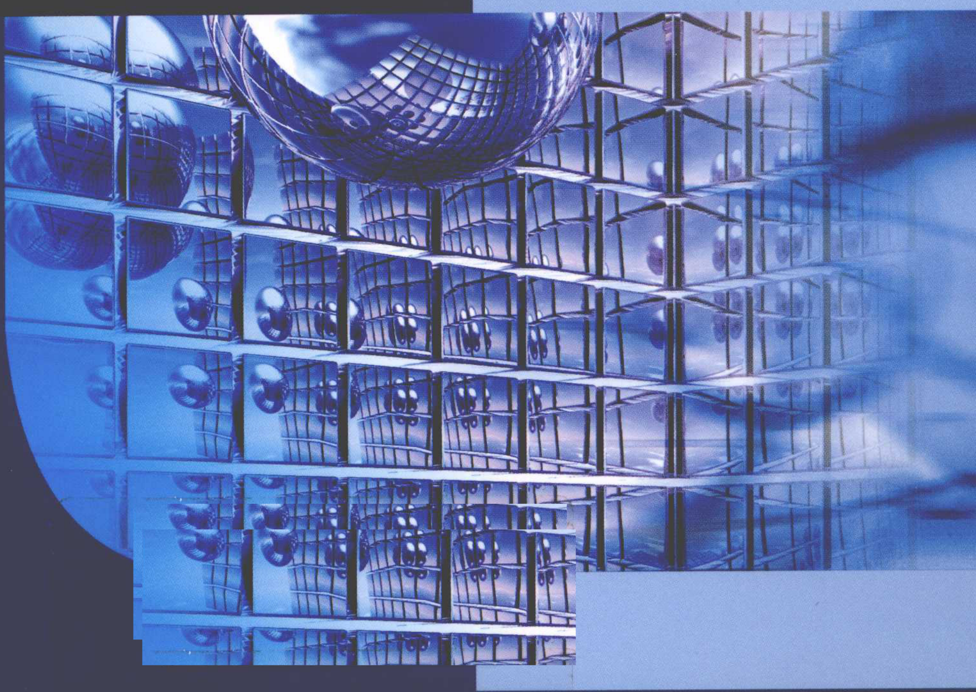
普通高等教育"十二五"电气信息类规划教材

自动化专业英语

◎ 戴文进　编著

ZIDONGHUA ZHUANYE YINGYU



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机械工业出版社
CHINA MACHINE PRESS

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本书共分电工电子、电动机及其拖动、控制理论与控制工程、计算机及其应用、人工智能技术五大部分。每一部分又分别包含英语原文（全部出自原版书籍与文献）、专业英语词汇、课文注释、参考译文和专业英语翻译与写作知识五部分。

本书取材新颖、内容丰富、注释详尽、译文准确，是高等院校“自动化专业英语”课程的适用教材，也可作为其他相近专业的参考书，还可供有关技术人员选用。

图书在版编目（CIP）数据

自动化专业英语/戴文进编著. —北京：机械工业出版社，2011.3
普通高等教育“十二五”电气信息类规划教材
ISBN 978-7-111-33340-1

Ⅰ.①自…　Ⅱ.①戴…　Ⅲ.①自动化—英语—高等学校—教材
Ⅳ.①H31

中国版本图书馆 CIP 数据核字（2011）第 018713 号

机械工业出版社（北京市百万庄大街 22 号　邮政编码 100037）
策划编辑：王保家　责任编辑：王雅新
版式设计：霍永明　责任校对：刘怡丹
封面设计：张　静　责任印制：乔　宇
北京瑞德印刷有限公司印刷（三河市胜利装订厂装订）
2011 年 4 月第 1 版第 1 次印刷
184mm×260mm · 23.25 印张 · 576 千字
标准书号：ISBN 978-7-111-33340-1
定价：39.80 元

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前　　言

“自动化专业英语”是高等院校自动化专业的一门重要的专业基础课程，该课程的学习，对于学生如何将所学得的基础英语运用于自动化专业领域，具有很重要的作用。

在该课程的长期教学实践中，作者积累了大量的教学经验和教学素材，现编著成《自动化专业英语》一书，由机械工业出版社出版。本书共分电工电子、电动机及其拖动、控制理论与控制工程、计算机及其应用、人工智能技术五大部分。每一部分又分别包含英语原文（全部出自原版书籍与文献）、专业英语词汇、课文注释、参考译文和专业英语翻译与写作知识五部分。

