

电力英语阅读与翻译

ENGLISH FOR ELECTRIC POWER INDUSTRY

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内 容 提 要

本书是电力企业工程技术人员和管理人员学习专业英语的培训教材，内容涉及电力系统的各个方面，包括：电力系统、电力系统故障、电力系统通信、火电厂、水电厂、变电站及其自动化、断路器、变压器、输电线和电缆、过电压绝缘、防雷和接地、电力系统测量仪表、继电器、电力系统继电保护、RTU 和 SCADA 系统和日本的配电自动化系统等十六章。本书中英文原文精选自国外经典教材、国际期刊以及设备说明书，并含有详细注释和中文对照。

本书可作为电力企业工程技术人员和管理人员学习专业英语的培训教材，亦可用作高等学校有关电力系统专业的学生和研究生、教师的参考书。

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前 言

随着我国电力系统的发展，对外交流和引进设备的增多，有必要提高电力系统职工的专业英语水平，以便他们能够更好地从事本职工作。为此，我们根据多年来举办培训班及开办专业英语课程的基本内容编写了本书。全书包括电力系统，电力系统故障，电力系统通信，火电厂，水电厂，变电站及其自动化，断路设备，变压器，输电线和电缆，过电压，绝缘、防雷和接地，电力系统测量仪表，继电器，电力系统继电保护，RTU 和 SCADA 系统，日本的配电自动化系统等十六章内容。

本书由刘健博士担任主编，边康莎、王丽琴和邢念增为副主编。书中第一、二、四、五、七、十、十一、十二、十三、十五、十六章由刘健编写，第八章由邢念增编写，第十四章由张时帆编写，第六章由刘佩芬编写，第三章由张忠武编写；所有中文的注释和词汇表由边康莎编写；书中的译文由王丽琴、边康莎、刘健、张时帆、刘佩芬、张忠武、陈延枫、王丽、颜惠宇、孙东群、白春、眭肖钰等同志完成。

在成书过程中始终得到孙永安先生的支持和鼓励，在此表示感谢！编者还要感谢西安理工大学陈治明校长、亢树森教授、钟颜儒教授和严百平博士的帮助，感谢西北电力设计院张永德副总工程师和西北电业职工大学林则荣教授、郭锡安校长、徐龙斌副校长、张文海副校长、彭安福副校长、张明教务长和倪建立先生的帮助。

由于时间仓促，水平有限，书中的错误和不当之外恳请批评指正。

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Chapter 1 The Electric Power System

Part 1 Minimum Power System

A minimum electric power system is shown in Fig. 1-1. the system consists of an energy source, a prime mover, a generator, and a load.

The energy source may be coal, gas, or oil burned in a furnace to heat water and generate steam in a boiler; it may be fissionable material which, in a nuclear reactor, will heat water to produce steam;¹ it may be water in a pond at an elevation above the generating station; or it may be oil or gas burned in an internal combustion engine.

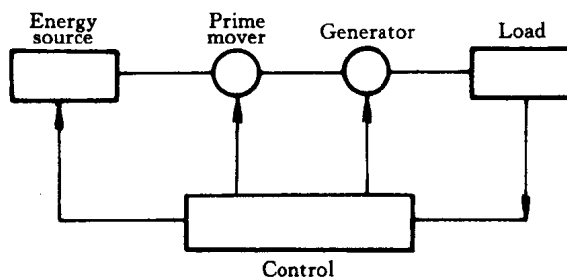


Fig. 1-1 The minimum electric power system

The prime mover may be a steam-driven turbine, a hydraulic turbine or water wheel, or an internal combustion engine. Each one of these prime movers has the ability to convert energy in the form of heat, falling water, or fuel into rotation of a shaft, which in turn will drive the generator.

The electrical load on the generator may be lights, motors, heaters, or other devices, alone or in combination. Probably the load will vary from minute to minute as different demands occur.

