Е.В. Тюнина

ELECTRICAL ENGINEERING

Учебное пособие

ФЛИНТА•НАУКА

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Пособие состоит из двух частей. Первая часть включает тексты по специальности для аудиторных занятий с рядом лексических закрепительных упражнений. Во второй части представлена тематика текстов для дополнительного чтения.

Для студентов, аспирантов и преподавателей технических факультетов вузов.

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Введение

Цель пособия — ознакомить студентов с текстами по специальности, научить работать с текстами, вести беседу по данным темам, овладеть необходимым лексическим минимумом, а также подвести студентов к самостоятельному чтению и пониманию научно-технической литературы по специальности на английском языке.

Пособие состоит из следующих разделов:

1) уроки, содержащие учебные тексты с упражнениями на закрепление лексического материала;

2) тексты для внеаудиторного чтения.

Тексты пособия носят познавательный и научно-популярный характер, некоторые из них снабжены рисунками, которые служат основой для мотивированного высказывания.

Пособие содержит 31 урок, каждый из которых рассчитан на студентов с определенным уровнем знаний и состоит из основного текста, тематического словаря и лексико-речевых упражнений, предназначенных для развития навыков поискового чтения и направленных на проверку понимания и навыков извлечения информации.

Тематические тексты, составляющие основу каждого урока первой части, расположены в логической последовательности и в определенном структурном порядке. Тексты представлены по различным уровням сложности: уровень А, В и С. Уровень А предназначается для групп с низким уровнем владения английским языком, а также может быть использован группами технического колледжа по соответствующим специальностям. Тексты этого уровня посильны. Уровень В включает тексты, содержащие лексику более сложного уровня, и предназначается для групп со средним уровнем владения английским языком. Уровень С подходит для групп с высоким уровнем владения языком, а также может быть использован некоторыми студентами как задание повышенного уровня сложности.

В пособии представлены тексты по следующей тематике: «Природа электричества», «Электрон и электрический ток», «Отрасли электричества», «Измерительные приборы», «Проводники электрического тока», «Генераторы», «Электрические моторы», « Трансформаторы».

Вторая часть пособия представляет собой самостоятельное, структурно-независимое пособие для развития навыков чтения и перевода технической литературы по специальности.

В заключение прилагается используемая литература.

Part I

ELECTRICAL ENGINEERING. ELECTRICITY

1. Text A

THE NATURE OF ELECTRICITY

The ancient Greeks knew that when a piece of **amber** is **rubbed** with **wool** or **fur, it achieves the power** of attracting light objects. Later on, the phenomenon was studied and the word *electric*, **after the Greek word "electron"** meaning amber, was used. Many scientists investigated electric phenomena, and during the nineteenth century many discoveries about the nature of electricity, and of **magnetism**, which is closely **related** to electricity, were made. It was found that if a **sealing-wax** rod is rubbed with a woolen cloth, and **a rod of glass** is rubbed with a silken cloth, an **electric spark** will pass between the sealing-wax rod and the glass rod when they are brought near one another. **More over**, it was found that a **force of attraction** operates between them. An electrified sealing-wax rod is repelled, however, by a wax rod, and also an electrified glass rod is repelled, by a similar glass rod.

The ideas were developed that there are two kinds of electricity, which were called **resinous** electricity, and that **opposite** kinds of electricity **attract** one another, **whereas** similar kinds **repel** one another.

Memorize the pronunciation of the following words:

amber [ˈæmbə] — янтарь
to rub [rʌb] — тереться, приходить в прикосновение
wool [wu:l] — шерсть
fur [fə:] — мех, шерсть
it achieves the power — он (она) приобретает способность
after the Greek word — от греческого слова
electron [iˈlektron] — электрон
magnetism [ˈmægnitizm] — магнетизм, магнитные свойства
to relate to [riˈleit] — относиться, иметь связь с
sealing-wax [wæks] **rod** — палочка из сургуча
a rod of glass — стеклянная палочка
electric spark — [iˈlektrik spa:k] — электрическая искра
more over — более того

force of attraction — сила притяжения
to repel [ri'pel] — отталкивать, отражать
to attract [ə'trækt] — притягивать
resinous [re'zinəs] — смолистый
opposite ['opəzit] — противоположный
whereas [wɛər'æz] — тогда как

Answer the questions:

1. What does a piece of amber achieve when it is rubbed with wool or fur?
2. When was the word *electric* used?
3. Is the word *electric* after the Greek word "electron"?
4. When were many discoveries about the nature of electricity and of magnetism made?
5. When does an electric spark pass between the sealing-wax rod and the glass rod?
6. What operates between two rods?
7. What are two kinds of electricity?

Exercise 1.1. *Find the following words and word combinations in the text:*

1. соприкасается с шерстью или мехом
2. приобретает способность притягивать легкие предметы
3. феномен был изучен
4. слово «электрический» от греческого слова «электрон»
5. тесно связаны с электричеством
6. электрическая искра возникнет между палочкой из сургуча и стеклянной палочкой
7. возникает сила притяжения
8. наэлектризованная стеклянная палочка отталкивается от
9. противоположные виды электричества притягивают друг друга
10. одинаковые виды отталкивают

Exercise 1.2. ***Find the wrong statements and correct them:***

1. When a piece of amber is rubbed with wool or fur, it achieves the power of repelling light objects.
2. An electric spark will pass between the glass rod and the sealing wax-rod because a force of attraction operates between them.
3. An electrified glass rod is repelled by a wax rod.
4. Similar kinds of electricity attract one another.
5. A force of attraction operates between a sealing-wax rod and a woolen cloth.

Exercise 1.3. ***Translate into English:***

1. В 19 веке были сделаны многие открытия о природе электричества и магнетизме.
2. Обнаружили, что палочка из сургуча отталкивается от шерстяной одежды и стеклянная палочка отталкивается от одежды из шелка.
3. Наэлектризованная палочка из сургуча отталкивается от такой же палочки.
4. Существует два вида электричества, которые были названы смоляным электричеством.

2. Text B

NATURE OF ELECTRIC CURRENT

In the modern conception of the **constitution of matter it is composed of atoms**. The atom **is made up of** a positive **nucleus** surrounded by negative **charges** of electricity, called **electrons**, which **revolve** about the nucleus at **tremendous speed**. The nucleus consists of a number of protons, each with a single positive charge, and, except for

hydrogen, one or more neutrons, which have no charge. The atom is **neutral** when it contains equal numbers of electrons and protons. A negatively charged **body** contains more electrons than protons. A positively charged body is one which contains fewer electrons than its normal number.

When the two ends of a **conductor** are connected to two points at different **potentials**, such as the **terminals** of a **battery**, we say that there is an electric **current** in the conductor. What actually happens?

The conductor has equal numbers of positive and negative charges in its atoms, and we want to know how the charges can be made to produce a current. The atoms in metals are packed so closely that **overlap to some extent**, so that it is comparatively easy for the **outer** electrons to pass from one atom to another if a small force is **applied** to them. The battery **causes** a potential difference between the ends of the **wire**, and thus **provides** forces that make the negative electrons in the wire move toward the point of higher potential electrons. This electron **flow** toward the positive electrode is the electric current. Naturally materials differ considerably in the ease with which electrons can be made to migrate from atom to atom.

The current will not flow unless there is an electric **circuit**. The **magnitude** of the current depends simply on the **rate** of flow of electrons along the conductor.

Memorize the pronunciation of the following words:

constitution [ˌkonstiˈtjuːʃn] — состав
matter [ˈmætə] — материал, вещество, материя
to compose [kəmˈpouz] — составлять, состоять
atom [ˈætəm] — атом
to be made up of — состоять
nucleus [ˈnjuːkliəs] — ядро
charge [tʃaːdʒ] — заряд
electron [iˈlektron] — электрон
to revolve [riˈvolv] — вращаться
tremendous [triˈmendəs] — огромный
hydrogen [ˈhaidridʒən] — водород

neutral ['nju:trəl] — нейтральный
body ['bodi] — тело
conductor [kən'dʌktə] — проводник
potentials [pə'tenʃəl] — потенциал, напряжение
terminal ['tə:minl] — зажим, ввод, вывод
battery ['bætəri] — батарея
current ['kʌrənt] — ток
they overlap to some extent — они взаимно проникают в какой-то мере
outer ['autə] — внешний, наружный
to apply [ə'plai] — применять
to cause [ko:z] — причинять, вызывать
wire ['waiə] — проволока
to provide [prə'vaid] — обеспечивать
to flow [flou] — поток, течь
circuit ['sə:kit] — схема, сеть, цепь
magnitude ['mægnitju:d] — величина, размеры, сила
rate [reit] — норма, скорость

Answer the questions:

1. What is the constitution of matter?
2. What is an atom?
3. What charges are called electrons?
4. What does the nucleus consist of?
5. Have neutrons any charges?
6. When is the atom neutral?
7. What is a negatively charged body?
8. What is a positively charged body?
9. What is an electric current?
10. Has the conductor equal numbers of positive and negative charges in its atoms?
11. Why are metals dense?
12. When can the outer electrons pass from one atom to another?
13. What are the examples of different potentials?
14. What does the battery cause and provide?
15. What does the magnitude of the current depend on?
16. What body contains more electrons than protons?

Exercise 1.1. ***Find the following words and word combinations in the text:***

1. строение материи
2. материя состоит из атомов
3. вращаются вокруг ядра
4. на огромной скорости
5. один положительный заряд
6. содержит равное количество
7. отрицательно (положительно) заряженное тело
8. источники разного напряжения
9. расположены очень близко
10. разница в напряжении
11. сила тока
12. зависит от скорости движения электронов

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The atom is made up of a negative nucleus surrounded by positive charges.
2. The electron consists of a number of protons each with a single negative charge.
3. Electrons revolve about the nucleus.
4. Neutrons have a single positive charge.
5. A negatively charged body contains more protons than electrons.
6. Electrons pass from one atom to another because the atoms overlap to some extent.
7. The electric current is the electron flow toward the negative electrode.

Exercise 1.3. ***Translate into English:***

1. Атом состоит из положительно заряженного ядра, окруженного отрицательными зарядами.

2. Электроны вращаются вокруг ядра на огромной скорости.
3. Ядро состоит из протонов и одного и более нейронов.
4. У протонов один положительный заряд, у нейтронов заряда нет.
5. Внешним электронам сравнительно легко перемещаться из одного атома в другой.
6. Проводник содержит равное количество положительных и отрицательных зарядов.
7. Батарея вызывает разницу в напряжении между концами проволоки.
8. Электрический ток — движение электрона в сторону положительно заряженного электрода.
9. Сила тока зависит от скорости движения электронов через проводник.

Exercise 1.4. ***Form sentences using the following word combinations:***

a negatively charged body; from negative to positive; from one atom to another; a number of protons; a single positive charge; equal number of electrons and protons; to differ in the ease.

3. Text B

WHAT IS AN ELECTRON?

What is an **electron**? We can think of the electron as a very small, **indivisible, fundamental particle** — a major **constituent** of all **matter**. All electrons appear to be **identical** and to have **properties** that do not change with time. Two **essential** characteristics of the electron are its **mass** and its **charge**. Qualitatively, we can think of an electron as a "piece of matter" that has weight and is **affected** by **gravity**. Just as the mass of any object is defined, we can define the mass of the electron by applying a force and **measuring** the resulting **rate** of change in the **ve-**

locity of the electron, that is, **the rapidity** with which its velocity changes. This rate of change is called acceleration, and the electron mass is then defined as **the ratio** of the applied force to the resulting acceleration. The mass of the electron is found to be about 9.11×10^{-28} **grams.**[1] Not only the electron but all matter appears to have positive mass, which is equivalent to saying that a force applied to any object **results in an acceleration**[2] in the same direction as the force.

How does the other aspect, the charge of the electron, **arise**? If we **investigate** further, we find that all electrons have an electric charge, and the **amount** of charge, like the mass, is identical for all electrons. No one has ever succeeded in isolating an amount of charge smaller than that of the electron. The sign of the electron charge is **conventionally** defined as negative; the electron thus represents the fundamental unit of a negative charge.

No experiment has yet succeeded in removing the charge from the electron, leaving only its mass. **Therefore**, instead of considering the electron a "massive" body that has **somehow acquired** a charge, it seems more realistic to think that the charge and the mass are two **inseparable** aspects of a single unity.

The motion of an electron, like that of any other body, results from a force acting on it. How can force be applied to an electron? One way is by gravity. Another is by bringing a second charge near the electron, thus **exerting** an attractive or **repulsive** force on it. In this case we may say that the second charge **sets up** electric field which applies a force to the first charge. Finally, we find that an electric current flow will affect the motion of a nearby charge, but only if that charge is already in motion. In this case, we say that the current sets up a magnetic field which applies a force to the moving charge. These three are the only known ways of applying force to an electron. The relationship between these fields, the charges producing them and resulting effects on other charges are the laws of electron motion.

Notes:

1. **9.11×10^{-28} grams** — nine point eleven multiplied by ten to the minus twenty-eighth power
2. **to result in an acceleration** — вызывать ускорение

Memorize the pronunciation of the following words:

electron [i'lektron] — электрон
indivisible [,indi'vizəbl] — неделимый
fundamental [,fʌndə'mentl] — основной
particle ['pa:tikl] — частица
constituent [kən'stitjuənt] — составная часть
matter ['mætə] — материя, вещество
identical [ai'dentikl] — тождественный
property ['propəti] — свойство
essential [i'senʃəl] — существенный, неотъемлемый
mass [mæs] — масса
charge [tʃa:dʒ] — заряд
to affect [ə'fekt] — воздействовать
gravity ['græviti] сила тяжести, удельный вес
to measure ['meʒə] — измерять
rate ['reit] — норма, скорость
velocity [vi'lositi] — скорость
rapidity [rə'piditi] — быстрота
ratio ['reiʃiou] — отношение, пропорция
to arise [ə'raiz] — возникать
to investigate [in'vestigeit] — исследовать
amount [ə'maunt] — количество, сумма
conventionally [kən'venʃənəli] — условно
therefore ['ðɛəfo:] — поэтому
somehow ['sʌmhau] — как-нибудь
to acquire [ə'kwaiə] — достигать, приобретать, получать
inseparable [in'sepərəbl] — неотделимый
to exert [ig'zə:t] — напрягать
repulsive [ri'pʌlsiv] — отталкивающий
to set up — *зд.* создавать

Answer the questions:

1. What is an electron?
2. What properties have electrons?
3. What are two essential characteristics of the electron?
4. How can we define the mass of an electron?
5. How is the rate of change called?