本书取材新颖、内容丰富、注释详尽、译文准确，是“自动化专业英语”课程的适用教材，也可作为其他相近专业的参考书，还可供有关技术人员使用。

在本书的编著过程中，作者的在校研究生林卿生、杨华、王宝福、谢友慧、王凯、陈向杰、赵杰、刘海静、邓志辉和王少夫同学在资料收集、文字录入、图表和曲线的绘制及扫描等方面做了大量工作，在此一并致谢。

虽然作者长期工作在专业英语的教学第一线，且对该课程的教学内容和方法有一定体会，但毕竟水平有限，故书中谬误之处在所难免，敬请读者不吝指正。

戴文进

目 录

Part 1 Electrics & Electronics

Unit 1 Circuit Elements and Parameters

1.1 Text

An electric circuit (or network) is an interconnection of physical electrical devices. The purpose of electric circuits is to distribute and convert energy into some other forms. Accordingly, the basic circuit components are an energy source (or sources), an energy converter (or converters), and conductors connecting them.

An energy source (a primary or secondary cell, a generator, and the like) converts chemical, mechanical, thermal or some other form of energy into electric energy. An energy converter, also called load (such as a lamp, heating appliance, or electric motor), converts electric energy into light, heat, mechanical work, and so on.

Events in a circuit can be defined in terms of e. m. f. (or voltage) and current. When electric energy is generated, transmitted and converted under conditions such that the currents and voltages involved remain constant with time, one usually speaks of direct-current (D. C.) circuits. 【1】

With time-invariant currents and voltages, the magnetic and electric fields of the associated electric plant are also time-invariant. This is the reason why no emfs of self-or mutual-induction appear in D. C. circuits, nor are there any displacement currents in the dielectric surrounding the conductors.

Fig. 1. 1. 1 shows in simplified form a hypothetical circuit with a storage battery as the source and a lamp as the load. The terminals of the source and load are interconnected by conductors (generally but not always wires). 【2】 As is seen, the source, load and conductors form a closed conducting path. The emf of the source causes a continuous and unidirectional current to circulate round this closed path.

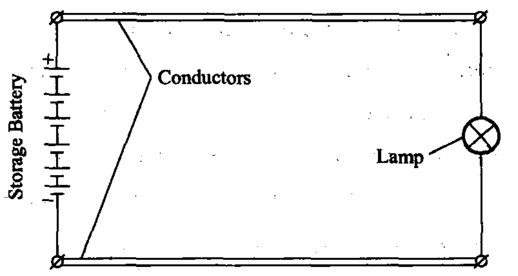

Fig. 1. 1. 1 A hypothetical circuit

This simple circuit made up of a source, a load and two wires is seldom, if ever, met with in practice. 【3】 Practical circuits may contain a large number of sources and loads interconnected in a variety of ways.

To simplify analysis of actual circuits, it is usual to show them symbolically in a diagram called a circuit diagram, which is in fact a fictitious or, rather, idealized model of an actual circuit of network. Such a diagram consists of interconnected symbols called circuit elements or circuit parameters. Two elements are necessary to represent processes in a D. C. circuit. These are a source of emf E and of internal (or "source") resistance R_s, and the load resistance (which includes the resistance of the conductors) R (Fig. 1. 1. 2).

Whatever its origin (thermal, contact, etc.), the source emf E (Fig. 1. 1. 2a) is numerically equal to the potential difference between terminals 1 and 2 with the external circuit open, 【4】 that is, when there is no current flowing through the source:

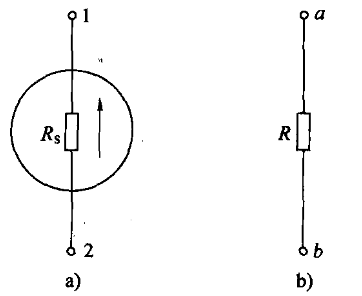

Fig. 1. 1. 2 Source and load resistance

$$E = \varphi_1 - \varphi_2 = V_{12} \tag{1.1.1}$$

The source emf is directed from the terminal at a lower potential to that at a higher one. On diagram, this is shown by arrows.

When a load is connected to the source terminals (the circuit is then said to be loaded) and the circuit is closed, a current begins to flow round it. Now the voltage between source terminals 1 and 2 (called the terminal voltage) is not equal to its emf because of the voltage drop V_s inside the source, that is, across the source resistance R_s

$$V_s = R_s I$$

Fig. 1. 1. 3 shows a typical so-called external characteristic $V = \varphi_1 - \varphi_2 = V(I)$ of a loaded source (hence another name is the load characteristic of a source). As is seen, increase of current from zero to $I \approx I_1$ causes the terminal voltage of the source to decrease linearly

$$V_{12} = V = E - V_s = E - R_s I$$

In other words, the voltage drop V_s across the source resistance rises in proportion to the current. This goes on until a certain limit is reached. Then as the current keeps rising, the proportionality between its value and the voltage drop across the source is upset, and the external characteristic ceases to be linear. This decrease in voltage may be caused by a reduction in the source voltage, by an increase in the internal resistance, or both.