The control system functions to keep the speed of the machines substantially constant and the voltage within prescribed limits, even though the load may change.² To meet these load conditions, it is necessary for fuel input to change, for the prime mover input to vary, and for the torque on the shaft from the prime mover to the generator to change in order that the generator may be kept at constant speed. In addition, the field current to the generator must be adjusted to maintain constant output voltage. The control system may include a man stationed in the power plant who watches a set of meters on the generator-output terminals and makes the necessary adjustments manually.³ In a modern station, the control system is a servomechanism that senses a generator-output conditions and automatically makes the necessary changes in energy input and field current to hold the electrical output within certain specifications.

New Words and Expressions

1. minimum *a*

最小的

2. prime mover

原动机

3. generator <i>n</i>	发电机	4. load <i>n</i>	负载
5. furnace <i>n</i>	炉膛, 燃烧室	6. boiler <i>n</i>	锅炉
7. fissionable <i>a</i>	可裂变的	8. reactor <i>n</i>	反应堆
fissionable material	核燃料	nuclear reactor	核反应堆
9. elevation <i>n</i>	高度, 海拔	10. internal combustion engine	内燃机
11. steam-driven turbine	汽轮机	12. hydraulic turbine	水轮机
13. convert <i>v</i>	变换, 转换	14. rotation <i>n</i>	旋转, 转动
15. shaft <i>n</i>	传动轴, 轴	16. combination <i>n</i>	组合, 合并
17. function <i>v</i>	起作用	18. substantially <i>ad</i>	大体上
19. constant <i>a</i>	恒定的, 稳定的	20. prescribed <i>a</i>	所规定的
21. torque <i>n</i>	力矩	22. field <i>n</i>	磁场
23. current <i>n</i>	电流	24. station <i>v</i>	值守, 值班
25. terminal <i>a</i>	末端的, 终端的	26. manually <i>ad</i>	人工的, 手动的
27. servomechanism <i>n</i>	伺服机构, 跟踪装置	28. specification <i>n</i>	技术要求
29. sense <i>v</i>	显示, 测定		

*

*

*

*

1. convert...into...	把...转换为...
2. in turn	转而, 随后
3. from minute to minute	随时, 瞬时
4. in addition	另外

Notes

1. ...; it may be fissionable material which, in a nuclear reactor, will heat water to produce steam; ...

它有可能是核反应堆中的核燃料, 用来加热水以产生蒸汽。

句中的介词短语 in a nuclear reactor 是定语, 修饰关系代词 which。which 引出的定语从句修饰 fissionable material。

2. The control system functions to keep the speed of the machines substantially constant and the voltage within prescribed limits, even though the load may change.

控制系统的作用是, 在负载有可能变化的情况下仍能保持机器的大体稳定并将电压控制在规定的范围内。

句中的 speed 和 voltage 是并列关系, 两者均为不定式 keep 的宾语。even though 所引出的是让步条件从句, 意为“即使是在...的情况下”。

3. The control system may include a man stationed in the power plant who watches a set of meters on the generator-output terminals and makes necessary adjustments manually.

控制系统可能会包括一位派守在电厂的值班员, 该值班员观察发电机输出终端的一整

套仪表,并做一些必要的手动调整。

句中的 stationed in the power plant 为过去分词短语,作定语修饰 man,意为“被派守在...”。紧接其后的关系代词 who 引出的定语从句仍修饰 man。该定语从句中有两个并列的谓语动词 watches 和 makes,分别指出被派守在电厂的值班员的两项任务。

Part 2 More Complicated Systems

In most situations the load is not directly connected to the generator terminals. More commonly the load is some distance from the generator, requiring a power line connecting them. It is desirable to keep the electric power supply at the load within specifications. However, the controls are near the generator, which may be in another building, perhaps several miles away.

If the distance from the generator to the load is considerable, it may be desirable to install transformers at the generator and at the load end, and to transmit the power over a high-voltage line (Fig. 1-2). For the same power, the higher-voltage line carries less current, has lower losses for the same wire size, and provides more stable voltage.