6. What is the mass of the electron?
7. What is identical for all electrons?
8. How is the sign of the electron charge defined?
9. What are two inseparable aspects of a single unity?
10. What does the electron represent?
11. What does the motion of an electron result from?
12. How can force to an electron be applied?
13. What sets up an electric field?
14. What sets up a magnetic field?
15. What are the laws of electron motion?

Exercise 1.1. ***Find the following words and word combinations in the text:***

1. составная часть материи
2. масса электрона составляет
3. электрический заряд
4. одинаковый для всех электронов
5. движение электрона
6. зависит от силы
7. создает электрическое поле

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The properties of the electrons do not change with time.
2. All electrons are identical and have permanent mass and velocity.
3. The electron mass is defined as the ratio of the applied force to the rate of change in the electron velocity.
4. The amount of charge is identical for all electrons.
5. The sign of the charge of the electron is positive.
6. The current affects a magnetic field.
7. An electric field applies a force to the first charge.

Exercise 1.3. ***Match the following:***

1. The rate of change is called....
2. The electron is a major constituent of....
3. ...is found to be 9.11×10^{-28} grams.
4. The amount of charge like the mass is.... for all electrons.
5. The charge sets up....
6. ...sets up a magnetic field.
7. Two ways of applying force to an electron are....

Exercise 1.4. ***Translate into English:***

1. Электрон — маленькая, неделимая, основная частица.
2. Свойства электрона не изменяются со временем.
3. Существенные характеристики электрона — масса, заряд.
4. Масса определяется как отношение силы к ускорению.
5. Знак заряда электрона отрицательный.
6. Заряд и масса — два неотделимых аспекта единого целого.
7. Движение электрона зависит от силы, действующей на него.

Exercise 1.5. ***What is:***

a) atom
b) a negatively charged body
c) a positively charged body
d) an electric current

4. Text A

DISCOVERY AN ELECTRON

In the closing years of the 19th century a professor of physics in Cambridge discovered the electron. That was J.J. Thomson. First he was a student and then a lecturer in mathematics at one of the Cambridge colleges. Thomson was a remarkable man. He saw further than his colleagues but even he couldn't **imagine** the **profound** effect of his discovery on the lives of the people in the 20th century. Thomson's discovery **paved the way** for many exciting new discoveries, for example, the discovery of the atomic **nucleus** and the proton by Ernest Rutherford, the discovery of the neutron, and the invention of the **particle accelerator** by Rutherford's pupils.

These discoveries **inspired** the great physicists who were then formulating their revolutionary theories — Planck's quantum theory, Einstein's [ain'stainz] theory of **relativity**, Bohr's model of the atom and others.

Scientists are moving forward towards a better understanding of its laws. Electrons do wonderful things in **calculating** machines, which besides working hundreds of times faster than any human calculator, can hear, see, feel, and touch. It is hard to imagine how we could calculate without using electronic calculating machines. More and more often we hear of scientists' using these machines in new fields. With the help of electronic calculating machines scientists succeeded in reading the language of an ancient people of Mexico.

Memorize the pronunciation of the following words:

to imagine [i'mædʒin] — представить себе
profound [prə'faund] — глубокий
to pave the way — проложить дорогу
nucleus ['nju:kliəs] — ядро
particle accelerator ['pa:tikl æk'seləreitə] — ускоритель частиц
to inspire [in'spaiə] — вдохновлять
relativity [rilə'tiviti] — относительность
to calculate ['kælkjuleit] — вычислять

Answer the questions on the text choosing the appropriate answer:

1. Who discovered the electron?
   a) a professor of chemistry; b) a professor of physics; c) a professor of biology.

2. What was J.J. Thomson?
   a) a lecturer in mathematics; b) a lecturer in chemistry; c) a lecturer in biology.
3. What is Thomson's characteristic feature?
   a) He could not see further than his colleagues;
   b) He was not able to see further than his colleagues;
   c) He saw further than his colleagues.
4. What was the result of Thomson's discovery?
   a) His discovery was not very important;
   b) His discovery paved the way for many new exciting discoveries;
   c) His discovery had no influence on other discoveries.
5. Who discovered the neutron?
   a) Darvin's pupils; b) Newton's pupils; c) Rutherford's pupils.
6. Whom did these discoveries inspire?
   a) the great chemists; b) the great physicists; c) the great biologists.
7. Who formulated quantum theory?
   a) Einstein did; b) Planck did; c) Bohr did.
8. Who formulated theory of relativity?
   a) Planck did; b) Einstein did; c) Bohr did.
9. Who discovered the model of the atom?
   a) Bohr did; b) Einstein did; c) Planck did.

Exercise 1.1. ***Translate into English:***

1. Томсон открыл электрон.
2. Открытие Томсона проложило дорогу многим открытиям.
3. Позднее были сформулированы квантовая теория Планка и теория относительности Эйнштейна.
4. Трудно представить себе нашу жизнь без использования электронных вычислительных машин.
5. Томсон не мог представить себе, какой глубокий эффект окажет открытие электрона.
6. Ученые добились успеха в изучении языка индейцев Мексики.

5. Text C

ELECTRON EMISSION

1. The **electron tube depends** for its action on a **stream** of electrons that act as **current carriers**. To produce this stream of electrons, a special metal **electrode (cathode)** is present in every tube. But at ordinary room temperatures the free electrons in the cathode cannot leave its **surface** because of certain **restraining** forces that act as a **barrier.** These attractive surface forces **tend** to keep the electrons within the cathode substance, except for a small portion that happens to have **sufficient kinetic** energy (energy of motion) to break through the barrier. The majority of electrons move too slowly for this to happen.

2. **To escape** from the surface of the material, the electrons must perform a certain amount of work to **overcome** the restraining surface forces. To do this work, the electrons must have sufficient energy **imparted** to them from some **external** source of energy, since their own kinetic energy is inadequate. There are four principal methods of obtaining electron emission from the surface of the material: thermionic emission, photoelectric emission, field emission, and secondary emission.

3. **Thermionic** emission. It is the most important and one most commonly used in electron tubes. In this method the metal is heated, resulting in increased thermal or kinetic energy of the **unbound** electrons. Thus, a greater number of electrons will **attain** sufficient speed and energy to escape from the surface of the **emitter**. The number of electrons **released** per unit area of an **emitting** surface is related to the absolute temperature of the cathode and quantity of the work an electron must perform when escaping from the emitting surface.

4. The thermionic emission is obtained by heating the cathode electrically. This may be produced in two ways: (1) by using the electrons emitted from the heating spiral for the conduction of current (direct heating) or (2) by arranging the heating spiral in a nickel cylinder **coated** with barium **oxide** which emits the electrons (indirect heating). Normally, the method of indirect heating is used.

5. **Photoelectric emission.** In this process the energy of the light radiation falling upon the metal surface is **transferred** to the free elec-

trons within the metal and speeds them up sufficiently to **enable** them to leave the surface.

6. **Field or cold-cathode emission.** The application of a strong electric field (i.e. a high positive **voltage** outside the cathode surface) will literally pull the electrons out of the material surface, because of the attraction of the positive field. The stronger the field is, the greater the field emission from the cold emitter surface is.

7. **Secondary emission.** When high-speed electrons suddenly strike a metallic surface, they give up their kinetic energy to the electrons and atoms which they strike. Some of the bombarding electrons **collide** directly **with** free electrons on the metal surface and may **knock** them **out** from the surface. The electrons freed in this way are known as secondary emission electrons, since the primary electrons from some other source must be available to bombard the secondary electron-emitting surface.

Memorize the pronunciation of the following words:

electron emission [i'lektron i'miʃn] — электронная эмиссия
electron tube — электронная лампа
to depend [di'pend] — зависеть
stream [stri:m] — поток
carrier of current — носитель тока
electrode [i'lektroud] — электрод
cathode ['kæθoud] — катод
surface ['sə:fis] — поверхность
to restrain [ris'trein] — сдерживать, удерживать
barrier ['bæriə] — препятствие
to tend — стремиться
sufficient [sə'fiʃnt] — достаточный
kinetic [kai'netik] — кинетический
to escape [is'keip] — выходить, вырываться
to overcome [,ouvə'kʌm] — преодолеть
to impart [im'pa:t] — передавать, наделять
external [eks'tə:nl] — внешний
thermionic — термоэлектронный
photoelectric emission — внешний фотоэффект

field emission — автоэлектронная(холодная) эмиссия
secondary emission — вторичная эмиссия
unbound [ʌn'baund] — свободный, несвязанный
to attain [ə'tein] — достигать
to emit [i'mit] — испускать(свет, тепло), излучать
emitter — излучатель, эмиттер
to release [ri'li:s] — освобождаться
coated ['kəutid] — покрытый
oxide ['oksaid] — окись
to transfer [træns'fə:] — передавать
to enable [i'neibl] — давать возможность
voltage ['voltidʒ] — напряжение
to collide with [kə'laid] — сталкиваться
to knock [nok] **out** — выбивать

Answer the questions:

1. What does the action of the electron tube depend on?
2. What is present in every tube to produce the stream of electrons?
3. What temperatures free electrons cannot leave their surface of the cathode at?
4. What forces tend to keep the electrons within the cathode substance?
5. What must the electrons do to escape?
6. What must the electrons have to overcome the restraining surface forces?
7. How many methods for obtaining electron emission are there?
8. What are they?
9. What imparts the external energy to the electrons in thermionic emission?
10. What energy is used for producing free electrons in photoelectric emission?
11. What is field emission?
12. How is secondary emission obtained?
13. What emission is the most commonly used in electronics?

Exercise 1.1. ***Translate the international words:***

Cathode, emitter, material, cylinder, portion, energy, radiation, temperature, thermal, adequate, absolute, special, emission, electron, normally.

Exercise 1.2. ***Find the following words and word combinations in the text:***

1. поток электронов
2. носитель тока
3. удерживающие силы
4. действует как барьер
5. стремятся удержать электрон
6. кинетическая энергия
7. внешний источник энергии
8. электроны ускоряются
9. проводимость тока
10. энергия передается свободным электронам
11. сталкиваются со свободными электронами
12. выбивать с поверхности

Exercise 1.3. ***Translate into English:***

1. В каждой электронной лампе присутствует катод.
2. Большинство электронов перемещаются очень медленно.
3. Кинетическая энергия прорывается сквозь барьер.
4. Чтобы вырваться с поверхности материала, электроны должны преодолеть силу притяжения поверхности.
5. Энергия вырывается с поверхности излучателя.
6. Высокое напряжение «извлекает» электроны с поверхности.
7. Когда электроны ударяются о поверхность металла, они передают кинетическую энергию атомам этого металла.

Exercise 1.4. ***Find the correct answer out of the three given to each question:***

1. Which of the following devices depends for its action on a stream of electrons in vacuum:
   a gas tube, an electron tube, a transistor.
2. Which of the following forces keep the electrons within the emitter substance:
   internal forces, external forces, attractive surface forces.
3. Which of the following kinds of emission depends on increased thermal energy of electrons:
   thermionic emission, secondary emission, field emission.
4. Which of the following kinds of emission depends on a strong field:
   thermionic emission, field emission, photoelectric emission.
5. Which of the methods of emission is the most important and widely used:
   field emission, thermionic emission, photoelectric emission.

Exercise 1.5. ***Finish each sentence choosing one of the three variants:***

1. The electron tube depends for its action on...
   (a) restraining forces; (b) a stream of electrons; (c) a magnetic field.
2. A special metal electrode is present in every tube to produce...
   (a) a magnetic field; (b) a stream of positive charges;
   (c) a stream of electrons.
3. At ordinary room temperatures the "free" electrons in the metallic cathode cannot leave its surface because of...
   (a) attractive forces acting as a barrier;
   (b) forces of the external magnetic field;
   (c) thermal energy of the atoms.
4. A small portion of electrons has sufficient kinetic energy to break through...
   (a) the surface of the tube; (b) the plate substance;
   (c) the surface barrier.

5. To escape from the surface of the cathode, the electrons must have...
   (a) attractive internal force;
   (b) sufficient energy from some external energy source;
   (c) low speed.
6. The energy for electron emission comes from...
   (a) internal sources; (b) external sources;
   (c) external and internal sources.
7. There are...
   (a) two principal methods of obtaining electron emission;
   (b) three principal methods of obtaining electron emission;
   (c) four principal methods of obtaining electron emission.
8. The cathode metal is heated in...
   (a) photoelectric emission; (b) cold-cathode emission;
   (c) thermionic emission.
9. In thermionic emission the cathode is made of...
   (a) metal; (b) semiconductor; (c) an insulator.
10. In thermionic emission the number of released electrons depends on...
    (a) resistance; (b) cooling; (c) temperature.
11. In photoelectric emission the energy of the light falls...
    (a) upon the surface of the non-conducting material;
    (b) into the glass envelope filled with the gas;
    (c) upon the surface of the metal.
12. In photoelectric emission the energy of the light radiation is transferred to...
    (a) free electrons; (b) bound particles; (c) positive charges.
13. In photoelectric emission electrons to which the energy of the light radiation is transferred are...
    (a) on the surface of the metal; (b) in the space about the cathode;
    (c) within the metal.
14. Field emission is...
    (a) hot-cathode emission; (b) photoelectric emission;
    (c) cold-cathode emission.
15. Electrons escape from the cathode surface because of...

(a) the attraction of the positive field;
(b) the attraction of the negative field;
(c) the cooling of the cathode's metal.

16. When high-speed electrons suddenly strike a metallic surface, they give up their kinetic energy to...
(a) electrons; (b) positive particles; (c) positive charges.

17. Some of the bombarding electrons collide directly with...
(a) positively charged particles; (b) uncharged particles;
(c) free electrons.

18. From the surface the bombarding electrons may knock out...
(a) uncharged particles; (b) free electrons; (c) positive charges.

19. The electrons freed by bombarding are known as...
(a) secondary emission electrons;
(b) thermionic emission electrons;
(c) photoelectric emission electrons.