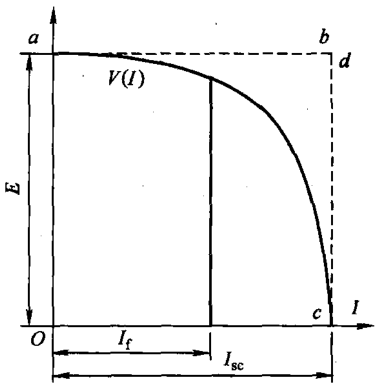

Fig. 1. 1. 3 Load characteristic of a source

The power delivered by a source is given by the equality

$$P_s = EI \tag{1.1.2}$$

Where, P_s is the power of the source.

It seems relevant at this point to dispel a common misconception about power. Thus one may hear that power is generated, delivered, consumed, transmitted, lost, etc. in point of fact, however, it is energy that can be generated, delivered, consumed, transmitted or lost. Power is just the rate of energy input or conversion, that is, the quantity of energy generated, delivered, transmitted, etc. per unit time. So, it would be more correct to use the term energy instead of power in the above context. Yet, we would rather fall in with the tradition.

The load resistance R (Fig. 1.1.2b), as a generalized circuit element, gives an idea about the consumption of energy, that is, the conversion of electric energy into heat, and is defined as

$$P = RI^2 \qquad (1.1.3)$$

In the general case, the load resistance depends solely on the current through the load, which fact is symbolized by the function $R(I)$.

By Ohm's law, the voltage across a resistance is

$$V = RI \qquad (1.1.4)$$

In circuit analysis, use is often made of the reciprocal of the resistance, termed the conductance, which is defined as

$$g = 1/R$$

In practical problems, one often specifies the voltage across a resistance as a function of current, $V(I)$, or the inverse relation $I(V)$ have come to be known as volt-ampere characteristics.

Fig. 1.1.4 shows volt-ampere curves for a metal-filament lamp, $V_1(I)$, and for a carbon-filament lamp $V_2(I)$. As is seen, the relation between the voltage and the current in each lamp is other than linear. The resistance of the metal-filament lamp increases and that of the carbon-filament lamp decreases with increase of current.

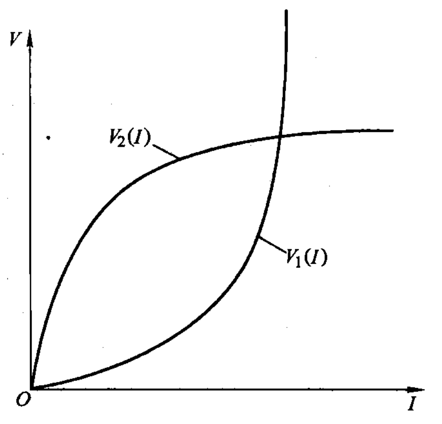

Fig. 1.1.4 Volt-ampere currents

Electric circuits containing components with non-linear characteristic are called non-linear.

If the emf and internal resistances of sources and associated load resistances are assumed to be independent of the current and voltage, respectively, the external characteristic $V(I)$ of the sources and the volt-ampere characteristic $V_1(I)$ of the loads will be linear.

Electric circuits containing only elements with linear characteristic are called linear.

Most practical circuits may be classed as linear. Therefore, a study into the properties and analysis of linear circuits is of both theoretical and applied interest.

1.2 Specialized English Words

circuit components 电路元件
circuit parameters 电路参数
electric circuit 电路
electrical device 电气设备
electric energy 电能
energy source 电源
primary cell 原生电池
secondary cell 再生电池
energy converter 电能转换器
conductor 导体
generator 发电机
heating appliance 电热器

direct-current (D. C.) circuit 直流电路
magnetic and electric field 电磁场
time-invariant 时不变的
Self-(or mutual-) induction 自（互）感
displacement current 位移电流
the dielectric 电介质
storage battery 蓄电池
wire 导线
emf. = electromotive force 电动势
unidirectional current 单方向电流
circuit diagram 电路图
load characteristic 负载特性
terminal voltage 端电压
external characteristic 外特性
load resistance 负载电阻
voltage drop 电压降
conductance 电导
volt-ampere characteristics 伏安特性
metal-filament lamp 金属丝灯泡
carbon-filament lamp 碳丝灯泡
non-linear characteristics 非线性特性