In some cases an overhead line may be unacceptable. Instead it may be advantageous to use an underground cable. With the power systems talked above, the power supply to the load must be interrupted if, for any reason, any component of the system must be removed from service for maintenance or repair.

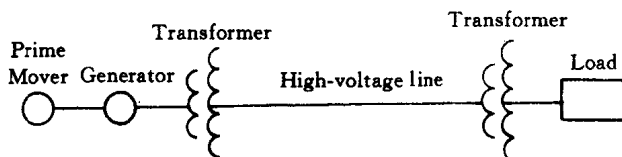


Fig. 1-2 A generator connected through transformers and a high-voltage line to a distant load

Additional system load may require more power than the generator can supply. Another generator with its associated transformers and high-voltage line might be added.

It can be shown that there are some advantages in making ties between the generators (1) and at the ends of the high-voltage lines (2 and 3), as shown in Fig. 1-3. This system will operate satisfactorily as long as no trouble develops or no equipment needs to be taken out of service.

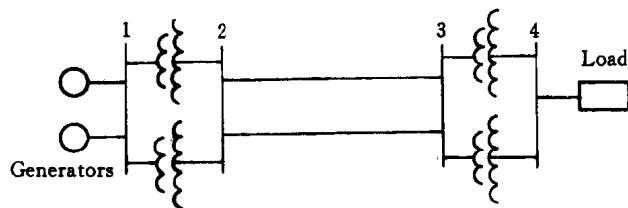


Fig. 1-3 A system with parallel operation of the generators, of the transformers and of the transmission lines

The above system may be vastly improved by the introduction of circuit breakers, which may be opened and closed as needed.¹ Circuit breakers added to the system, Fig. 1-4, permit selected piece of equipment to switch out of service without disturbing the remainder of system.²

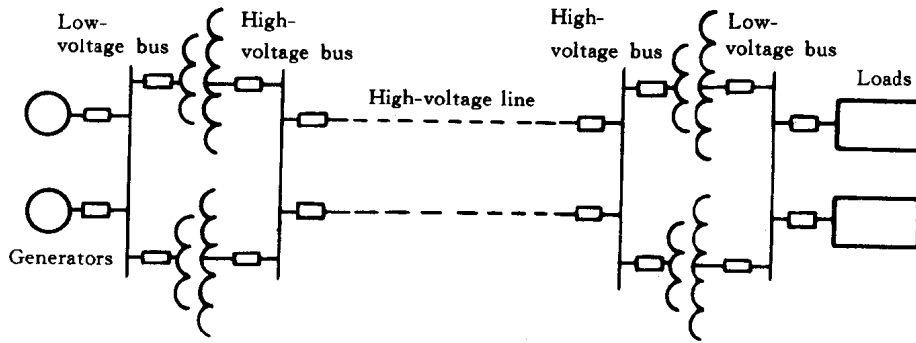


Fig. 1-4 A system with necessary circuit breakers

With this arrangement any element of the system may be deenergized for maintenance or repair by operation of circuit breakers. Of course, if any piece of equipment is taken out of service, the total load must then be carried by the remaining equipment. Attention must be

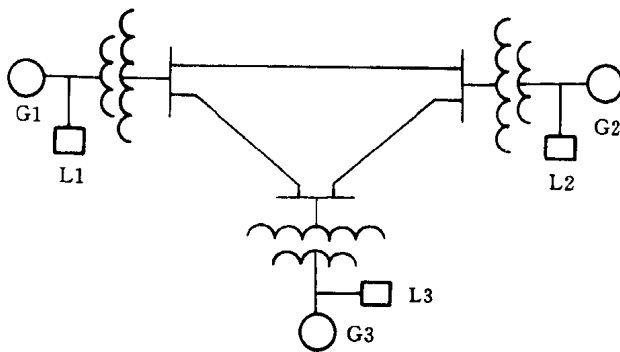


Fig. 1-5 Three generators supplying three loads over high-voltage transmission lines

given to avoid overloads during such circumstances. If possible, outages of equipment are scheduled at times when load requirements are below normal.