20. The most important and the most commonly used method of emission is...
(a) secondary emission; (b) field emission; (c) thermionic emission.

6. Text B

BRANCHES OF ELECTRICITY

The study of electricity may be **divided** into three classes or **branches: magnetism, electrostatics**, and **electrodynamics**. Magnetism is the **property** of the **molecules** of **iron** and certain other substances through which they **store** energy in a field of force because of the arranged movement of the electrons in their atoms. Electrostatics is the study of electricity at rest, or static electricity. Examples of this type of electricity are charges on condensers plates. Rubbing glass with silk produces static electricity. Electrodynamics is the study of electricity in motion, or dynamic electricity. The electricity, which flows through **wires** for light and power purposes, is a good example of latter type of electricity.

This flow of electricity through a **conductor** is analogous to the flow of water through a **pipe**. A difference of **pressure** at the two ends of the pipe is necessary in order to **maintain** a flow of water. A difference of electric pressure is necessary to maintain a flow of electricity in a conductor. Different substances differ in electrical conductivity because of the ease with which their atoms **give up** electrons. Electrical energy has **intensity** and quantity. Instruments have been devised which can be used to measure it in **amperes** and **volts**.

Memorize the pronunciation of the following words:

to divide [di'vaid] — делить
branch [bra:ntʃ] — отрасль, раздел
magnetism ['mægnitizm] — магнетизм
electrostatics [i'lektro'stætiks] — электростатика
electrodynamics [i'lektrodai'næmiks] — электродинамика
property ['propəti] — свойство
molecule ['molikju:l] — молекула
iron ['aiən] — железо
to store [stɔ:] — сохранить, накопить
wire ['waiə] — провод, проволока
conductor [kən'dʌktə] — проводник
pipe ['paip] — труба
pressure ['preʃə] — давление, напряжение
to give up — бросать
to maintain [men'tein] — поддержать, сохранять
intensity [in'tensiti] — напряженность, интенсивность
ampere ['æmpɛə] — ампер
volt [voult] — вольт

Notes:

through which they store energy in a field of force — благодаря которому они накапливают энергию в силовом поле
arranged movement — направленное движение
at rest — в покое
charges on condenser plates — заряды на пластинках конденсатора
for light and power purposes — для освещения и питания силовых установок

Answer the questions:

1. What are three branches of electricity?
2. What is magnetism?
3. What produces static electricity?
4. What is electrostatics?
5. What is electrodynamics?
6. What is the example of electrodynamics?
7. What are examples of electrostatics?
8. How is a flow of electricity in a conductor maintained?
9. Why do different substances differ in electrical conductivity?
10. What instruments are used to measure electrical energy?

Exercise 1.1. ***Find the following words and word combinations in the text:***

1. делится на три раздела
2. свойство молекул железа
3. сохранять энергию в силовом поле
4. направленное движение электронов
5. движение электрического тока по проводнику
6. разница напряжения
7. атомы теряют электроны
8. электрическая проводимость

Exercise 1.2. ***Form sentences combining suitable parts of the sentences given in columns I and II:***

I	II
1. Magnetism is	the study of electricity at rest
2. The study of electricity is	examples of electrostatics
3. Charges on condenser plates are	examples of electrodynamics
4. The electricity which flows through wires is	divided into branches

5. Electrostatics is	the study of electricity in motion
6. Electrodynamics is	the property of substances to store energy

Exercise 1.3. ***Translate into English:***

1. Магнетизм — это свойство молекул железа сохранять энергию в силовом поле.
2. Электродинамика — это изучение электричества в движении.
3. Электростатика — это изучение электричества в покое.
4. Благодаря магнетизму молекулы железа накапливают энергию в силовом поле.
5. Заряды на пластинках конденсатора — пример электростатики.
6. Поток электрического тока в проводнике можно сравнить с потоком воды в трубе.
7. Чтобы сохранить поток электрического тока в проводнике, необходима разница потенциалов.

Exercise 1.4. ***Explain in English the meaning of the following words:***

1. magnetism
2. electrostatics
3. electrodynamics

7. Text B

ELECTRIC CURRENT

Ever since Volta first produced a **source of continuous current**, men of science have been forming theories on this subject. For some time they could see no real difference between the newly-discovered

phenomenon and the former understanding of **static charges**. Then the famous French scientist **Ampere** (after whom the unit of current was named) **determined** the difference between the current and the static charges. In addition to it, Ampere gave the current direction: he supposed the current to flow from the positive **pole** of the source round the **circuit** and back again to the negative pole.

We **consider** Ampere to be right in his first statement that he was certainly wrong in the second, as to the direction of the current. The student is certain to remember that the flow of current is in a direction opposite to what he thought.

Let us turn our attention now to the electric current itself. The current which flows along wires consists of moving electrons. What can we say about the electron? We know the electron to be a **minute particle** having an electric charge. We also know that that charge is negative. As these minute charges travel along a wire, that wire is said to carry an electric current.

In addition to travelling through **solids**, however, the electric current can flow through **liquids** and even through **gases**. In both cases it produces some most important effects to meet industrial requirements.

Some liquids, such as **melted** metals, for example, **conduct** current without any change to themselves. Others, called **electrolytes**, are found to change greatly when the current passes through them.

When the electrons flow in one direction only, the current is known to be **d.c.**, that is, **direct current**. The simplest source of power for the direct current is a battery, as a battery **pushes** the electrons in the same direction all the time (i.e., from the negatively charged **terminal** to the positively charged terminal).

The letters **a.c.** stand for **alternating current**. The current under consideration flows first in one direction and then in the opposite one. The a.c. used for power and lighting purposes is **assumed** to go through 50 cycles in one second. One of the great **advantages** of a.c. is the **ease** with which **power** at low **voltage** can be changed into an almost similar amount of power at high voltage and vice versa. Hence, on the one hand, alternating voltage is increased when it is necessary for long-distance **transmission** and, on the other hand, one can decrease it to meet industrial **requirements** as well as to operate various **devices** at home.

Although there are numerous cases when d.c. is required, at least 90 per cent of electrical energy to be generated at present is a.c. In fact, it finds wide application for lighting, heating, industrial, and some other purposes.

One cannot help mentioning here that Yablochkov, Russian scientist and inventor, was the first to apply a.c. in practice.

Memorize the pronunciation of the following words:

source [sɔ:s] — источник
continuous current — постоянный ток
phenomenon [fj'nɔmjnən] — феномен
static ['stətik] — статический
charge ['tʃa:dʒ] — заряд
ampere ['æmpɛə] — ампер
to determine [di'tə:min] — определять, решать
pole [poul] — полюс
circuit ['sə:kit] — цепь, схема
to consider [kən'sidə] — считать
minute [mai'nju:t] — крошечный
particle ['pa:tikl] — частица
solid — твердое тело
liquid ['likwid] — жидкость
to melt ['melt] — плавить
gas ['gæs] — газ
requirement [ri'kwaiəmənt] — потребность
to conduct [kən'dʌkt] — проводить
electrolyte — электролит
d.c. (direct current) — постоянный ток
to push ['puʃ] — толкать, продвигать
a.c. (alternating current) — переменный ток
terminal ['tə:minl] — зажим, ввод, выход
advantage [əd'va:ntidʒ] — преимущество
power ['pauə] — мощность, сила
ease ['i:z] — уменьшение, ослабление
voltage ['voltidʒ] — напряжение

to transmit [trænz'mit] — передавать
device [di'vais] — устройство
to assume [ə'sju:m] — принимать, полагать

Answer the questions:

1. Who first produced a source of continuous current?
2. Whom was the unit of current named after?
3. Who determined the difference between the current and the static charges?
4. What did Ampere suppose?
5. What can you say about an electron?
6. What charges do you know?
7. When does a wire carry an electric current?
8. Do liquids conduct current?
9. What can you say about the electrolytes?
10. What do you call d.c.?
11. What is the advantage of a.c.?
12. Where is a.c. used?
13. Who first applied a.c.?
14. What does the current consist of?

Exercise 1.1. *Find the following equivalents in the text:*

1. источник постоянного тока
2. статические заряды
3. направление тока
4. крошечная частица
5. расплавленные металлы
6. постоянный (переменный) ток
7. положительно (отрицательно) заряженный
8. низкое (высокое) напряжение
9. напряжение повышается (понижается)
10. передача на большие расстояния
11. различные устройства
12. применять переменный ток на практике

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Exercise 1.2. *Form sentences combining suitable parts of the sentences given in columns I and II:*

I	II
1. The electric current is	1. the energy of position
2. Kinetic energy is	2. electricity at rest
3. Static energy is	3. the flow of moving electrons
4. Potential energy is	4. the energy of motion
5. The direct current is	5. a discharge of electricity
6. Lightning is	6. the flow of electrons in one direction

Exercise 1.3. *Find the wrong statements and correct them:*

1. Electrons flow from the positively charged terminal of the battery to the negatively charged terminal.
2. Ampere supposed the current to flow from the negative pole to the positive one.
3. Static electricity is used for practical purposes.
4. Static electricity is not very high in voltage and it is easy to control it.
5. Volta took great interest in atmospheric electricity and began to carry on experiments.
6. The direct current is known to flow first in one direction and then in the opposite one.
7. The direct current used for power and lightning purposes is assumed to go through 50 cycles a second.

Exercise 1.4. *Translate into English:*

1. Вольт впервые открыл источник постоянного тока.
2. Единица тока была названа в честь Ампера.
3. Ампер определил разницу между током и статическими зарядами.

4. Ток идет по проводам вокруг цепи от положительного полюса и возвращается к отрицательному.
5. Ток течет в противоположном направлении.
6. Ток — это движение электронов.
7. Крошечные заряды движутся по проводам.
8. Ток может проходить через жидкости и газы.
9. Расплавленные металлы проводят ток.
10. Когда ток проходит через электролиты, они изменяются.
11. Постоянный ток — это однонаправленное движение электронов.
12. Переменный ток — это движение электронов.

Exercise 1.5. ***Explain why:***

1. Static energy cannot be used to light lamps, to boil water, to run electric trains.
2. Voltage is increased and decreased.
3. The unit of electric current is called the volt (ampere).
4. Ampere was wrong as to the current direction.
5. The current is said to flow from the positive end of the wire to its negative end.

8. Text A

UNIT OF ELECTRICAL CURRENT AND CURRENT MEASUREMENT

The electron is an **extremely** small unit, and for this reason it is not a **convenient** unit to use in the **measurement** of electric current or of quantity of electricity. The presence of an electric current in a **circuit** may be **detected** and its **strength** may be measured by a number of different methods. Each method is based upon some effect which the current produces under given conditions.

One of these effects is known as electrolytic **dissociation.** The **properties** of most **conducting liquids** are such that when a direct current is **maintained** in them, the **constituent** elements of the liquid are **separated**. For example, when two copper plates are **dipped** in a solution of copper sulphate and a direct current is maintained in a liquid entering at one plate, the **anode,** and leaving at the other, the **cathode,** metallic copper leaves the solution and is **deposited** on the cathode.

Memorize the pronunciation of the following words:

convenient [kən'vi:njənt] — удобный, подходящий
extremely [iks'tri:mli] — крайне
to measure ['meʒə] — измерять
circuit ['sə:kit] — цепь, схема
to detect [di'tekt] — открывать, обнаруживать
strength ['streŋθ] — сила
dissociation [di'souʃieʃn] — распад, разложение
property ['propəti] — свойство
to conduct [kən'dʌkt] — проводить
liquid ['likwid] — жидкость
to maintain [men'tein] — поддерживать, сохранять
to separate ['seprit] — отделять
constituent [kən'stitjuənt] — избирательный
to dip — погружать
solution [sə'lu:ʃn] — раствор
sulphate ['sʌlfeit] — сульфат
plate [pleit] — пластина
anode ['ænoud] — анод
catode ['kæθoud] — катод
to deposite [di'pozit] — отлагать, давать осадок

Notes:

extremely small unit — чрезвычайно малая единица
and for this reason — и поэтому
by a number of different methods — рядом различных методов
is based upon — основывается на
under given conditions — при данных условиях

are such that — таковы, что
are dipped in — погружены в

Answer the questions:

1. What is an electron?
2. Why is an electron not a convenient unit to use in the measurement of electric current?
4. What can we measure?
3. How may the presence of an electric current in a circuit be detected?
5. What is each method based upon?
6. What is electrolytic dissociation?
7. What are the properties of most conducting liquids?
8. When are the constituent elements of the liquid separated?

Exercise 1.1. *Find the following equivalents in the text:*

1. измерение электрического тока
2. присутствие тока в цепи
3. может быть обнаружено
4. проводящие жидкости
5. ток поддерживается
6. раствор сульфата меди

Exercise 1.2. *Find the wrong statements and correct them:*

1. The electron is an extremely big unit.
2. The electron is a convenient unit to use in the measurement of electric current.
3. The strength of electric current may be measured by several methods.
4. The properties of most conducting liquids are defined by the separation of the constituent elements of the liquid.

Exercise 1.3. ***Translate from Russian into English:***

1. Электрон — чрезвычайно малая единица.
2. Электрон поэтому не является подходящей единицей для измерения тока.
3. Присутствие электрического тока в цепи может быть обнаружено.
4. Сила тока измеряется рядом различных методов.
5. Электролитическая диссоциация — один из эффектов, на которых основываются методы измерения.
6. Свойством проводящих жидкостей является разделение избирательных элементов.
7. Медные пластины погружены в раствор сульфата меди.
8. Медь оседает на катоде.
9. Постоянный ток поддерживается на аноде.

9. Text A

CAPACITY

When two **insulated conductors**, one of which is **charged**, are brought into contact, the charge **spreads** over both con-ductors. The uncharged conductor becomes charged. A larger conductor receives a larger part of the charge. The **potential** of the two conductors becomes the same as soon as they are brought into contact, but the quantity of electricity is not the same on each. The larger portion of the charge is on the larger conductor.

We say that the conductors have not the same **capacity** for electricity. The capacity of the conductor **depends** upon its size.

The capacity of the conductor is **measured** by the quantity of electricity which must be given to it in order to raise its potential to a given **amount**.

From this **definition** it is seen that if the capacity of a conductor increases while the quantity of electricity on it remains constant, its potential will become less.