1.3 Notes

【1】When electric energy is generated, transmitted and converted under conditions such that the currents and voltages involved remain constant with time, one usually speaks of direct-current (D. C.) circuits. 这是一个主从复合句，when... time，是一个由 when 引导的时间状语从句，one... circuits. 是整个句子的主句。只是在从句中又包含了一个由 such that 引导的结果状语从句，该从句的主语是 the currents and voltages，involved 是它的后置定语，意为“牵涉到的，涉及到的”，remain 是系动词作谓语，结果状语从句是系表结构。因此，整句翻译成“当电能在产生、传输和变换时，若电路中相关的电流和电压不随时间而变化，我们便称其为直流电路。”可以看到结果状语从句并未直接译出。在此采用了翻译方法中的“转换法”，将其转译成条件状语从句，这样中文的译文更地道。

【2】The terminals of the source and load are interconnected by conductors (generally but not always wires). 中的 generally but not always wires = generally wires, but not always wires，意为“通常这种导体是导线，但少数情况下也有例外。”

【3】This simple circuit made up of a source, a load and two wires is seldom, if ever, met with in practice. = This simple circuit made up of a source, a load and two wires is seldom met with in practice, if it is ever met with in practice sometimes. 意为“这种由一个电源、一个负载和两根导线组成的简单电路即使在实践中有时也能遇到，也是很少见的”。

【4】Whatever its origin (thermal, contact, etc.), the source emf E (Fig. 1. 1. 2a) is numerically equal to the potential difference between terminals 1 and 2 with the external circuit open... 中的 between terminals 1 and 2 说明 difference，而 with the external circuit open 则修饰 terminals 1 and 2，因此此句译为“无论电动势 E 的原动力是什么（即不论是热的、机械的还是其他什么形式），其大小就等于 1、2 两端之间的开路电压”。

1.4 Translation

电路元件与参数

电路（或网络）是各电器装置的实物连接体。电路的作用是分配电能和转换能量形式。

因此，电路的基本元件是电源、能量转换器以及它们之间的连接导线。

电源（如原生电池、再生电池和发电机等）将化学能、热能或其他形式的能量转换成电能。能量转换器（也称作负载，比如灯泡、取暖器及电动机等）将电能转换成光、热和机械等能量。

电路的工作情况可以用电动势（或电压）和电流来描述。当电能在产生、传输和变换时，若电路中相关的电流和电压不随时间而变化，我们便称其为直流电路。对于时不变的电流和电压，与电气设备相联系的电场和磁场也是时不变的。这也就是为什么在直流电路中没有自感和互感电动势及在导体的周围电介质中也没有位移电流的原因。

图 1.1.1 用简化的方式表示以蓄电池作电源，灯泡作负载的一个假想电路。电源和负载端有导体（通常是导线，但少数情况下也有例外）连接，如图所示，电源、负载和导体形成一个闭合回路。电动势产生一个绕该闭合回路的连续单向电流。

这种由一个电源、一个负载和两根导线组成的简单电路，在实际中即使能碰见也是很少的。实际电路可能包括许多按不同方式连接的电源和负载。

为简化对实际电路的分析，通常将它画成用符号表示的电路图，这种电路图实际上是虚构的，或更确切地说是实际电路或网络的理想模型。这种电路由相互连接的电路元件或电路参数符号组成。为了表示一个直流电路，至少要有两种元件，这就是电动势为 E、内阻为 R_s 的电源和负载电阻（包括连接导体的电阻）R（见图 1.1.2）。

无论电动势 E 的原动力是什么（即不论是热、摩擦还是其他形式产生的），电源电动势 E（见图 1.1.2a）在数值上等于 1、2 两端之间的开路电压，即当电源中无电流通过时

$$E = \varphi_1 - \varphi_2 = V_{12} \tag{1.1.1}$$

电源电动势的方向是从低电位点指向高电位点，在电路图中用箭头表示。

当一负载与电源相连（此时电路称为已载荷）形成闭合回路，在此回路中便有电流。由于电源内部的压降 V_s（也即内阻 R_s 上的压降）

$$V_s = R_s I$$

这时电源 1、2 两端之间（也称端电压）便不等于它的电动势。

图 1.1.3 表示了一个带负载后电源的典型外特性 $V_{12} = \varphi_1 - \varphi_2 = VI$（也称为电源的负载特性）。从图中可看出，当电流从零增大到 $I \approx I_1$ 时，电源端电压将线性下降

$$V_{12} = V = E - V_s = E - R_s I$$

换句话说，电源内阻两端的压降 V_s 与电流成正比，该过程一直持续到电流达到某一临界值为止。然后，随着电流的继续增大，其与电源端电压之比值便变了，外特性也不再为线性的。电压的这种下降也许是由于电源电压的下降，也许是由于内阻的增大，或者两者兼而有之。