Fig. 1-5 shows a system in which three generators and three loads are tied together by three transmission lines. No circuit breakers are shown in this diagram, although many would be required in such a system.

New Words and Expressions

1. complicated <i>a</i>	复杂的	2. desirable <i>a</i>	理想的
3. considerable <i>a</i>	值得考虑的,相当大的	4. transformer <i>n</i>	变压器
5. stable <i>a</i>	稳定的	6. unacceptable <i>a</i>	不可接受的
7. advantageous <i>a</i>	有利的	8. high voltage line	高压线路
9. overhead line	架空线路	10. underground cable	埋地电缆
11. component <i>n</i>	(组成)部分	12. maintenance <i>n</i>	维修、检修
13. associated <i>a</i>	联接的,关联的	14. circuit breaker	断路器
15. deenergize <i>v</i>	切断、断电	16. outage <i>n</i>	停电
		deenergized <i>a</i>	不带电的
17. schedule <i>v</i>	排定,安排	18. diagram <i>n</i>	图、简图
19. transmission line	输电线		

*	*	*	*
1. in some cases	在某些情况下	2. for any reason	无论何种原因
3. as long as	只要	4. switch out (off)	关闭, 断开

Notes

1. ..., which may be opened and closed as needed.

句中的 as needed 系一个有省略成分的时间状语从句。

2. Circuit breakers added to the system, Fig. 1-4, permit selected piece of equipment to switch out of service without disturbing the remainder of system.

系统中增加的断路器(如图 1-4 所示)可使选定的设备退出运行,而不会使系统的其他部分受到影响。

Part 3 Typical System Layout

The generators, lines, and other equipment which form an electric system are arranged depending on the manner in which load grows in the area and may be rearranged from time to time.¹

However, there are certain plans into which a particular system design may be classified. Three types are illustrated: the radial system, the loop system, and the network system. All of these are shown without the necessary circuit breakers. In each of these systems, a single generator serves four loads.

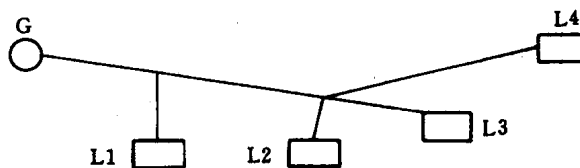


Fig. 1-6 A radial power system supplying several loads

The radial system is shown in Fig. 1-6. Here the lines form a "tree" spreading out from the generator. Opening any line results in interruption of power to one or more of the loads.

The loop system is illustrated in Fig. 1-7. With this arrangement all loads may be served even though one line section is removed from service. In some instances during normal operation, the loop may be open at some point, such as A. In case a line section is to be taken out, the loop is first closed at A and then the line section removed. In this manner no service interruptions occur.

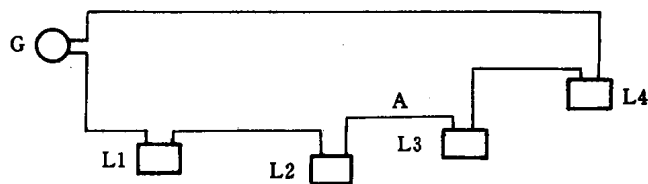


Fig. 1-7 A loop arrangement of lines for supplying several loads

operation, the loop may be open at some point, such as A. In case a line section is to be taken out, the loop is first closed at A and then the line section removed. In this manner no service interruptions occur.

Fig. 1-8 shows the same loads being served by a network. With this

arrangement each load has two or more circuits over which it is fed.

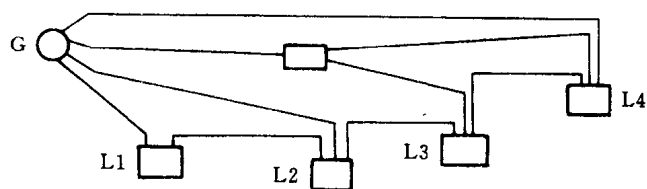


Fig. 1-8 A network of lines for supplying several loads

Distribution circuits are commonly designed so that they may be classified as radial or loop circuits. The high-voltage transmission lines of most power systems are arranged as networks. The interconnection of major power systems results in net-

works made up many line sections.