Condenser. Any arrangement by which the capacity of a conductor is increased artificially is called a *condenser.*

Memorize the pronunciation of the following words:

insulated ['insjuleit] — изолированный
conductor [kən'dʌktə] — проводник
to charge [tʃa:dʒ] — заряжать
to spread [spred] — распространяться
potential [pə'tenʃəl] — потенциал, потенциальный
capacity [kə'pæsiti] — совместимость, способность
to depend [di'pend] — зависеть
to measure ['meʒə] — измерять
amount [ə'maunt] — сумма, количество
definition [defi'niʃn] — определение
condenser [kən'densə] — конденсатор

Notes:

are brought into contact — приводятся в соприкосновение
the charge spreads over — заряд распространяется по
as soon as — как только
is not the same on each — не одно и тоже в каждом из них
the larger portion of the charge — большая часть заряда
depends upon its size — зависит от его размера
remains constant — остается постоянным
becomes less — уменьшается

Answer the questions:

1. When does the charge spread over both insulated conductors?
2. What conductor becomes charged?
3. What part of the charge does a larger conductor receive?
4. When does the potential of the two conductors become the same?

5. What portion of the charge is on the larger conductor?
6. Have conductors the same capacity for electricity?
7. What does the capacity of the conductor depend upon?
8. How is the capacity of the conductor measured by?
9. When will the potential of the conductor become less?
10. What is a condenser?

Exercise 1.1. ***Find the following words and word combinations in the text:***

1. изолированные проводники
2. проводник заряжен
3. незаряженный проводник
4. отличаются по совместимости
5. измеряется
6. чтобы увеличить потенциал
7. согласно этому определению
8. пропускная способность проводника увеличивается
9. пропускная способность проводника искусственно уменьшается

Exercise 1.2. ***Complete the sentences:***

1. When two insulated conductors one of which is..., are brought into contact, the charge...
2. ... becomes the same as soon as they are brought into contact.
3. A larger conductor receives...
4. The capacity of the conductor depends... and is measured by...
5. The potential of the conductor will become less when...
6. A condenser is an arrangement by which the capacity of a conductor is...
7. The charge spreads over both conductors when they...
8. The conductors have...

Exercise 1.3. ***Translate into English:***

1. Заряд распространяется по двум изолированным проводникам, когда они приводятся в соприкосновение.
2. Потенциал обоих проводников становится одинаковым.
3. Незаряженный проводник становится заряженным.
4. Пропускная способность проводника зависит от его размера, поэтому проводники характеризуются различной пропускной способностью.
5. Если пропускная способность конденсатора увеличится, его потенциал уменьшится.

10. Text B

KINDS OF CIRCUITS

Circuits can be **divided** into four classes: **series, parallel**, combination of **series-parallel**, and **network**.

Series circuits are those having only one closed **path** for the flow of electricity. All the elements, or devices, which **make up the circuit**, are connected **in tandem**, one after the other, so that the end of one is connected to the beginning of the other; or, in other words, the positive terminal of one is connected to the negative terminal of another. If the series circuit **is opened anywhere**, the current will not flow through the circuit.

A parallel circuit is one divided into two or more branches, each branch carrying part of the current. **Another way of saying** the same thing is that all the elements or devices are connected so that one half of the terminals is fastened **to a common point** or a common conductor, and the other half is **fastened** to another common point, or another conductor.

Notes:

make up the circuit — образует цепь
in tandem — последовательно

is opened anywhere — разомкнуть где-нибудь
another way of saying — иначе говоря
to a common point — к общей точке

Memorize the pronunciation of the following words:

circuit ['sə:kit] — цепь, схема
series ['siəri:z] — последовательная
to devide [di'vaid] — делить
parallel ['pærəlel] — параллельная
network — сеть, сетевой
series-parallel — последовательно-параллельная
path [pa:θ] — путь
to fasten ['fa:sn] — прикреплять

Answer the questions:

1. What classes can circuits be divided into?
2. What are series circuits?
3. How are devices, which make up the circuit, connected?
4. When does the current not flow through the circuit?
5. What is a parallel circuit?

Exercise 1.1. *Find the following equivalents in the text:*

1. цепи можно разделить
2. близкий путь
3. соединены последовательно
4. подсоединен к началу
5. положительный (отрицательный) зажим
6. разделена на ответвления
7. прикреплены к общей точке
8. общий проводник

Exercise 1.2. *Find the wrong statements and correct them:*

1. There are 4 branches of circuits: series, parallel, combination of series-parallel.
2. The positive terminal of a device is connected to the positive terminal of the second one.
3. Devices in the series circuits aren't connected in tandem.
4. The current flows through the circuit if the series circuit is opened anywhere.
5. Each branch of a parallel circuit carries part of the current.
6. Two halves of the terminals are fastened to different common conductors.

Exercise 1.3. *Match the following:*

1. ... has only one closed path for the flow of electricity.
2. Devices making up the circuit are connected in ...
3. The positive terminal is connected to the ...
4. ... is divided into two or more branches.
5. ... are fastened to various common points.

a) a parallel circuit.
b) negative terminal.
c) terminals.
d) a series circuit.
e) tandem.

Exercise 1.4. *Translate into English:*

1. Параллельная цепь состоит из нескольких ответвлений, каждое из которых пропускает ток.
2. Зажимы подсоединены к общим проводникам.
3. Последовательная цепь имеет только один путь для прохождения тока.
4. Элементы цепи соединены последовательно, то есть конец одного к началу другого.

5. В последовательной цепи положительный зажим подсоединен к отрицательному.

11. Text C

ELECTRIC CIRCUIT

The electric **circuit** is the subject to be dealt with in the present article. But what does the above term really mean? We know the circuit to be a complete path, which carries the current from the **source** of **supply** to the **load** and then carries it again from the load back to the source.

The purpose of the electrical source is to produce the necessary electromotive force required for the flow of current through the circuit.

The path along which the electrons travel must be complete **otherwise** no electric power can be supplied from the source to the load. Thus we close the circuit when we switch on our electric lamp.

If the circuit is broken or, as we generally say, "opened" anywhere, the current is known to stop everywhere. **Hence**, we break the circuit when we switch off our electrical devices. Generally speaking, the current may **pass** through **solid conductors, liquids**, gases, **vacuum**, or any combination of these. It may flow in turn over **transmission** lines from the power-stations through transformers, **cables** and switches, through lamps, heaters, motors and so on.

There are various kinds of electric circuits such as open circuits, closed circuits, **series** circuits, **parallel** circuits and short circuits.

To understand the difference between the following circuit connections is not difficult at all. When electrical devices are **connected** so that the current flows from one device to another, they are said to be connected in series. Under such conditions the current flow is the same in all parts of the circuit, as there is only a single **path** along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit. The parallel circuit provides two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path, and part through another. The lamps in your room and your house are generally connected in parallel.

Now we shall turn our attention to the short circuit sometimes called "the short". The short circuit is produced when the current is allowed to return to the source of supply without control and without doing the work that we want it to do. The short circuit often results from cable **fault** or wire fault. Under certain conditions, the short may cause fire because the current flows where it was no supposed to flow. If the current flow is too great, a **fuse** is to be used as a **safety** device to stop the current flow.

The fuse must be placed in every circuit where there is a danger of **overloading** the line. Then all the current to be sent will pass through the fuse.

When a short circuit or an overload causes more current to flow than the carrying capacity of the wire, the wire becomes hot and sets fire to **the insulation**. If the flow of current is great than the carrying capacity of the fuse, the fuse **melts** and opens the circuit.

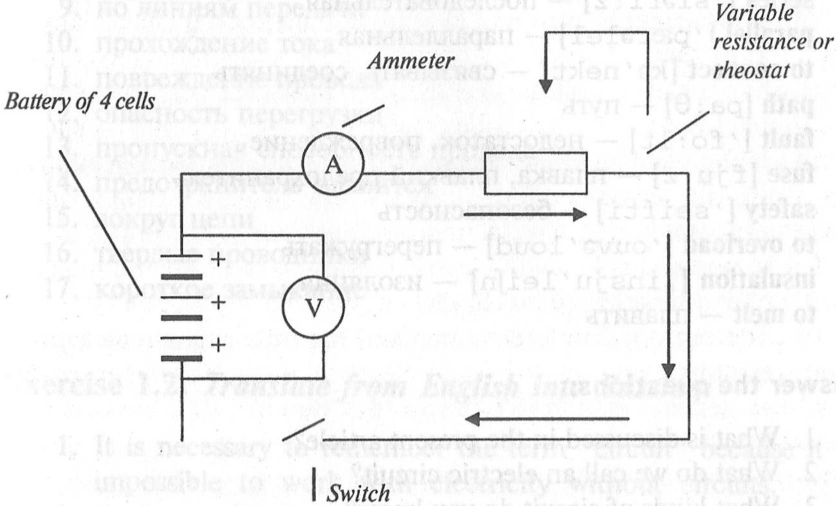

Figure 1. A Simple Electric Circuit

A simple electric circuit is illustrated in Figure. In this figure a 4-cell battery has been used, the switch being in an open position. If the switch is in closed position, the current will flow around the circuit in the direction shown by the arrows.

Memorize the pronunciation of the following words:

circuit [ˈsəːkit] — цепь
source [ˈsoːs] — источник
supply [səˈplai] — подача, питание
to load [loud] — грузить, загружать, нагружать
otherwise [ˈʌðəwaiz] — иначе, в противном случае
hence [ˈhens] — следовательно
to pass — проходить
solid — твердый, крепкий
conductor [kənˈdʌktə] — проводник
liquid [ˈlikwid] — жидкость
vacuum [ˈvækjuəm] — вакуум, пустота
transmission [trænzˈmiʃn] — передача
cable [ˈkeibl] — кабель
series [ˈsiəriːz] — последовательная
parallel [ˈpærəlel] — параллельная
to connect [kəˈnekt] — связывать, соединять
path [paːθ] — путь
fault [ˈfoːlt] — недостаток, повреждение
fuse [fjuːz] — плавка, плавкий предохранитель
safety [ˈseifti] — безопасность
to overload [ˈouvəˈloud] — перегружать
insulation [ˌinsjuˈleiʃn] — изоляция
to melt — плавить

Answer the questions:

1. What is discussed in the present article?
2. What do we call an electric circuit?
3. What kinds of circuit do you know?
4. When is a "short" produced?

5. What does a short circuit often result from?
6. What safety device is used when the current in the circuit is too great?
7. What do we mean by the term "short circuit"?
8. What does the term "closed circuit" mean?
9. Why does the current flow when the circuit is closed?
10. What do you call a fuse?
11. Does the current flow when the switch is in an open position?

Exercise 1.1. ***Find the following equivalents in the text:***

1. электрическая цепь
2. проводит ток
3. источник питания
4. включать лампу
5. закрыть цепь
6. ток исчезает
7. выключать цепь
8. выключать электроприборы
9. по линиям передачи
10. прохождение тока
11. повреждение провода
12. опасность перегрузки
13. пропускная способность провода
14. предохранитель плавится
15. вокруг цепи
16. твердые проводники
17. короткое замыкание

Exercise 1.2. ***Translate from English into Russian:***

1. It is necessary to remember the term "circuit" because it is impossible to work with electricity without circuits.
2. A short circuit may cause wire fault because of cable fault.

3. Travelling through solids, the electric current can flow through liquids and gases.
4. The magnitude of the current as well as the voltage and resistance may vary from a small amount to a very large quantity.
5. When a cold object and a hot one are brought into contact, the former gets warmer and the latter gets colder.
6. Fuses are used for safety devices.

Exercise 1.3. ***Complete the statements choosing the appropriate answer:***

1. The circuit is a complete path which carries the current from the source of supply to the ...
   a) liquid.
   b) load.
   c) vacuum.
2. The circuit is closed when we ... an electric lamp.
   a) switch off
   b) open
   c) switch on
3. The current is known to stop when the circuit is ...
   a) broken.
   b) opened.
   c) closed.
4. If the current flows from one device to another, the devices are connected in ...
   a) parallel.
   b) series.
   c) combination of two kinds.
5. The current flow is the same and has only a single path in ... circuit.
   a) series
   b) parallel
6. ... circuit provides several paths for the passage of current.
   a) parallel
   b) series

Exercise 1.4. ***Translate from Russian into English:***

1. Цель электрического источника — генерировать силу для прохождения тока по цепи.
2. Цепь закрывается, когда включается электрическая лампа.
3. Если цепь выключается, ток исчезает.
4. Последовательная цепь характеризуется одним путем прохождения тока, а параллельная — несколькими.
5. Примером последовательной цепи является электрический звонок.
6. Примером параллельной цепи является лампа.
7. «Короткая» цепь образуется, когда ток возвращается к источнику питания вхолостую.
8. Короткое замыкание возникает из-за повреждения проводки.
9. Во время короткого замыкания пропускная способность провода меньше, чем поток электронов.
10. Предохранитель в цепи помогает избежать опасности перегрузки линии.

Exercise 1.5. ***Speak on difference between:***

1. Closed circuits and open circuits.
2. Series circuits and parallel circuits.
3. Fuses and switches.

12. Text B

MEASURING DEVICES

Ammeters and **Voltmeters**. Ammeters measure the current flowing in a circuit and normally have **scales**, which are **graduated** or **calibrated in amperes**, milliamperes or microamperes.

Voltmeters are used to measure the **potential** difference between two points in a circuit. The calibration of voltmeters is usually in **volts**, millivolts, or microvolts.

The main difference between the two instruments of the same type or design is in the **resistance** of the operating coil; **identical** moving units may be used for either meter. An ammeter is connected in the positive or negative lead in series with a circuit and, therefore, must have a low resistance **coil**; otherwise the readings would be incorrect, as the coil would **absorb** an **appreciable** amount of power.

A voltmeter is connected in parallel across the points of a circuit where the difference of potential is to be measured. The resistance of the operating coil must, in this instance, be as high as possible, to limit the amount of current **consumed** by it, or else a drop in potential due to the meter would **occur** and the pointer **indication** would not represent the true potential difference across the circuit.

