each other[3] all along the electric wire. That is why the electrically run things[4] in your house are connected to the wall socket by metal wire. If you were reading this book under an electric lamp and somebody pulled the wire out of the socket,

---

1. **could harness them to a plow or a wagon:** 能把馬套上犁或車. 2. **might come apart:** 可以脫离(原子核). 3. **bump each other:** 相互推撞. 4. **electrically run things:** 电器.

the light would go out.[1] The electricity has not been turned off,[2] but it has no way to get from its place in the socket to the light bulb. It can go only where it is pushed, and it cannot travel through the air and get into the light bulb by itself.[3]

But not all the electrons in copper wire carrying electric current come in one end and go out the other![4] Some new ones come in from the plant that supplies the electric current, and others are pushed out, but the electrons that make up the wire are there all the time.[5] These electrons are always moving around, changing places, and going where they please. Before they can be put to work, something must happen to make them all flow in the same direction.[6] As soon as they all push along the wire TOGETHER, they have power.

When you turn on the electric switch,[7] you are forcing the free electrons (which are electrons that have come apart from their nuclei) to push each other in one direction, in a steady stream along the wire. At the wall socket, more and more negative electrons are being pushed into the wire. At the other end of the wire, positive atoms are pulling these electrons towards themselves. (Positive

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1. **go out:** 熄灭. 2. **has not been turned off:** 并未关掉. 3. **by itself:** 靠自己. 4. **come in one end and go out the other:** 一端流进，另一端流出. 5. **Some new ones come in from the plant..., but the electrons that make up the wire are there all the time.** 一些新的电子由供給电流的发电厂进入(导綫)，而另一些电子则被推出导綫，但是构成导綫的电子的数量始終不变. 这里: ones 指 electrons. plant = power plant, 发电厂. all the time, 始終. 6. **something must happen to make ... in the same direction:** 必須設法使它們(电子)都朝同一方向流动. 7. **turn on the electric switch:** 打开电門; 合上开关.

atoms are atoms that are hungry for[1] electrons.) This is what makes current flow through a conductor. Electrons are pushed in at one end and pulled toward the other end. This pressure which makes the electrons flow from one end of the wire to the other is called VOLTAGE. The higher the concentration or pressure of electrons in a wire, the higher[2] the voltage is. A VOLT is the measurement of the pressure[3] that makes electric current flow. It does not take very many volts to turn your radio on, but the number of volts needed to run an electric streamliner[4] is tremendous. You have probably noticed signs along a railroad track, fastened to the towers that hold the overhead electric wires.[5] The signs may say,[6] "DANGER — 16,000 VOLTS." That is the amount of electric pressure running through those wires.

The power plant where this pressure is made may be hundreds of miles away from the railroad track and from the wall socket in your house. The real beginning of this electric power may be even farther away than the power plant — in a coal mine or an oil well or a great river. Water power or coal or oil works the generator in the power plant. The generator makes electricity[7] and sends it through wires and cables, across the countryside and under the streets to your house. Then, when you

---

1. **are hungry for:** 渴望得到. 2. **The higher..., the higher ...:** 越..., 越... (前者为因，后者为果). 3. ***measurement of the pressure:*** 衡量电压的单位. 4. **electric streamliner:** 电气列車. 5. **overhead electric wires:** 架空电綫. 6. **The signs may say:** 标志上可能写着. 7. **makes electricity:** 发电.

turn on your electric switch, this voltage pushes the electrons up the wire to their job.

Here is an experiment that may give you a better idea of[1] how pressure makes the electrons in the metal wire into electric power.

Put some tiny pebbles or beads into a large drinking straw.[2] If you hold it level,[3] they may move around a little in the straw or even trickle out, but they will just drop to the ground. Now hold a piece of paper in front of the straw and blow hard into the other end. The pebbles will shoot out of the straw so fast that they will knock the paper aside.[4] Some may even tear right through it.[5]

By applying pressure, you have forced the pebbles to rush through the straw and have even given them enough power to push away the paper. In the same way, the pressure of voltage, applied to the electrons in the wire, will make them shoot through it[6] in a current. If the voltage heats the wire enough, the electrons will jump right out of the wire, just as the pebbles shot out of the straw.

Pushing the electrons out of their metal is the first important step in starting them to work. But if you pushed them out into space, they would be like wild horses, scattering in every direction.[7] Before you can catch

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1. **give you a better idea of:** 帮助你更好地了解. 2. **drinking straw:** 喝飲料用的麦管. 3. **hold it level:** 把它平着拿. 4. **will knock ... aside:** 将把...撞开. 5. **may even tear right through it:** 甚至会破紙而过. right, *adv.* 起加强語气的作用. 6. **shoot through it:** 高速通过导綫. 7. **scattering in every direction:** 向四面八方散开.

the electrons to harness them, you must fence them in,[1] and the enclosure you use is called an ELECTRON TUBE.

Most electron tubes are VACUUMS. This means that most of the air has been taken out of them, though some electron tubes contain small amounts of gas.