New Words and Expressions

1. typical <i>a</i>	典型的	2. layout <i>n</i>	布局, 配置
3. particular <i>a</i>	特殊的	4. classify <i>v</i>	分类
5. illustrate <i>v</i>	图解, 说明	6. radial system	辐射状系统
7. loop system	环网系统	8. network system	网络系统
9. distribution circuit	配电线路	10. interconnection <i>n</i>	互联
11. section <i>n</i>	分段, 部分		
*	*	*	*
1. result in	导致	2. in case	假使, 万一

Notes

1. The generators, lines, and other equipment which form an electric system are arranged depending on the manner in which loads grows in the area and may be rearranged from time to time.

一个由发电机、线路以及其他设备构成的电力系统, 其布局取决于当地的负荷增长方式, 并有随时调整的可能。

本句的主结构为 The generators, lines, and other equipment ... are arranged ... and maybe rearranged ...

Part 4 Auxiliary Equipment

Circuit breakers are necessary to deenergize equipment either for normal operation or on the occurrence of short circuits. Circuit breakers must be designed to carry normal-load currents continuously, to withstand the extremely high currents that occur during faults, and to separate contacts and clear a circuit in the presence of fault. Circuit breakers are rated in terms of these duties.

When a circuit breaker opens to deenergize a piece of equipment, one side of the circuit breaker usually remains energized, as it is connected to operating equipment. Since it is

sometimes necessary to work on the circuit breaker itself, it is also necessary to have means by which the circuit breaker may be completely disconnected from other energized equipment. For this purpose disconnect switches are placed in series with the circuit breakers. By opening these disconnects, the circuit breaker may be completely deenergized, permitting work to be carried on in safety.

Various instruments are necessary to monitor the operation of the electric power system. Usually each generator, each transformer bank, and each line has its own set of instruments, frequently consisting of voltmeters, ammeters, wattmeters, and varmeters.

When a fault occurs on a system, conditions on the system undergo a sudden change. Voltages usually drop and currents increase. These changes are most noticeable in the immediate vicinity of fault. On-line analog computers, commonly called relays monitor these changes of conditions, make a determination of which breaker should be opened to clear the fault, and energize the trip circuits of those appropriate breakers.¹ With modern equipment, the relay action and breaker opening causes removal of fault within three or four cycles after its initiation.

The instruments that show circuit conditions and the relays that protect the circuits are not mounted directly on the power lines but are placed on switchboards in a control house. Instrument transformers are installed on the high-voltage equipment, by means of which it is possible to pass on to the meters and relays representative samples of the conditions on the operating equipment. The primary of a potential transformer is connected directly to the high-voltage equipment. The secondary provides for the instruments and relays a voltage which is a constant fraction of voltage on the operating equipment and is in phase with it. Similarly, a current transformer is connected with its primary in the high-voltage circuit. The secondary winding provides a current which is a known fraction of the power-equipment current and is in phase with it.

Bushing potential devices and capacitor potential devices serve the same purpose as potential transformers but usually with less accuracy in regard to ratio and phase angle.