Wattmeters. The measurement of the power in a D. C. circuit at any instant can be **achieved** by means of an ammeter and voltmeter, as the power in **watts** is the product of the current and the **voltage**. With A. C. circuits, however, the **instantaneous values** are always changing. To measure A. C. power correctly, therefore, it is necessary to use the third instrument to measure the phase difference. The normal practice, however, is to combine these three instruments in one which will give a direct reading of power in watts.

The most commonly used **apparatus** for measuring **insulation** resistance is the **megohmmeter** or "megger". The device is easy to handle. It consists of a hand-driven generator in a permanent magnet frame, which causes a moving coil to register the insulation resistance in **ohms** or **megohms**, the amount of which is indicated by a pointer.

The "megger" is also used for continuity, ground, and shot-circuit testing in general electrical power work.

Notes:

the device is easy to handle — прибор удобен в эксплуатации
hand-driven — приводимы в движение рукой
permanent magnet frame — каркас постоянного магнита
is used for continuity, ground and short-circuit testing — используется для проверки непрерывности, заземления и короткого замыкания

Memorize the pronunciation of the following words:

ammeter ['æmi:tə] — амперметр
voltmeter ['voultmi:tə] — вольтметр
scale [skeil] — масштаб, размер
to graduate ['grædjueit] — градуировать, наносить деления
to calibrate ['kælibreit] — градуировать
ampere ['æmpεə] — ампер
potential [pə'tenʃəl] — потенциал
volt [voult] — вольт
resistance [ri'zistəns] — сопротивление
identical [ai'dentik(ə)l] — тождественный
coil [koil] — катушка, спираль
to absorb [əb'so:b] — поглощать, всасывать
appreciable [ə'pri:ʃəbl] — заметный, ощутимый
to consume [kən'sju:m] — потреблять, расходовать
to occur [ə'kə:] — случаться
indication [,indi'keiʃn] — указание
to achieve [ə'tʃi:v] — достигать, выполнять
watt [wŏt] — ватт
instantaneous [,instən'teinjəs] — мгновенный
value ['vælju:] — значение
voltage ['voltidʒ] — напряжение
to combine [kəm'bain] — комбинировать, сочетать
apparatus [,æpə'reitəs] — прибор
insulation [,insju'leiʃn] — изоляция
megohmmeter — мегомметр, мегер
ohm [oum] — ом
megohm — мегом

Answer the questions:

1. What kinds of measuring devices do you know?
2. What do ammeters measure?
3. What units of measuring have ammeters?
4. What do voltmeters measure?
5. What is the calibration of voltmeters?
6. What is the difference between ammeters and voltmeters?

7. How is an ammeter connected?
8. What resistance coil has an ammeter?
9. How is a voltmeter connected?
10. What resistance has a voltmeter?
11. Why must the resistance of a voltmeter be high?
12. Why would a drop in potential occur?
13. Why does the pointer indication represent wrong data?
14. What do wattmeters measure?
15. What do megohmmeters measure?
16. What does a megohmmeter consist of?
17. What is a megohmmeter used for?

Exercise 1.1. ***Find the following equivalents in the text:***

1. измеряют силу тока
2. измеряется в амперах
3. используются для измерения
4. разница потенциалов
5. сопротивление катушки
6. соединен последовательно
7. достигается посредством
8. мощность в ваттах
9. цепь постоянного тока
10. цепь переменного тока
11. легко управляемый
12. указательная стрелка
13. для измерения изоляции сопротивления
14. разница фаз

Exercise 1.2. ***Find the wrong statements and correct them:***

1. Voltmeters measure the potential difference between two points in a circuit.
2. Ammeters measure the power in a D. C. circuit.

3. An ammeter is connected in parallel.
4. A voltmeter is connected in series.
5. A wattmeter measures A. C. power.
6. A megohmmeter is used for measuring insulation resistance.
7. A megohmmeter registers the insulation resistance in amperes.

Exercise 1.3. ***Translate into Russian:***

1. Амперметры измеряют силу тока в амперах.
2. Вольтметры измеряют разницу потенциалов между двумя точками в цепи в вольтах.
3. Разница между амперметром и вольтметром заключается в сопротивлении катушки.
4. Амперметр подсоединен в проводнике последовательно.
5. Вольтметр подсоединен параллельно через участки цепи, где должна измеряться разница потенциалов.
6. Ваттметр измеряет мощность переменного тока.
7. Измерение силы постоянного тока осуществляется посредством амперметра и вольтметра.
8. Мегомметр — прибор для измерения изоляции сопротивления.

Exercise 1.4. ***What is:***

1. A voltmeter.
2. An ammeter.
3. A wattmeter.
4. A megohmeter.

13. Text B

HOW ELECTRICAL ENERGY IS PRODUCED

There are several methods of **producing** electricity for practical **purposes**. The **battery** of a **pocket torch** may be **contrasted** with the **source** of **enormous** energy represented by a larger **power station**. Both are examples of electrical energy **application** to a particular purpose, and in general the purpose **determines the nature of the method** used to produce the energy.

Practical methods of producing electricity may be enumerated as follows:

1. **Chemical**, as represented by the **various** types of batteries or **primary cells** in which the electricity is produced **by purely chemical actions**.
2. **Electromagnetic**, forming the basis of **rotating** generators operation in which the electricity is produced by conductors **moving through a magnetic field**. This is the method **employed** in practice for generators of various sizes.
3. **Thermo-electric**, in which **the heating** of the **junction** between two different metals produced a very small voltage, which may be used for purposes of temperature measurement and as a source of power.
4. **Piezo-electric**, in which a very small voltage is produced **across certain faces of a crystal** by applications of mechanical **pressure**. This effect is used, for example, **as a means** of frequency control in radio **oscillators** or **for gramophone pick-ups**, but it is not suitable for power supply.
5. **Electronic, characterized** by the **flow** of electron **through evacuated or gas-filled tubes**, and having the following forms:

a) **Thermionic emission**, in which the electrons are produced by the heating of special materials.

b) **Photo-electric** emission, in which electrons **are liberated at the surface** of certain **substances by the action of light**.

c) **Secondary emission**, in which electrons **are driven from** a material **by the impact of** electrons or other **particles** on its surface.

d) **Field emission**, in which electrons are drawn from the surface of a metal by the applications of very powerful electric fields.

Notes:

pocket torch — карманный фонарь
power station — электростанция
the nature of the method — характер метода
primary cells — гальванические элементы
by purely chemical actions — чисто химическими реакциями
moving through a magnetic field — движущиеся в магнитном поле
across certain faces of a crystal — на определенных гранях кристалла
as a means — как средство
for gramophone pick-ups — для патефонных звукоснимателей
through evacuated or gas-filled tubes — в вакуумных или газонаполненных лампах (трубах)
are liberated at the surface — высвобождаются с поверхности
by the action of light — под воздействием света
are driven from — выбиваются
by the impact of — столкновением, ударом
it may be pointed out — можно отметить

Memorize the pronunciation of the following words:

to produce [,prəd'ju:s] — производить, вырабатывать
purpose ['pə:pəs] — цель
battery ['bætəri] — батарея
to contrast [kən'træst] — противопоставлять, контрастировать
source [so:s] — источник
enormous [i'no:məs] — огромный
application [,æpli'keiʃn] — применение
to determine [di'tə:min] — определять, устанавливать
various ['vεəriəs] — различный
cell [sel] — элемент
chemical ['kəmikəl] — химический
electromagnetic — электромагнитный
to rotate [rou'teit]— вращать
to employ [im'ploi] — применять, использовать
thermo-electric — термоэлектрический
junction ['dʒʌnkʃn] — соединение, стык

to heat [hi:t] — плавить
piezo-electric — пьезоэлектрический
pressure ['preʃə] — давление, напряжение
oscillator ['osileitə]— генератор, осциллятор, вибратор
to characterize ['kæriktəraiz] — характеризовать
flow [flou] — поток
thermionic — термоэлектронный
emission [i'miʃn]— выделение, излучение, эмиссия
photoelectric — фотоэлектрический
to liberate ['libəreit] — освобождать
surface ['sə:fis] — поверхность
substance ['sʌbstəns] — вещество, материя
secondary emission — вторичная эмиссия
impact ['impækt] — удар, столкновение
field emission — автоэлектронная (холодная) эмиссия
particle ['pa:tikl] — частица

Answer the questions:

1. What are examples of the application of electrical energy?
2. What determines the nature of the method of producing electricity?
3. What are practical methods of producing electricity?
4. How is chemical method represented by?
5. How is electricity produced by chemical method?
6. Where is electromagnetic method employed?
7. How is electricity produced by electromagnetic method?
8. What is thermo-electric method?
9. What purposes may a small voltage be used for?
10. How is a small voltage produced by piezo-electric method?
11. How is electronic method characterized?
12. What are forms of electronic method?

Exercise 1.1. *Find the following equivalents in the texs:*

1. несколько методов
2. выработка электрической энергии
3. практические цели

4. батарейка карманного фонарика
5. источник энергии
6. применение электрической энергии
7. определяет характер метода
8. для выработки энергии
9. химические реакции
10. применяется на практике
11. вращение генератора
12. низкое напряжение
13. механическое давление
14. средство регулирования частоты
15. поток электронов
16. плавка металлов
17. стык между металлами
18. мощные электрические поля
19. в результате столкновения электронов с поверхностью

Exercise 1.2. ***Find the wrong statements and correct them:***

1. Electrical energy determines the nature of the method used to produce the energy.
2. The electricity using chemical method is produced in primary cells by chemical actions.
3. Due to electromagnetic method the electricity is produced in generators by operation of conductors moving through a magnetic field.
4. In thermo-electric method a very small voltage is produced across faces of a crystal by applications of a mechanical pressure.
5. In piezo-electric method a very small voltage is produced by the heating of the junction between two metals.
6. Piezo-electric method is employed in practice for various generators.
7. Chemical method is used for purposes of temperature measurement.

8. Electronic method is used as a means of frequency control.
9. In thermionic emission electrons are liberated at the surface of substances by the action of light.

Exercise 1.3. ***Translate into English*:**

1. Существует несколько методов выработки электроэнергии.
2. Цель определяет характер метода, который используется для производства электроэнергии.
3. Химический метод представлен различными видами батареи или гальванических элементов, в которых электричество вырабатывается с помощью химических реакций.
4. При пьезоэлектрическом методе электричество вырабатывается при применении механического давления на определенных гранях кристалла.
5. Термоэлектрический метод характеризуется плавкой на стыке металлов.
6. При применении электронного метода электроны движутся в вакуумных или газонаполненных лампах.
7. Эффект использования механического давления применяется как средство для регулирования частоты в радио осцилляторах и для патефонных звукоснимателей.
8. Электричество в генераторах вырабатывается проводниками, движущимися в магнитном поле.
9. При фотоэлектрической эмиссии электроны высвобождаются с поверхности вещества под воздействием света.
10. При холодной эмиссии электроны выбиваются с поверхности металла под воздействием мощных электрических полей.

Exercise 1.4. ***Give definitions to the following*:**

1. Electromagnetic method.
2. Chemical method.

3. Thermo-electric method.
4. Piezo-electric method.
5. Electronic method.
6. Thermionic emission.
7. Photo-electric emission.
8. Field emission.
9. Secondary emission.

14. Text B

MAGNETIC EFFECT OF AN ELECTRIC CURRENT

The invention of the **voltaic cell** in 1800 gave electrical experimenters a **source** of a **constant** flow of a current. Seven years later the Danish scientist and experimenter, Oersted, decided to establish the relation between a flow of current and a magnetic needle. It took him at least 13 years more to find out that a compass needle is **deflected** when brought near a wire through which the electric current flows. At last, during a lecture he adjusted, by chance, the **wire** parallel to the needle. Then, both he and his class saw that when the current was **turned on**, the needle deflected almost at right **angles towards** the **conductor**. As soon as the direction of the current was **reversed**, the direction of the needle pointed in was reversed too.

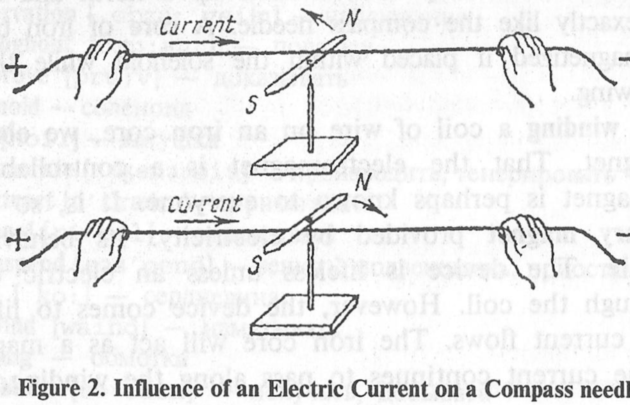

Figure 2. Influence of an Electric Current on a Compass needle

As seen in Figure 1, the north end of the needle moves away from us when the current flows from left to right. Oersted also pointed out that provided the wire were **adjusted** below the needle, the deflection was reversed.

The above-mentioned phenomenon highly interested Ampere who repeated the experiment and added a number of **valuable observations** and statements. He began his research under the influence of Oersted's discovery and carried it on **throughout** the rest of his life.

Everyone knows the rules thanks to which we can always find the direction of the magnetic effect of the current. It is known as Ampere's rule. Ampere established and **proved** that magnetic effects could be produced without any magnets by means of electricity alone. He turned his attention to the behaviour of the electric current in a single straight conductor and in a conductor that is formed into a **coil**, i.e. a **solenoid**.

When a wire conducting a current is formed into a coil of several turns, the amount of magnetism is greatly increased.

It is no difficult to understand that the greater the number of turns of wire, the greater is the m.m.f. (that is magnetomotive force) produced within the coil by any constant amount of current flowing through it. In addition, when doubling the current, we double the magnetism **generated** in the coil.

A solenoid has two poles, which **attract and repel** the poles of other magnets. While **suspended**, it takes up a north and a south direction exactly like the compass needle. A **core** of iron becomes strongly magnetized if placed within the solenoid while the current is flowing.

When **winding** a coil of wire on an iron core, we **obtain** an electromagnet. That the electromagnet is a controllable and **reliable** magnet is perhaps known to everyone. It is, so to say, a **temporary magnet** provided by electricity. Its behaviour is very simple. The device is lifeless unless an electric current flows through the coil. However, the device comes to life provided the current flows. The iron core will act as a magnet as long as the current continues to pass along the winding.