电源提供的功率由下式确定：

$$P_s = EI \tag{1.1.2}$$

式中，P_s 为电源功率。

在此看来应该消除关于功率的一种错误的概念，比如人们可能听说过关于功率的产生、提供、消耗、传输、损耗等的说法，然而事实上，只有能量才有产生、提供、消耗、传输和损耗的说法，功率仅是能量的输入或转换的比率，即单位时间内产生、提供和传输的能量值。因此，在上述内容中用“能量”这个术语而不用“功率”会更准确些，不过人们习惯

了传统的说法。

作为一种抽象化的电路元件，负载电阻 R（见图 1.1.2b）形成了一个消耗能量的概念，即将电能转换成热量，因此定义为

$$P = RI^2 \tag{1.1.3}$$

通常，负载电阻仅取决于通过负载的电流，这一点可用 $R(I)$ 的函数符号来表示。由欧姆定律可知，电阻两端的电压为

$$V = RI \tag{1.1.4}$$

在电路分析中，常常使用电阻的倒数，称之为电导，其定义为

$$g = 1/R$$

在实际问题中，人们常常不是将电阻表示为电流的函数 $R(I)$，而是将电阻两端电压表示为电流的函数 $V(I)$，或其反函数 $I(V)$。函数 $V(I)$ 或 $I(V)$ 的关系就是人们熟知的伏安特性。

图 1.1.4 中的曲线 $V_1(I)$ 和 $V_2(I)$ 分别表示金属丝灯泡和碳丝灯泡的伏安特性曲线。如图所示，每个灯泡的电流和电压之间的关系并不是线性的。随着电流的增加，金属丝灯泡的电阻是增加的，而碳丝灯泡的电阻是减小的。

含有非线性元件的电路称为非线性电路。

假如电源的电动势和内阻与其连接的负载电阻被认为均不随电流和电压变化而变化，那么电源的外特性 $V(I)$ 和负载的伏安特性 $V_1(I)$ 将为线性的。

仅含线性元件的电路称为线性电路。

大多数实际电路可归为线性电路。因此，对线性电路性能和线性电路分析的研究就具有理论和实践的双重意义。

1.5 About English & Chinese Language

1.5.1 英汉语言之共同处

1. 语言的起源和产生的规律

从语言的起源和产生的规律来说，英汉两种语言都具有人类语言的共同特征。

尽管在关于语言的产生过程、原始语言的主要形态以及人类语言始于何时等一些问题上至今尚无定论或记载，但有一点是肯定的，那就是语言是人类在自身的进化以及生活、生产及社会活动中，由于交流思想和情感的需要而逐渐产生的。语言是人类所特有的，它遵从人类共同的活动规律和认识规律。因此，人类的语言具有许多共同特征。

我们语言的形成有两大原则：一是随意性；二是规律性。所谓语言的随意性就是：一种说法刚出现时是随意的，但当其为社会全体成员所接受，人人都这么说时，便成了语言。所谓语言的规律性就是：语言的结构（包括词的构成、句子结构及表达方式等）又往往要遵循一定的规律，也就是要符合语法规则。包括英汉两种语言在内的人类所有的语言都具有这种共同特征，即语言既是随意的，又是规范的。此外，人类语言的共同特征还有：语言是行为、语言以声音为媒介、语言是分级的、语言是变化的、语言存在组合和选择关系，以及语言之间具有相似的结构等。

人类语言的共性是两种语言（包括英语和汉语）之间翻译的基础。

2. 语言与逻辑思维的关系

从语言与逻辑思维的关系来说，英汉两种语言的语序都符合人类逻辑思维的自然顺序，

即句子的结构都是按照

S（主语）+V（谓语动词）+O（宾语）

的基本模式排列。

如：在英语中有

We study English.