New Words and Expressions

1. auxiliary <i>a</i>	辅助的	2. short circuit	短路
3. withstand <i>v</i>	经受住	4. fault <i>n</i>	故障
5. contact <i>n, v</i>	接触	6. rate <i>v</i>	估算, 定额
7. energize <i>v</i>	带电	8. disconnect switch	隔离开关
9. monitor <i>v, n</i>	监视, 监视仪	10. vicinity <i>n</i>	附近, 邻近
11. voltmeter <i>n</i>	电压表	ammeter	电流表
wattmeter	有功功率表	varmeter	无功功率表
12. immediate <i>a</i>	最接近的, 立刻	13. analog computer	模拟计算机
14. relay <i>n</i>	继电器	15. determination <i>n</i>	判断

16. trip circuit	跳闸电路	17. clear <i>v</i>	清除, 排除
18. removal of fault	事故处理	19. cycle <i>n</i>	周期
20. initiation <i>n</i>	起动	21. mount <i>v</i>	安装, 固定
22. switchboard <i>n</i>	配电盘, 开关屏	23. Instrument transformer	测量互感器
24. sample <i>n</i>	信号值, 采集值	25. primary <i>n</i>	原边, 一次侧
26. potential transformer	电压互感器	27. secondary <i>n</i>	次边, 二次侧
28. current transformer	电流互感器	29. winding <i>n</i>	绕组, 线圈
30. bushing <i>a</i>	套管(式)的	31. ratio <i>n</i>	变比
*	*	*	*
1. in the presence of	在有…的情况下	2. in terms of	根据
3. on-line	联网的, 在线的	4. by means of	用…的办法
5. a fraction of	几分之一	6. in phase with	与…同相位
7. regard to	就…而言		

Notes

1. On-line analog computers, commonly called relays, monitor these changes of conditions, make a determination of which breaker should be opened to clear the fault, and energize the trip circuits of those appropriate breakers.

在线的模拟计算机(通常称之为继电器的)监测这些条件的变化, 判断应断开哪只断路器以清除故障, 并使那些应该跳闸的断路器的跳闸线圈带电。

此句主结构为 On-line computers... monitor..., make..., and energize...

第一节 最小的电力系统

如图 1-1 所示, 最小的电力系统由能源、原动机和负载构成。

能源可以是煤、油或天然气, 它们在锅炉炉膛内燃烧, 将水加热成蒸汽; 也可以是核反应堆中可裂变的核燃料; 也可以是高于发电厂的池塘中的水或是在内燃机中燃烧的油或天然气。

原动机可以是汽轮机、水轮机、水车、或内燃机。无论是哪一种原动机, 都是将蒸汽的热能、落水的势能或燃料燃烧发出的能量转变成了传动轴的转动, 从而驱动发电机。

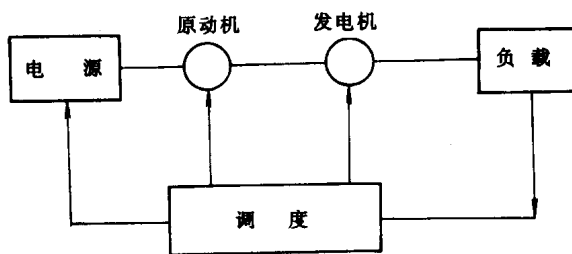


图 1-1 最小的电力系统

电力负载则可能是单一的灯、电机、加热器以及其他用电器或是它们的组合。当然随着需求的变化, 负载会不时地变化。

控制系统的作用是, 在负载有可能变化的情况下仍能保持机器的稳定, 并将电压控制在规定的范围内。为了适应负荷的变化, 有必要改变燃料的投入量和原动机的输入以及从原动机到发电机的传动轴的

力矩，以便使发电机保持匀速运转。此外，须调节发电机的磁场电流，以使输出的电压恒定。控制系统可能会包括一位派守在电厂的值班员，该值班员观察发电机输出终端的一整套仪表，并做一些必要的手动调整。在一个现代化的发电厂，控制系统实际上是一个能表明输出情况，自动对能量输入及磁场电流进行必要调节以便使电力输出满足技术指标的伺服机构。

Chapter 2 Faults on Power Systems

Part 1 Faults and Its Damage

Each year new designs of power equipment bring about increased reliability of operation. Nevertheless, equipment failures and interference by outside sources occasionally result in faults on electric power systems. On the occurrence of a fault, current and voltage conditions become abnormal, the delivery of power from the generating stations to the loads may be unsatisfactory over a considerable area, and if the faulted equipment is not promptly disconnected from the remainder of the system, damage may result to other pieces of operating equipment.