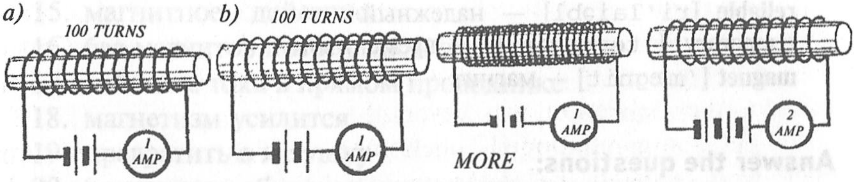

Figure 3. The dependence of the amount of magnetism on the number of wire turns and the strength of the current:
a) the number of wire turns in the coil affects the magnetic strength; b) the strength of the current through the coil influences the magnetic strength of the coil

Memorize the pronunciation of the following words:

voltaic [vol'teiik] — гальванический
cell [sel] — элемент
source [sɔ:s] — источник
constant ['konstənt] — постоянный
to deflect [di'flekt] — отклонять
wire ['waiə]— провод, проволока
to turn on — открыть, включить
angle ['æŋgl] — угол
towards [tə'wo:dz] — по направлению, по отношению
conductor [kən'dʌktə] — проводник
to reverse [ri'və:s] — переставлять, переворачивать, отменить
to adjust [ə'dʒʌst] — регулировать, устанавливать, приспособлять
valuable ['væljuəbl] — ценный
observation [,obzə:'veiʃn] — наблюдение
throughout [θru:aut] — повсюду
to prove [pru:v] — доказывать
solenoid — соленоид
coil [koil]— катушка
to generate ['dʒenəreit] — производить, генерировать
to attract [ə'trækt] — притягивать
to repel [ri'pel] — отталкивать
to suspend [səs'pend] — вешать, подвешивать, приостанавливать
core [ko:] — сердцевина
to wind [waind] — наматывать
winding — обмотка
to obtain [əb'tein]— получать, добывать

reliable [rɪ'laɪəbl] — надежный
temporary ['tempərərɪ] — временный
magnet ['mægnɪt] — магнит

Answer the questions:

1. When was the voltaic cell invented?
2. What did the invention of the voltaic cell give?
3. What did Oersted decide to establish?
4. What did he find out?
5. When did the needle deflect?
6. Who repeated Oersted's experiment?
7. Do you know Ampere's rule?
8. What did Ampere establish and prove?
9. When is magnetism greatly increased?
10. Is the magnetic effect produced when the charges are at rest?
11. What is an electromagnet?
12. When does the iron core act as a magnet?

Exercise 1.1. *Find the following equivalents in the text:*

1. гальванический элемент
2. источник постоянного тока
3. зависимость между потоком тока и намагниченной иглой
4. стрелка отклоняется
5. находится около проволоки
6. через которую проходит ток
7. проволока параллельна игле
8. ток возник
9. под прямым углом
10. помещена под иглой
11. отклонение стрелки
12. ценные наблюдения
13. под влиянием
14. благодаря которому

15. магнитное действие
16. без магнитов посредством электричества
17. действие тока в прямом проводнике
18. магнетизм усилится
19. превратить в катушку
20. количество оборотов проволоки
21. внутри катушки
22. притягивают и отталкивают полюса магнитов
23. компасная стрелка
24. указывать в северном/южном направлении
25. сильно намагничивается
26. железная сердцевина
27. принцип действия прост
28. устройство оживает
29. действует как магнит
30. проходит по обмотке

Exercise 1.2. ***Choose the right answer:***

1. The invention of the voltaic cell gave electrical experimenters a source of ...
   a) alternating current.
   b) constant current.
2. Oersted decided to establish the relation between ...
   a) a flow of current and a magnetic needle.
   b) a flow of current and a conductor.
   c) a magnet and a magnetic needle.
3. A compass needle is deflected when brought near wire through which ...
   a) the current was reserved.
   b) the current flows.
4. The north end of the needle moves away when the current flows ...
   a) from left to right.
   b) from right to left.
   c) towards the conductor.

5. Magnetic effect can be produced without any ...
   a) needles.
   b) magnets.
6. Ampere studied ...
   a) the deflection of the needle.
   b) the behaviour of the current in a single straight conductor.
7. When a wire conducting a current is formed into a coil of several turns, the amount of magnetism ...
   a) is greatly decreased.
   b) is greatly increased.
8. The iron core acts as a magnet ...
   a) when the current passes along the winding.
   b) while the current is flowing within the winding.
   c) we double the current.

Exercise 1.3. ***Fill in the blanks with the suitable words given below:***

where, which, when, who, that

1. We know ... Oersted established the relation between the flow of electric current and a magnetic needle.
2. The great scientists Volta, Ampere, and Yablochkov may be named among those ... have greatly contributed to electrical engineering.
3. The end ... the lines of force leave the coil after passing through its core will act like a north magnetic pole.
4. ... there is a certain connection between electricity and magnetism was proved by experiments.
5. ... he placed the wire parallel to the needle, he saw ... the needle deflected.
6. A wire ... is wound in the form of a solenoid acts like a magnet as long as it is carrying a current.

Exercise 1.4. ***Translate into English:***

1. Датский ученый установил зависимость между потоком тока и намагниченной иглой.

2. Он обнаружил, что стрелка отклоняется около проволоки, через которую проходит электрический ток.
3. Стрелка отклонилась к проводнику под прямым углом.
4. Направление тока изменилось.
5. Когда возник ток, стрелка отклонилась.
6. Ток течет слева направо.
7. Когда проволока находится ниже стрелки, направление стрелки меняется.
8. Магнитное действие возникает под воздействием электричества.
9. Магнетизм тока усиливается в катушке.
10. Соленоид действует как компасная стрелка.
11. Электромагнит получается при обмотке катушки.
12. Ток проходит через катушку вдоль обмотки.
13. Катушка действует как магнит.
14. Сердцевина сильно намагничивается.

15. Text B

CONDUCTORS AND INSULATORS

All **substances** have some **ability** of **conducting** the electric current, however, they **differ** greatly in the **ease** with which the current can pass through them. Metals, for example, conduct electricity with ease while **rubber** does not allow it to flow freely. Thus, we have conductors and **insulators**.

What do the terms "conductors" and "insulators" mean? Substances through which electricity is easily **transmitted** are called conductors. Any material that strongly **resists** the electric current flow is known as an insulator.

Let us first turn our attention to conductivity that is the conductor's ability of passing electric charges. The four factors, conductivity **depends on**, are: the size of the wire used, its length and temperature as well as the kind of material to be employed.

It is not difficult to understand that a large water pipe can pass more water than a small one. In the same manner, a large conductor will **carry** the current more readily than a thinner one.

It is quite understandable, too, that to flow through a short conductor is certainly easier for the current than through a long one in spite of their being made of **similar** material. Hence, the longer the wire, the greater is its opposition, that is resistance, to the passage of current.

As mentioned above, there is a great difference in the conducting ability of **various** substances. For example, almost all metals are good electric current conductors. Nevertheless, **copper** carries the current more freely than **iron**; and silver, in its turn, is a better conductor than copper.

Generally speaking, copper is the most widely used conductor. That is why the electrically operated devices in your home are connected to the wall **socket** by copper wires. Indeed, if you are reading this book by an electric lamp light and somebody **pulls** the metal wire **out** of the socket, the light will go out at once. The electricity has not been turned off but it has no **path** to travel from the socket to your electric lamp. The flowing electrons cannot travel through space and get into an electrically operated device when the circuit is broken. If we use a piece of **string** instead of metal wire, we shall also find that current stops flowing.

A material like string which resists the flow of the electric current is called insulator.

There are many kinds of insulation used **to cover** the wires. The kind used depends upon the purposes the wire or a cord is meant for. The insulating materials we generally use to cover the wires are rubber, **asbestos**, glass, **plastics** and others.

Rubber covered with cotton, or rubber alone is the insulating material usually used to cover desk lamp cords and radio cords.

Glass is the insulator to be often seen on the poles that carry the telephone wires in city streets. Glass insulator strings are usually suspended from the towers of high voltage transmission lines. One of the most important insulators of all, however, is air. That is why power transmission line wires are **bare** wires depending on air to keep the current from **leaking off**.

Conducting materials are by no means the only materials to play an important part in electrical engineering. There must certainly be a conductor, that is a path, along which electricity is to travel and there must be insulators keeping it from leaking off the conductor.

Memorize the pronunciation of the following words:

substance [ˈsʌbstəns] — вещество, материя
ability [əˈbiliti] — способность
to conduct [kənˈdʌkt] — проводить
to differ [ˈdifə] — различаться
ease [ˈi:z] — легкость
rubber [ˈrʌbə] — резина
insulator [ˈinsjuleitə] — изолятор
to transmit [trænzˈmit] — передавать
to resist [riˈzist] — сопротивляться
to depend on [diˈpend] — зависеть
to carry [ˈkæri] — проводить, носить
similar [ˈsimilə] — подобный, похожий
various [ˈvɛəriəs] — различный
copper [ˈkopə] — медь
iron [ˈaiən] — железо
socket [ˈsokit] гнездо, патрон, розетка
path [pa:θ] — путь
to pull out — вытаскивать
string — веревка
to cover [ˈkʌvə] — покрывать
asbestos [æzˈbestəs] — асбест
plastics [ˈplæstiks] — пластмасса
bare [bɛə] — голый
to leak off [ˈlik] — течь, пропускать

Answer the questions:

1. Do all substances conduct the electric current easily?
2. What is a conductor?

3. What does conductivity depend upon?
4. What materials are the best conductors of electricity?
5. Does temperature influence the conductor's resistance?
6. What feature of the conductor is illustrated here?
7. What is the difference between a conductor and an insulator?
8. What insulators do you know?
9. Why are power transmission line wires bare?
10. What insulation is on the cords of your electrical devices used?

Exercise 1.1. ***Find the following equivalents in the text:***

1. способность проводить электрический ток
2. сильно различаются
3. ток проходит
4. сопротивляется электрическому току
5. проводимость зависит от
6. размер, длина, температура провода
7. несмотря на то, что сделаны из подобного материала
8. разница в пропускной способности
9. вытаскивать провод из розетки
10. вместо проволоки
11. сопротивляется потоку электронов
12. линии передач
13. голые провода
14. проводящие материалы
15. вышки высокого напряжения

Exercise 1.2. ***Find the wrong statements and correct them:***

1. Some substances have an ability of conducting the electric current.
2. All substances differ greatly in the ease with which the current can pass through them.

3. Substances that conduct electricity are called insulators.
4. Substances that resist the electric current flow are called conductors.
5. The conductivity depends on the size of the wire used, its shape and temperature.
6. All metals are bad electric current conductors.
7. Copper carries the current more freely than iron.
8. Copper is a better conductor than silver.
9. The flowing electrons cannot get into a device when the circuit is broken.
10. While using a piece of string instead of a metal wire, the current stops flowing.
11. The insulators are rubber, plastics, and glass.
12. One of the most important conductors is air.

Exercise 1.3. ***Translate into English:***

1. Все вещества имеют способность пропускать ток.
2. Металлы пропускают электричество.
3. Проводники — это материалы, через которые легко проходит электрический ток.
4. Изоляторы сопротивляются потоку электрического тока.
5. Если мы используем веревку вместо проволоки, ток исчезает.
6. Стекло как изолятор можно часто видеть на телефонных проводах.
7. Изоляционные материалы покрывают провода.
8. Медь имеет большую пропускную способность, чем железо.
9. Проводимость зависит от размера проволоки, ее длины и температуры.
10. Медь — наиболее широко используемый проводник.

16. Text B

HEATING EFFECT OF AN ELECTRIC CURRENT

The production of **heat** is perhaps the most **familiar** among the principal effects of an electric current, either because of its development in the **filaments** of the electric lamps or, may be, because of the possible danger from **overloaded wires**.

As you know, of course, a metal wire carrying a current will almost always be at a higher temperature than the temperature of that very wire unless it carries any current. It means that an electric current passing along a wire will heat that wire and may even cause it to become red-hot. Thus, the current can be **detected** by the heat developed **provided** it **flows** along the wire.

The reader is certain to remember that the heat produced per second **depends** both **upon** the **resistance** of the **conductor** and upon the **amount** of current carried through it. **As a matter of fact**, if some current flown along a thin wire and then the same amount of current were sent through a thicker one, a different amount of heat would be developed in both wires. When the current is sent through the wire which is too thin to carry it freely, then more electric energy will be **converted** into heat than in the case of a thick wire conducting a small current.

Let us suppose now that a small current is following along a thick metal conductor. Under such conditions the only way to discover whether heat has been developed is to make use of a sensitive **thermometer** because the heating is too **negligible** to be detected by other means. If, however, our conductor were very thin while the current were large, the amount of **generated** heat would be much greater than that produced in the thick wire. In fact, one could easily feel it. Thus, we see that the thinner the wire, the greater the developed heat. On the **contrary**, the larger the wire, the more negligible is the heat produced.

Needless to say, such heat is greatly desirable at times but at other times we must **remove** or, at least, **decrease** it as it represents a **waste** of useful energy. In case heat is developed in a **transmission** line, a generator, or a motor, it is but a waste of electric energy and **overheating** is most undesirable and even dangerous. It is this waste that is generally called "heat loss" for it serves no useful purposes and does decrease **efficiency**. **Nevertheless**, one should not forget that the heat developed in the electric circuit is of great practical importance for heating, lighting and other purposes. **Owing** to it we are provided with a large number of **appliances**, such as: electric lamps that light our homes, streets and factories, electrical heaters that are widely used to meet industrial requirements, and a hundred and one other necessary and **irreplaceable** things which have been serving mankind for so many years.

In short, many of the **invaluable** electrical appliances without which life would seem strange and impossible at present can be utilized only because they transform electric energy into heat.

The production of heat by an electric current is called heating effect. One might also name its light effect provided the heat in the conductor be great enough to make it **white-hot**, so that it gives off light as well as heat. Take the filament of an electric lamp as an example. We know it to glow because of heat. By the way, were we able to look inside a hot electric iron, we should see that its wires were **glowing** too. A similar statement could be **applied** as well to almost any electric heating device. All of them give off a little and a lot of heat.