There are two reasons for taking the air out of[2] electron tubes. One is that the air atoms are so huge that the electrons would smack into them[3] and come to a stop. The other is that the metal parts of a tube cannot burn without air, no matter how hot they get.[4] An electric light bulb is a vacuum and so is a radio tube.[5]

If you look at an electric light bulb, you will see a thin wire either looped or zigzagging through the middle.[6] This wire is called the FILAMENT, and it is made of a special kind of metal called tungsten. The electric current runs into the filament and starts pushing and jiggling on the electrons there,[7] bumping them into each other until they move faster and faster. As they move faster, they start sending off[8] little rays of heat.

This is the same thing that happens when you make a fire[9] by rubbing two pieces of wood together, and it is called FRICTION. When you rub your sticks together,

---

1. **fence ... in:** 把.. 围起来. 2. **taking ... out of ...:** 把...从...中抽出. 3. **would smack** [smæk] **into them:** 将撞在原子上. 4. **no matter how hot they get:** 不管它們变得怎样热. 这里 get = become. 5. **An electric ... and so is a radio tube.** 电灯泡是眞空的，无綫电电子管也是眞空的. 6. **a thin wire ... through the middle:** 一根不是绕成圈状的就是弯成鋸齿状的細导綫穿过 (灯泡的) 中部. 7. **pushing and jiggling** ['dʒiglin] **on the electrons there:** 推动那儿的电子. 8. **start sending off:** 开始輻射. 9. **make a fire:** 取火.

the electrons in the wood jiggle against each other[1] and send off little heat rays that start the fire. The electrons in the filament of a light bulb can't start a fire because there is no air in the bulb and nothing can burn without air.

You can prove this by putting a glass over a lighted candle.[2] As soon as the flame has used up[3] all the air under the glass, it will go out.

The electrons in the hot filament can't burn, but the rays they send off make the white-hot glow[4] we call electric light. If the electric light bulb were not a vacuum, the filament would soon burn up,[5] and the light would go out. Sometimes the electrons in an electric light bulb move so fast that they jump out of the filament. When they do, they stop working to make light, and are just dark smudges inside the glass of the bulb.

In a radio tube, though, as in all electron tubes, the electrons are *supposed* to[6] leave the filament, and they don't go to work until they are free. Different kinds of electron tubes get the electrons loose[7] in different ways, but getting them loose is the first thing they must all do before these electrons can be put to work.

This is the big difference between things that are run electrically and things that are run electronically.[8] When electricity is used as power, the electric current

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1. **jiggle against each other:** 相互挤压. 2. **putting a glass over a lighted candle:** 把玻璃环罩在点燃着的蜡烛上. 3. **has used up:** 已經耗尽. 4. **white-hot glow:** 白热光. 5. **would soon burn up:** 将馬上烧掉. 6. **are supposed to:** 应該. 7. **get ... loose:** 释放.... 8. **things that are run electrically and ... electronically:** 电气器件和电子器件.

never leaves the wires that conduct it. Some of the electrons that make up electric current are free in the spaces between the atoms, but some stay with their nuclei. These push against the free electrons that flow along the wire, and the free electrons have a hard time getting past the atoms.[1] Sometimes they are even pulled into the atoms, and other electrons are pushed out. Part of their power is wasted because of this tug o' war,[2] which is always going on. It is used up in just getting through the wire.

This struggle by the atoms to keep the free electrons from getting past[3] is called RESISTANCE. The harder it is for the electrons to get through the wire, the more resistance we say is in the wire, and the more voltage it takes to push them through. A copper wire has less resistance than a tungsten wire. That is why electric current flows through the copper wire, while in the tungsten wire the battle is so much fiercer that all the pushing and shoving simply makes the wire glow with heat.

When things are run electronically, the electric current that has been imprisoned in the wire is freed. Free electrons have more power and are easier to control than electrons that are always being pulled here and there by the nuclei. The job of electronics is to get these electrons loose and make them use their full power to do a special sort of work.

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1. have a hard time getting past the atoms: 在穿經原子时頗为艰难. **2. because of this tug o' war:** 由于这場拉鋸战. **o'=of.** **3. to keep ... from getting past:** 阻止…通过.

CHAPTER THREE

ELECTRON TUBES

The beginning of all electronic power is in the vacuum tube where the electrons are freed. Some of these tubes are no bigger than marbles,[1] and some are 25 feet tall, but certain things about all of them are alike.[2]

The first thing is that they all contain metal as the SOURCE of the electrons, the place from which they come.[3] In a radio tube the source is called a filament, as it is in a light bulb, but in most electron tubes the metal source is called a CATHODE. A filament is a thin wire that is itself heated. If the heat is supplied by a special built-in heater, the source is called a cathode.

The tube must be airtight so nothing will burn, and there must be a way for[4] the electric power to get in and for the new power that is made in the tube to get out. The shell of the tube itself is called the ENVELOPE.

All electron tubes must have a PLATE to collect the electrons once they are free. This plate is usually called the ANODE, and the anode is where the electronic power really starts to work. To understand the way the anode is used, we have to understand another very important thing about electrons and atoms.

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1. no bigger than marbles ['mɑ:blz]: 不比玻璃弹子 (小孩游戏用) 大. **2. but certain things ... are alike:** 但是所有电子管的某些情形是相似的. **3. the place from which they come:** 电子的发源地. **4. there must be a way for ...:** 必须用一种办法使....