在汉语中相应的也有

我们学英语。

正是这种相似之处，才使英汉之间直译的翻译形式得以存在。

3. 语言的基本类型

从语言的基本类型来说，英汉两种语言基本同属分析性语言，其词形的变化都比较少。

从语言的语法结构上说，世界上的各种语言分为综合性语言和分析性语言两大类。英语的词形变化很少，主要依靠词序，或者通过虚词和某些语言习惯来表示各语法成分之间的关系，基本属于分析语言。而汉语根本就没有词形的变化，可以说是纯粹的分析语言。正是英汉两种语言之间的这个共性，为英汉之间的翻译提供很多便利。

但凡事都有两面性，正因为英语基本属于分析性语言，因此，其句子结构不尽严谨，特别是在一些复杂的长句中，句子各成分之间以及各子句之间的相互关系不够明确，有时不太好从语法结构上加以辨识，而往往要借助句子的具体含义来进行分析，这便使得我们在学习英语和从事英汉翻译工作中常常遇到不少困难。

1.5.2 英汉语言之差异

1. 在语源上分属不同的语系

全世界共有六千多种语言（其中亚洲2165种，欧洲225种，非洲2011种，美洲1000种，大洋洲及其附近岛屿1302种），这些语言分为若干种语系（Language Family）。其中主要有汉藏语系、印欧语系、闪语系、班图语系、南亚语系及印第安语系等大语系。这些大语系又分若干小语系乃至小语群，如下所示：

世界主要语系（或大语群）
- 汉藏语系
  - 汉台小语系（含汉语）
  - 藏缅小语系
- 闪语系
- 班图语系
- 南亚语系
- 印第安语系
- 印欧语系
  - 印度小语系
  - 斯拉夫小语系
  - 日耳曼小语系
    - 东日耳曼小语群
    - 北日耳曼小语群
    - 西日耳曼小语群（含英语）
  - 罗马小语系

由上可知，英语属印欧大语系中的日耳曼小语系中的西日耳曼小语群，而汉语则属汉藏语系中的汉台小语系。可见，英汉这两种语言在语源上相距甚远。

2. 在文化上存在着巨大差异

语言不是单纯的交际工具，它是文化的起源，又植根于文化之中，是民族文化的一个重要组成部分。它传达文化，反映文化，随文化的变化而变化，随文化的发展而发展。同时语言也因文化的多样性而异彩纷呈。不同的文化，其在语言上存在着很大文化差异。英汉两种语言在文化上的差异主要表现如下：

（1）词义的文化差异　词汇是语言中最活跃和最富有弹性的成分，也是文化载荷量最大的成分。一个民族语言的词汇，是其特有的物质环境、社会结构及精神信仰等的集中反映。不同语言中的词汇，有各自特有的文化背景、使用场合和文化内涵。所以，从严格意义上说，英汉两种语言之间很难找到所谓的“对应词”。

有了这种理解，便可深刻理解翻译的含义。两种语言之间的翻译过程，决不是其间字词的对译。

（2）语法的文化差异　不同语言的语法结构，有不同的思维原则作指导。汉语的语法准则是“达意”，其强调“意合”；而英语语法准则则是“完形”，其强调“形合”。因此，汉语语法对词的形式和顺序等没有太多的特别要求，句中成分的位置往往可以相互调换。而英语语法则注重形式上的联系，它往往通过词形的变化，或用各种连词和介词等来表现词与词之间的关系，通过句子成分的“各居其位”来体现意义。

此外，汉语的语法特点是注重“时间顺序”，叙事往往通过多个动词或动词词组的连用，按时间的先后和事理的推移，一件一件地描述事物，讲究“时序连贯”。而英语的构句特点是以谓语动词为核心，用包括非限制性动词短语在内的各种形式的短语或从句等，来“构筑”句子框架，讲究“空间层次”。

（3）语篇的文化差异　所谓语篇，是指大于句子的且意义完整的语言单位。如一篇文章或一次谈话等。不同的语言由于其文化思维模式的不同，在组织语篇的方式上也各不相同。英语的行文方式是“直线型”，即以主题句开头，后接例证句，最后总结；或者反过来，先是例证句，最后以主题句结尾。英文行文直接，强调严密的逻辑推理，讲究一个“实”字。而汉语的行文方式是“螺旋型”的，即不直接论证主题，而是“旁征博引”，往往是古人怎么说，名人怎么说，圣人怎么说等，从各种外围角度论证主题。

Unit 2　Ideal Sources Series and Parallel Equivalent Circuits

2.1　Text

Consider an elementary circuit containing a single source of emf E and of internal resistance R_s, and a single load R (Fig. 1.2.1) (omitted). The resistance of the conductors of this type of circuit may be neglected. In the external portion of the circuit, that is, in the load R, the current is assumed to flow from the junction a (which is at a higher potential such that $\varphi_a = \varphi_1$) to the junction b (which is at a lower potential such that $\varphi_b = \varphi_2$). The direction of current flow may be shown either by a hollow arrowhead or by supplying the current symbol with a double subscript whose first digit identifies the junction at a higher potential and the second the junction at a lower potential. 【1】 Thus for the circuit of Fig. 1.2.1, the current $I = I_{ab}$.

We shall show that the circuit of Fig. 1. 2. 1 containing a source of known emf E and source resistance R may be represented by two types of equivalent circuits.