Memorize the pronunciation of the following words:

heat [hi:t] — тепло, плавка
familiar [fə'miljə] — известный
filament ['filəmənt] — нить
to overload ['ouvə'loud] — перегружать
wire ['waiə] — проволока, провод
to detect [di'tekt] — открывать, обнаруживать
to provide [prə'vaid] — обеспечивать
to flow [flou] — течь
to depend [di'pend] **upon** — зависеть
resistance [ri'zistəns] — сопротивление
conductor [kən'dʌktə] — проводник

amount [ə'maunt] — количество
as a matter of fact — на самом деле, фактически
to convert [kən'və:t] — превращать
thermometer [θə'momitə] — термометр, градусник
negligible ['neglidʒəbl] — незначительный
to generate ['dʒenəreit] — производить
contrary ['kontrəri] — противоположный
needless to say — нечего и говорить
to remove [ri'mu:v] — устранять, удалять
to decrease [di:'kri:s] — уменьшать
waste ['weist] — остатки
transmission [trænz'miʃn] — передача
to overheat ['ouvə'hi:t] — перегревать(ся)
efficiency [i'fiʃənsi] — коэффициент полезного действия, продуктивность
nevertheless [,nevəðə'les] — несмотря на, тем не менее
owing to — вследствие, благодаря
appliance [ə'plaiəns] — приспособление, прибор
irreplaceable [,iri'pleisəbl] — незаменимый
invaluable [in'væljuəbl] — неоценимый
white-hot — раскаленный до бела
to glow [glou] — пылать
to apply [ə'plai] — применять

Answer the questions:

1. What is the most familiar principal effect of an electric current?
2. Why is heating effect of an electric current is the most familiar?
3. Has a metal wire carrying a current a higher temperature than a wire that carries any current?
4. What does an electric current heat?
5. How does an electric current heat a wire?
6. How can electricity be detected?
7. Why does the current-carrying wire become red-hot?
8. What does the heat produced per second depend upon?
9. Why is heat developed in a transmission line undesirable?
10. What device turns heat into work?

11. What do we call the heating effect of an electric current?
12. When does the conductor become white-hot?
13. What takes place inside any electric heating device?
14. What is called "heat loss" and doesn't decrease efficiency?

Exercise 1.1. ***Find the wrong statements and correct them:***

1. выработка тепла
2. известна среди эффектов
3. нити электрической лампы
4. опасность перегрузки провода
5. проводящая ток
6. проходящий по проводу
7. обнаруживается по теплу
8. становится раскаленным
9. сопротивление проводника
10. зависит от сопротивления
11. в обоих проводах
12. свободно проводит
13. будет преобразована в тепло
14. при таких условиях
15. чувствительный термометр
16. незначительное тепло
17. количество преобразованного тепла
18. выброс полезной энергии
19. линия передач
20. количество неоценимых приборов
21. незаменимые вещи
22. внутри раскаленного железа
23. плавка проводов

Exercise 1.2. ***Find the wrong statements and correct them:***

1. An electric current passing along a wire will heat it.
2. The heat depends on the amount of current carried through the conductor.

3. When the wire is thin, then the more electric energy will be converted into heat.
4. The thinner the wire, the more negligible the developed heat.

Exercise 1.3. ***Match the following:***

1. ... if it is possible to convert electrical energy into heat.
2. ... if it is able to look inside a hot electric iron.
3. ... if it is desirable at times to remove heat.
4. ... if heat decreases efficiency.

Exercise 1.4. ***Translate from Russian into English:***

1. Тепловой эффект электрического тока наиболее известен.
2. Эффект электрического тока можно обнаружить на нитях электрической лампы.
3. Провод, через который проходит ток, всегда имеет бо́льшую температуру, чем тот, что не проводит ток.
4. Если провод перегревается, по нему проходит электрический ток.
5. Тепло зависит от сопротивления проводника и силы тока, проходящего через него.
6. При прохождении тока по проводу, провод становится раскаленным.
7. Электрическая энергия превращается в тепло.
8. Тепло можно обнаружить только с помощью термометра, так как количество тепла незначительно.
9. Тонкий провод вырабатывает большее количество тепла, чем толстый.
10. На линии передач, в моторе или генераторе, перенагревание нежелательно и даже опасно.
11. Выброс энергии может привести к уменьшению КПД.
12. Тепло, вырабатываемое в электрических цепях, имеет практическую ценность.

13. Тепловой эффект — выработка тепла электрическим током.
14. Многие приборы являются незаменимыми вещами, которые служат человечеству на протяжении многих лет.

Exercise 1.5. ***Ask your groupmate the following questions (Questions for group discussion):***

1. What principal effects of an electric current are.
2. How the current passing along the wire can be detected.
3. Where different electrical appliances are used.
4. When overheating is the most undesirable and even dangerous.

17. Text A

GENERATORS

A device for **converting** mechanical energy into electric energy is called a generator. The function of a motor is just the **reverse**, that is, it **transforms** electric energy into mechanical energy. The **enormous** energy of **steam engines**, gas engines, and water **turbines** can now be transformed into electricity and **transmitted** many miles. The generator has revolutionized modern industry by **furnishing** cheap electricity.

The **essential** parts of a generator are: (a) the magnetic field, which is produced by **permanent magnets** or electromagnets; and (b) a moving **coil** of copper wire, called the **armature**.

D.c. generators are used for electrolytic processes. Large d.c. generators are used in certain manufacturing processes, such as steel making. Generators of small **capacities** are used for various special purposes, such as **welding**, automobile generators, train lighting, communication systems, etc.

Memorize the pronunciation of the following words:

device [di'vais] — устройство
to convert [kən'və:t] — превращать
reverse [ri'və:s] — обратный
to transform [træns'fɔ:m] — преобразовывать
enormous [i'nɔ:məs] — огромный
steam [sti:m] — паровой
engine ['endʒin] — двигатель
turbine ['tə:bin] — турбина
to transmit [trænz'mit] — передавать
to furnish ['fə:niʃ] — снабжать, доставлять
essential [i'senʃəl] — существенный, неотъемлемый
permanent ['pə:mənənt] — постоянный, неизменный
magnet ['mægnit] — магнит
coil ['kɔil] — катушка
armature ['a:mətjuə] — якорь
capacity [kə'pæsiti] — мощность
welding — сварка

Answer the questions:

1. What is a generator?
2. What is the difference between a generator and a motor?
3. What are two essential parts of a generator?
4. What are d.c. generators used for?
5. What processes are generators of small capacities used for?

Exercise 1.1. *Find the following equivalents in the text:*

1. устройство для преобразования
2. обратная (противоположная) функция
3. паровой двигатель
4. превращается в электрическую энергию
5. снабжать дешевой электроэнергией
6. катушка из медной проволоки
7. электролитические процессы

8. малая мощность
9. изготовление стали

Exercise 1.2. ***Match the following sentences choosing the appropriate answers:***

1. ... converts electric energy into mechanical energy.
   a) generator; b) motor
2. The function of a motor is just the ...
   a) similar; b) reverse
3. ... is produced by electromagnets.
   a) a coil; b) armature; c) the magnetic field
4. A moving coil of copper wire is called ...
   a) circuit; b) motor; c) armature
5. Large d.c. generators are used for...
   a) welding; b) steel making
6. Parts of a generator are ...
   a) armature and magnetic field; b) wire and electric field

Exercise 1.3. ***Translate from Russian into English:***

1. Генератор преобразовывает механическую энергию в электрическую.
2. Мотор преобразовывает электрическую энергию в механическую.
3. Магнитное поле создается электромагнитами.
4. Якорь — это катушка из медной проволоки.
5. Генераторы используются для электролитических процессов.
6. Составные части генератора — магнитное поле, которое создается электромагнитами, и якорь.

18. Text B

GENERATORS

The **dynamo** invented by Faraday in 1831 is certainly a primitive **apparatus compared** with the powerful, highly **efficient** generators and **alternators** that are in use today. **Nevertheless**, these machines operator on the same principle as the one invented by the great English scientist. When asked what use his new invention had turn: "What is the use of a new-born child?" As a matter of fact, "the new-born child" soon became an **irreplaceable device** we cannot do without.

Although used to operate certain devices requiring small currents for their operation, batteries and **cells** are unlikely to supply light, heat and power on a large **scale**. Indeed, we need electricity to light up millions of lamps, to run trains, to lift things, and to drive the machines. Batteries could not **supply** electricity enough to do all this work.

That dynamo-electric machines are used for this purpose is a well-known fact. These are the machines by means of which mechanical energy is turned directly into electrical energy with a loss of only a few percent. It is calculated that they produce more than 99.99 per cent of all the world's electric power.

There are two types of dynamos, namely, the generator and the alternator. The former supplies d.c. which is similar to the current from a battery and the latter, as its name **implies**, provides a.c.

To generate electricity both of them must be continuously **provided** with energy from some outside source of mechanical energy such as **steam engines**, steam **turbines** or water turbines, for example.

Both generators and alternators consist of the following principal parts: an **armature** and an **electromagnet**. The electromagnet of a d.c. generator is usually called a **stator** for it is in a static condition while the armature (the rotor) is **rotating**. Figure shows the principles the construction of an elemantary d.c. generator **is based upon**. We see the armature, the electromagnet, the **shunt winding**, the **commutator**, and the **load**. Alternators may be divided into two types: 1) alternator that have a stationary armature and a rotating electromagnet; 2) alternators whose armature serves as a rotor but this is sedlom done. In order to get a strong e.m.f., the rotors in large machines rotate at a speed of thousands of revolutions per minute (r.p.m.). The faster they rotate, the greater the output voltage the machine will produce.

In order to produce electricity under the most economical conditions, the generators must be as large as possible. In addition to it, they should be kept as fully loaded as possible all the time.

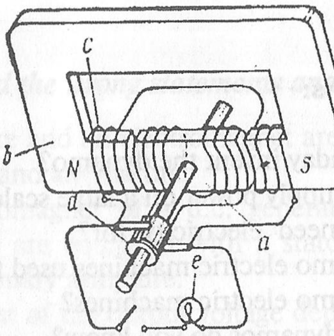

Figure 4. A Simple Type of Elementary Direct Current Generator (dynamo)

Memorize the pronunciation of the following words:

dynamo [ˈdainəmou] — динамо
apparatus [ˌæpəˈreitəs] — прибор, аппарат
to compare [kəmˈpɛə] — сравнить
efficient [iˈfiʃənt] — эффективный, продуктивный
alternator [o:lˈtə:nəitə] — генератор переменного тока
nevertheless [ˌnevəðəˈles] — несмотря на, тем не менее
irreplaceable [ˌiriˈpleisəbl] — незаменимый
device [diˈvais] — устройство, прибор
cell [sel] — элемент
scale [skeil] — масштаб
to supply [səˈplai] — снабжать, замещать
to imply [imˈplai] — предполагать, подразумевать
to provide [prəˈvaid] — снабжать, обеспечивать
steam [sti:m] — паровой
engine [ˈendʒin] — двигатель

turbine ['tə:bin] — турбина
armature ['a:mətjuə] — якорь
electromagnet [i' lektrou'mægnet] — электромагнит
stator ['steitə] — статор
to rotate [rou'teit] — вращаться
to base upon [beis] — основываться
shunt winding [ʃʌnt 'waindiK] — параллельная обмотка
commutator ['komju:teitə] — коммутатор
load [loud] — груз

Answer the questions:

1. When did Faraday invent the dynamo?
2. Can batteries supply power on a large scale?
3. What do we need electricity for?
4. What are dynamo electric machines used for?
5. What are dynamo electric machines?
6. What types of dynamos do you know?
7. What must both the generator and the alternator be provided with?
8. What are sources of mechanical energy?
9. What are the principal parts of a generator?
10. How is the electromagnet of a d.c. generator usually called?
11. What principles is the construction of an elementary d.c. generator based on?
12. What types of alternators do you know?
13. What must the generators be in order to produce electricity under the most economical conditions?

Exercise 1.1. ***Find the following equivalents in the text:***

1. незаменимое устройство
2. в большом масштабе
3. небольшая сила тока
4. не вырабатывают достаточно электрической энергии

5. превращается в электрическую энергию
6. внешний источник механической энергии
7. паровой двигатель
8. при неподвижном состоянии
9. якорь вращается
10. неподвижный якорь
11. вращающийся электромагнит
12. вращается со скоростью

Exercise 1.2. ***Find the wrong statements and correct them:***

1. An armature and an electromagnet are the main parts of both generators and alternators.
2. The electromagnet of a d.c. generator is rotating.
3. Alternators are equipped with a stator in a static condition and a stationary armature.
4. The amount of the output voltage depends on the rotor revolutions per minute.

Exercise 1.3. ***Form five sentences combining suitable parts of the sentences given in columns I and II:***

I	II
1. The electric current	1. is a temporary magnet provided by electricity.
2. The e.m.f.	2. is an electrical appliance used in daily life.
3. The heat engine	3. is a path to be followed by the current from the source and back to the source.
4. The iron	4. is the force that makes electrons move along a conductor.
5. The electromagnet	5. is a device by means of which heat is turned into work.

Exercise 1.4. ***Translate from Russian into English:***

1. Динамо-машины, изобретенные Фарадеем, — примитивные устройства по сравнению с генераторами постоянного и переменного тока.
2. Они стали незаменимыми устройствами, которые мы используем сегодня.
3. Элементы и батарейки не обеспечивают электрической энергией в большом масштабе.
4. При помощи генераторов механическая энергия превращается в электрическую.
5. Источники механической энергии — паровые двигатели, паровые турбины.
6. Генератор для производства электричества использует энергию из внешних источников.
7. Составляющие части генератора — якорь и электромагнит.
8. При неподвижном состоянии генератора якорь вращается.
9. В конструкции генератора можно увидеть якорь, электромагнит, параллельную обмотку и коммутатор.

Exercise 1.5. ***Ask your groupmate the following questions. (Questions for group discussion):***

1. if batteries can supply light, heat and power on a large scale.
2. if the electromagnet is temporary magnet provided by electricity.
3. if the electromagnet is lifeless unless the electric current flows though the coil.
4. if the iron core will act as a magnet as long as the current continues to pass along the winding.
5. if the alternator provides a.c.
6. if the generator must be turned by some outside source of mechanical energy.