A fault is the unintentional or intentional connecting together of two or more conductors which ordinarily operate with a difference of potential between them. The connection between the conductors may be by physical metallic contact or it may be through an arc. At the fault, the voltage between the two parts is reduced to zero in the case of metal-to-metal contacts, or to a very low value in case the connection is through an arc. Currents of abnormally high magnitude flow through the network to the point of fault. These short-circuit currents will usually be much greater than the designed thermal ability of the conductors in the lines or machines feeding the fault. The resultant rise in temperature may cause damage by the annealing of conductors and by the charring of insulation. In the period during which the fault is permitted to exist, the voltage on the system in the near vicinity of the fault will be so low that utilization equipment will be inoperative. It is apparent that the power system designer must anticipate points at which faults may occur, be able to calculate conditions that exist during a fault, and provide equipment properly adjusted to open the switches necessary to disconnect the faulted equipment from the remainder of the system¹. Ordinarily it is desirable that no other switches on the system are opened, as such behavior would result in unnecessary modification of the system circuits.

New Words and Expressions

1. fault <i>n</i>	故障	2. damage <i>n</i>	危害
3. reliability <i>n</i>	可靠性	4. interference <i>n</i>	干扰, 妨碍
5. abnormal <i>a</i>	异常的, 不规则的	6. delivery <i>n</i>	传输
7. promptly <i>ad</i>	迅速地	8. intentional <i>a</i>	故意的
9. potential <i>n, a</i>	电势, 潜在的	10. metallic <i>a</i>	金属性的
11. arc <i>n</i>	电弧	12. magnitude <i>n</i>	幅值, 大小
13. resultant <i>a</i>	总合的	14. annealing <i>n</i>	退火, 锻烧

15. feed <i>v</i> fed (过去式) 给...馈电 fed(过去分词)	16. charring <i>n</i> 焦化, 炭化
17. insulation <i>n</i> 绝缘	18. vicinity <i>n</i> 临近处
19. utilization equipment 用电设备	20. inoperative <i>a</i> 无法使用的
21. anticipate <i>v</i> 预见到	22. modification <i>n</i> 变更, 调整
*	*
1. bring about 促使, 带来	2. on the occurrence of 当...发生的时候

Notes

1. It is apparent that the power system designer must anticipate points at which faults may occur, be able to calculate conditions that exist during a fault, and provide equipment properly adjusted to open the switches necessary to disconnect the faulted equipment from the remainder of the system.

该句中情态动词 *must* 后共有三个并列的谓语动词, 分别为 *anticipate*, *be able to* 和 *provide*。

Part 2 Overload

A distinction must be made between a fault and an overload. An overload implies only that loads greater than the designed values have been imposed on system. Under such a circumstance the voltage at the overload point may be low, but not zero. This undervoltage condition may extend for some distance beyond the overload point into the remainder of the system. The currents in the overloaded equipment are high and may exceed the thermal design limits. Nevertheless, such currents are substantially lower than in the case of a fault. Service frequently may be maintained, but at below-standard voltage.

Overloads are rather common occurrences in homes. For example, a housewife might plug five waffle irons into the kitchen circuit during a neighborhood party. Such an overload, if permitted to continue, would cause heating of the wires from the power center and might eventually start a fire. To prevent such trouble, residential circuits are protected by fuses or circuit breakers which open quickly when currents above specified values persist. Distribution transformers are sometimes overloaded as customers install more and more appliances. The continuous monitoring of distribution circuits is necessary to be certain that transformer sizes are increased as load grows.

New Words and Expressions

1. distinction <i>n</i> 识别, 辨认	2. impose <i>v</i> 将...强加于
3. undervoltage <i>a</i> 电压不足的	4. extend <i>v</i> 延伸, 扩散
5. exceed <i>v</i> 超过, 超出	6. substantially <i>ad</i> 事实上, 实际上