As already started, the terminal voltage of a loaded source is lower than the source emf by an amount equal to the voltage drop across the source resistance:

$$V=\varphi_1-\varphi_2=E-V_s=E-R_sI \qquad (1.2.1)$$

On the other hand, the voltage across the load resistance R is

$$V=\varphi_a-\varphi_b=RI \qquad (1.2.2)$$

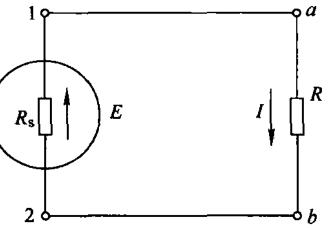

Fig. 1. 2. 1 Circuit of containing emf

Since $\varphi_1=\varphi_a$ and $\varphi_2-\varphi_b$, from Eqs. (1.2.1) and (1.2.2), it follows that $E-R_sI=RI$,

or

$$E=R_sI+RI \qquad (1.2.3)$$

and

$$I=E/(R_s+R)$$

From the last equation we conclude that the current through the source is controlled by both the load resistance and the source resistance. Therefore, in an equivalent circuit diagram the source resistance R may be shown connected in series with the load resistance R. This configuration may be called the series equivalent circuit (usually known as the Thevenin equivalent source).

Depending on the relative magnitude of the voltages across R and R, we can develop two modifications of the series equivalent circuit. In the equivalent circuit of Fig. 1. 2. 2a, V is controlled by the load current and is decided by the difference between the source emf E and the voltage drop V. If $R_s << R$ and, for the same current, $V_s << V$ (that is, if the source is operating under conditions very close to no-load or an open-circuit), we may neglect the internal voltage drop, put $V_s=RI=0$ (very nearly) and obtain the equivalent circuit of Fig. 1. 2. 2b. What we have got is a source whose internal resistance is zero ($R=0$). It is called an ideal voltage source. In diagrams it is symbolized by a circle with an arrow inside and the letter E beside it. When applied to a network, it is called a driving force or an impressed voltage source. The terminal voltage of an ideal voltage source is independent of the load resistance and is always equal to the emf E of the practical source it represents. Its external characteristic is a straight line parallel to the x-axis (the dotted line ab in Fig. 1. 2. 3). The other equivalent circuit (Fig. 1. 2. 3) may be called the parallel equivalent circuit (usually known as the Norton equivalent). It may also have two modifications. To prove this, we divide the

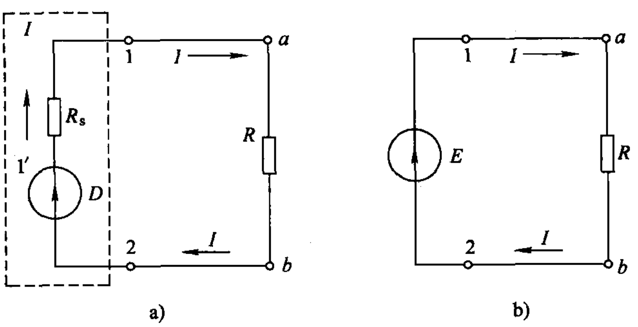

Fig. 1. 2. 2 Equivalent circuit

right-and left-hand sides of Eqs. (1.2.3) by R_s

$$E/R_s = I + V/R_s = I + Vg_s$$

or

$$J = I + I_s \qquad (1.2.4)$$

Where $J = E/R_s$ current with the source short-circuited (with $R = 0$);

$I_s = V/R_s = Vg_s$ current equal to the ratio of the terminal source voltage to the source resistance;

$I = V/R = Vg$ load current.

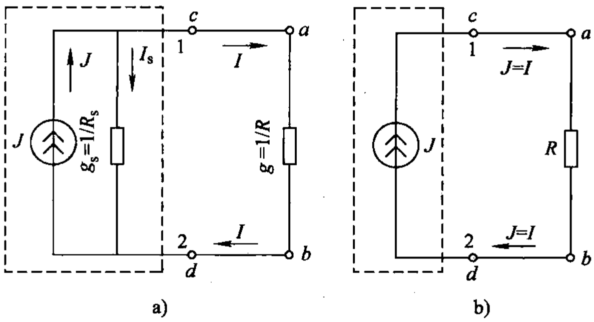

Fig. 1.2.3 Parallel equivalent circuit

Eq. (1.2.4) is satisfied by the equivalent circuit of Fig. 1.2.3a, in which the source resistance R_s is placed in parallel with the load resistance R.

If $g << g$ or $R >> R$ and, for the same voltages across R and R, the current $I << I$ (that is, if the source is operating under conditions approaching a short-circuit), we may put $I = Vg = 0$ (very nearly) and get the equivalent circuit of Fig. 1.2.3b.

What we have got is a source of zero internal conductance, $g_s = 0$ ($R_s = \infty$). It is called an ideal current source. When applied to a circuit, it is called a driving force of an impressed current source. The current of an ideal current source is independent of the load resistance R and is equal to E/R_s. The external characteristic of an ideal current source is a straight line parallel to the y-axis (the dotted line cd in Fig. 1.2.3).

Thus whether a real energy source may be represented by an ideal voltage source or an ideal current source depends on the relative magnitude of R_s and R. A real source, though, may be represented by an ideal voltage or current source also when R_s is comparable with R. In such a case, either R_s, or $g_s = 1/R$ (Fig. 1.2.2a and 1.2.3a, respectively) should be removed from the source and lumped with R or $g = 1/R$.

Ideal voltage and current sources are active circuit elements, while resistances and conductance are passive elements.

In developing an equivalent circuit, it is important to take into account, as much as practicable, the known properties of each device and of the circuit as a whole.

Let us develop an equivalent circuit for a two-wire power transmission line of length l, diagrammatically shown in Fig. 1.2.4 a. There is a generator of emf E and of source resistance R_s at the sending end and a load of resistance R_2 at the receiving end of the line.

It is obvious that the receiving end voltage will be less than the sending end one by an amount equal to the voltage drop across the resistance of the line conductors. The current at the receiving end will be smaller than that at the sending end by an amount equal to the leakage current (due to imperfect insulation).

Let each line conductor have a resistance $R_0/2$ and a conductance g_0 per unit length of the line.

We divide the line into length elements dx (Fig. 1.2.4a). Then each length element will have

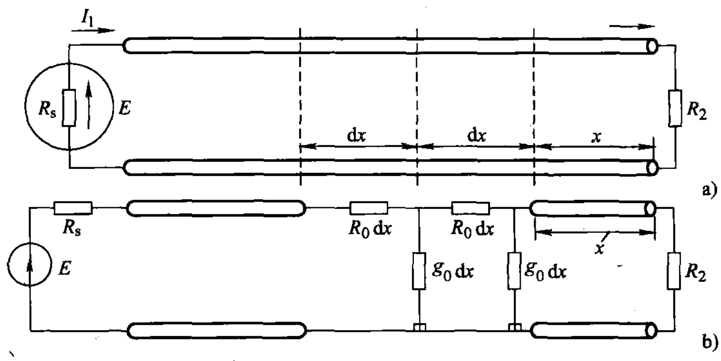

Fig. 1. 2. 4 Circuit for two-wire power transmission line

associated with it the combined resistance of the "go" and "return" wires, $R_0\,dx = (R_0/2)\,dx + (R_0/2)\,dx$ and a conductance $g_0 dx$. 【2】 Accordingly, the entire line may be represented by a network of elements each of resistance $R_0 dx$ and conductance $g_0 dx$ (Fig. 1. 2. 4b). The sending end generator in this network is represented by a voltage source (of emf E and of source resistance R_s).

Form this equivalent circuit we can find the voltage and current at any point on the line in terms of specified voltage and current at the sending or receiving end.

If the leakage current of the line is only a small fraction of the load current, we may neglect it and remove all conductance $g_0 dx$ from the network. This will leave us with a simple, single-loop network with one and the same current in each of its elements, such as shown in Fig. 1. 2. 5, where the line resistance $R_{line} = R_0 l$ is connected in series with R_s and R_2. The network of Fig. 1. 2. 5 may be used for analysis of line performance without a consideration of leakage currents.

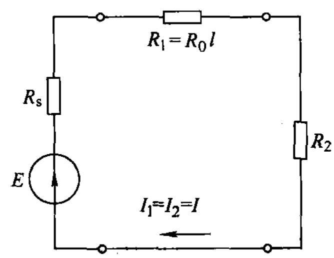

Fig. 1. 2. 5 Equivalent circuit of Fig. 1. 2. 4

It takes some practice to learn to develop equivalent circuits such as will reflect the behavior of physical prototypes in the most faithful manner and meet the requirements of the problem at hand. 【3】

2. 2 Specialized English Words

ideal source 理想电源
series and parallel equivalent circuit 串并联等效电路
internal resistance 内阻
sending end 发送端
double subscript 双下标
ideal voltage source 理想电压源
ideal current source 理想电流源
active circuit elements 有源电路元件
passive circuit elements 无源电路元件
power transmission line 输电线
receiving end 接收端
leakage current 漏电流