19. Text C

DIRECT CURRENT GENERATORS AND THEIR APPLICATION

The **essential** difference between a **d.c. generator** and **a.c. generator** is that the former has a **commutator by means of which the generated e.m.f.** is made continuous, **i.e.**, the commutator mechanically **rectifies** the alternating e.m.f. so that it is always of the same **polarity**. This is not, however, **the only difference** between them.

A d.c. generator as well as a motor of conventional type is made up of the following parts: **outer frame**, or **yoke**, **pole cores**, **pole coils**, **armature core**, **armature windings**, **commutator**, **brushes**, and **bearings**. Of these, the yoke, pole cores, armature core, and the air **gap** between amature and pole core form the magnetic circuit while the pole coils, armature windings, commutator, and brushes form the electric circuit.

Generator fields may be **either** of two main types — **separately excited** or **self-excited**. The self-excited type is further classified as **series-wound**, **shunt-wound** and **compound-wound**.

In general practice compound-wound machines are used.

D.C. generators are used for electrolytic **processes** such as electroplating. We know that large d.c. generators are employed in certain manufacturing processes, such as **steel making**.

The d.c. generator **of small capacities** is used for various special purposes such as **arc welding**, automobile generators, train lighting systems, etc. It also finds rather extensive use in **connection** with communication systems.

For supplying **direct-current power networks, the supply comes** first from an alternating-current source and is **converted** to direct current by synchronous convertors or motor-generator sets.

Memorize the pronunciation of the following words:

essential [i'senʃəl] — существенный, неотъемлемый
commutator ['komju:teitə] — коммутатор

to rectify ['rektifai] — выпрямлять
polarity [pou'læriti] — полярность
outer frame [freim] — внешняя рама
yoke [jouk] — ярмо
pole cores ['ko:] — магнитные сердечники, сердечники полюсов
pole coil [koil] — полюсные катушки
armature['a:mətjuə] **core** — сердечник якоря
armature winding ['waindiŋ] — обмотки якоря
brush [brʌʃ] — щетка
bearing ['bɛəriŋ] — подшипник
gap [gæp] — пустота, разрыв
to excite [ik'sait] — возбуждать
series ['siəri:z] — последовательный
electroplating — гальваностегия, гальванопокрытие
to employ [im'ploi] — применять
procces ['prouses]— процесс
connection [kə'nekʃn]— соединение, связь
to convert [kən'və:t] — превращать

Notes:

d.c. generator — генератор постоянного тока
a.c. generator — генератор переменного тока
by means of which — посредством которого
the generated e.m.f. — генерируемая ЭДС
i.e. = id est = that is — то есть
the only difference — единственная разница
is made up — состоит
either of — любым из
separately excited — с независимым возбуждением
self-excited — самовозбуждающиеся
series-wound generator — генератор с последовательным возбуждением
shunt-wound generator — генератор с параллельным возбуждением
compound-wound generator — генератор со смешанным возбуждением
steel making — производство стали
of small capacities — малых мощностей
arc welding — дуговая сварка
direct-current power networks — силовые сети постоянного тока
the supply comes — *зд.* энергия поступает

Answer the questions:

1. What is the difference between a d.c. generator and a.c. generator?
2. What does the commutator rectify?
3. What is always of the same polarity?
4. What role does the commutator play?
5. What parts is a d.c. generator made up of?
6. What composing parts form the magnetic circuit?
7. What composing parts form the electric circuit?
8. What types of generator fields do you know?
9. How is the self-excited type subdivided into?
10. What types of generators are used in practice?
11. What purposes are d.c. generators used for?
12. What processes are large d.c. generators applied in?
13. What purposes are d.c. generators of small capacities used for?
14. How does the supply for direct-current networks come?
15. What is the supply converted into?

Exercise 1.1. ***Find the equivalents in the text:***

1. существенная разница
2. одинаковая полярность
3. коммутатор выпрямляет
4. обычный тип
5. воздушное пространство
6. электролитические процессы
7. для различных целей
8. источник переменного тока
9. система освещения поездов
10. системы коммуникации

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The difference between a d.c. generator and a.c. generator is that the winding has a commutator by means of which the compounding e.m.f. is made continuous.

2. There is the only difference between a d.c. and a.c. generator.
3. A d.c. generator is made up of the following parts: outer frame, pole coils, lathe-bed, armature winding, commutator, abrasive wheel, pipes, and brushes.
4. The yoke, pole coils, and the air gap between armature and pole core form the electric circuit.
5. The pole cores, armature windings, commutator, and brushes form the electric current.
6. Generator fields may be of three types.
7. There are three types of self-excited generators such as series-wound, shunt-wound, and compound-wound.
8. The supply comes first from a d.c. source and is converted to a.c.

Exercise 1.3. ***Complete the following sentences using the given below variants:***

1. Compound-wound machines are used ...
2. D.C. generators are used ...
3. Large d.c. generators are used ...
4. D.C. generators of small capacities are used ...

a) in general practice.
b) in arc welding, automobile generators, train lighting systems.
c) in steel making.
d) for electrolytic processes such as electroplating.

Exercise 1.4. ***Translate from Russian into English:***

1. Генератор постоянного тока имеет коммутатор.
2. Коммутатор выпрямляет постоянную ЭДС.
3. Ярмо, магнитные сердечники и сердечник якоря образуют магнитную цепь.
4. Полюсные катушки, обмотки якоря, коммутатор и щетки образуют электрическую цепь.
5. Генераторы бывают двух типов: с независимым возбуждением и самовозбуждающиеся.

20. Text C

MAGNETOHYDRODYNAMIC GENERATOR

Magnetohydrodynamics (MHD) is a field of **fluid** mechanics. The latter **deals with** the flow of the fluid or gas **conducting** electricity in the magnetic field. As gases can flow too they are consider as **liquids**.

More than a hundred years ago in 1831, Faraday discovered electromagnetic **induction**. Today every schoolchild knows the experiment from the school physics laboratory. If a conductor connected to an electric circuit crosses the space between the poles of a magnet, an electric current is induced in it. But the metal conductor can be **replaced** by any other conductor. For example, it may be a flow of electroconducting liquid or gas.

If gases are **heated** to some thousands of **degrees**, the atoms that **make** them **up** are broken down into electrically charged **particles**, the latter **interacting** with the magnetic field.

A high temperature gas in a MHD generator gives the same result as a cooper **armature** in the conventional d.c. generator. By means of suitable electrodes part of the energy of the ionized gas passing through the magnetic field is **converted** directly into electricity. It is this **conversion** that we are mostly interested in.

An MHD generator combines the functions of both a steam turbine and an electrical generator. As the energy of the gas is converted directly into electrical energy, an MHD generator is in principle a much simpler device than a turbogenerator.

As shown in Figure it consists of a **nozzle**, a channel with electrodes, and **insulators**, located in the magnetic field. The generator under consideration has no moving parts that cause energy losses. Thus, it can withstand much higher temperatures than those of the turbines.

As a result of high temperature operation a power plant with an MHD generator is more efficient than a turbine power plant. Studies show that as MHD power plant can reach 50% efficiency, and 55–60% in the future, the highest obtainable efficiency of a thermal power plant being 40%.

MHD energy conversion becomes possible only with the right combination of gas **velocity**, electrical conductivity and magnetic field induction.

It is the study of the above-mentioned combination that has led to the development of three approaches to the MHD power generation. The first one is the open cycle generator where the ionized gas **flux** is **injecting** into the nozzle of the channel. The second approach is the closed cycle generator in which plasma **circulates** inside the MHD generator itself. In the third, a liquid metal is used instead of plasma in the channel. All three approaches are **investigated** at present. So far, the open cycle generator seems to be the most **feasible** of them.

The first experimental industrial MHD installation "U-25" was constructed in Moscow. The above installation is known to have been put into operation in 1971. Its capacity is 20,000 kW. The U-25 operates on natural gas and has a magnet about 10 metres long.

By the end of the past century the **consumption** of electricity is expected to be ten times as great as it is today. To increase power production rapidly, we shall not only have to build giant thermal power plants but also to develop principally new power generation methods.

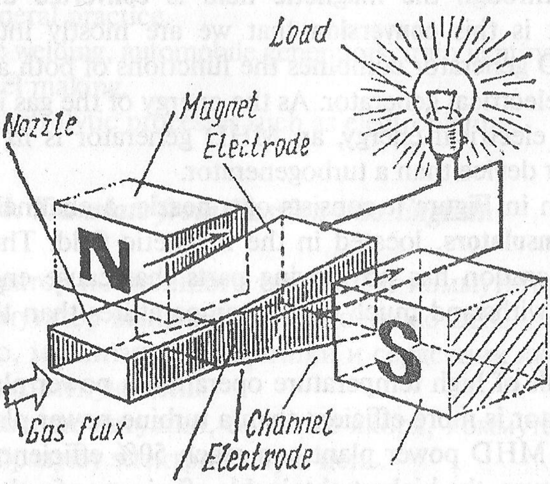

Figure 5. MHD Generator

Memorize the pronunciation of the following words:

fluid ['flu:id] — текущий, жидкий, жидкость
to deal with [di:l] — иметь дело с
to conduct [kən'dʌkt] — проводить
liquid ['likwid] — жидкость
induction [in'dʌkʃn] — индукция
to replace [ri'pleis] — заменять
to heat [hi:t] — нагревать, плавить
degree [di'gri:] — градус
to make up — составлять
particle ['pa:tikl] — частица
to interact [,intə'rækt] — взаимодействовать
armature ['a:mətjuə] — якорь
to convert [kən'və:t] — превращать
conversion [kən'və:ʃn] — превращение
nozzle ['nozl] — сопло
insulator [,insju'leitə] — изолятор
velocity [vi'lositi] — скорость
flux ['flʌks] — течение, поток, флюс
to inject [in'dʒekt] — впрыскивать
to circulate ['sə:kjuleit] — циркулировать
to investigate [in'vestigeit] — исследовать
feasible ['fi:zəbl] — возможный, осуществимый
installation [,instə'leiʃn] — установка, проводка
consumption [kən'sʌmpʃn] — потребление, расход

Answer the questions:

1. What does fluid mechanics deal with?
2. Why are gases considered as liquids?
3. Who discovered electromagnetic induction?
4. What experiment does every schoolchild know?
5. When are the atoms of gases broken down into electrically charged particles?
6. What particles interact with the magnetic field?
7. What function does an MHD generator combine?
8. Why is an MHD generator a much simpler device than the turbogenerator?

9. What does an MHD generator consist of?
10. Why is a power plant with an MHD generator more efficient than a turbine power plant?
11. What is the first approach to MHD power generator?
12. What can you say about the first Soviet MHD installation?
13. What is its capacity?

Exercise 1.1. *Find the following equivalents in the text:*

1. область гидромеханики
2. связана с потоком жидкости
3. проводящий электрическую энергию
4. электромагнитная индукция
5. проходит расстояние
6. полюса магнита
7. проводник можно заменить
8. несколько тысяч градусов
9. заряженные частицы
10. взаимодействуя с магнитным полем
11. медный якорь
12. ионизированный газ
13. превращается в электрическую энергию
14. объединяет функции
15. сочетание скорости, проводимости и индукции
16. входит (впрыскивается) в сопло канала
17. жидкий металл

Exercise 1.2. *Form seven sentences combining suitable parts of the sentences given in columns II and I:*

I	II
1. Magnetohydrodynamics is	1. the function of a steam turbine and an electrical generator.
2. Faraday discovered	2. a liquid metal is used instead of plasma in the channel.

3. An MHD generator combines	3. the consumption of the electricity will be ten times great as it is today.
4. An MHD generator consists	4. the right combination of the electrical conductivity, velocity, and the magnetic field.
5. The first problem was	5. electromagnetic induction.
6. In the third approach	6. of a nozzle, a channel with electrodes, and insulators.
7. By the end of the past century	7. a field of fluid mechanics.

Exercise 1.3. ***Fill the blanks with the words and expressions given bellow. Translate the sentences:***

1. with the result; 2. as a result; 3. results; 4. resulted in; 5. the results; 6. resulted from

1. We have discussed ... obtained.
2. When the electric current flows along the conductor, heat ... .
3. Faraday's experiments ... a great discovery.
4. Almost all bodies expand ... of heating.
5. Faraday carried on different experiments with coils, wire and magnetic needles with varying ... .
6. In a cell a potential difference is maintained by the chemical action; copper is at a higher potential than zinc ... that a current of positive electricity flows from the cooper to the zinc.
7. The possibility of designing first MHD power plants ... the investigation of MHD energy conversion.

Exercise 1.4. ***Arrange the following words with the pairs of synonyms:***

1. feasible; flux; to transform; liquid; to investigate; speed; to build; wire; change; conventional.
2. velocity; to construct; possible; to research; conductor; transformation; to convert; fluid; flow.

Exercise 1.5. ***Translate from Russian into English:***

1. Гидродинамический магнитный генератор — это область гидродинамики.
2. Поток жидкости или газа проводит электрическую энергию в магнитном поле.
3. Проводник проходит расстояние между полюсами магнита.
4. Проводником может быть поток жидкости или газа.
5. Газ нагревается до нескольких тысяч градусов.
6. Заряженные частицы взаимодействуют с магнитным полем.
7. Ионизированный газ превращается в электрическую энергию.
8. Превращение энергии происходит только при правильном сочетании скорости газа, электрической проводимости и индуктивности магнитного поля.
9. Генератор эффективнее, чем турбина, так как объединяет в себе функции паровой турбины и электрического генератора.
10. Генератор состоит из сопла, канала с электродами и изоляторами, помещенными в магнитное поле.

21. Text A
ELECTRIC MOTORS

There is a wide **variety** of **d.c.** and **a.c.** motors. There are **shunt** motors, **series** motors, synchronous motors, induction motors, single-, two-, and three-phase motors. They are used **to drive** various machines. A **ball-bearing** fully-enclosed **fan-cooled** direct-current motor is showing in Figure.

Direct-current motors are of three principal kinds, and are named according to the manner in which their field **coils** are connected to the **armature**. They are named respectively: series, shunt, and **compound**.

In the series motors the field **windings** and armature are connected in series with each other. All the current which passes through the armature passes through the field coils. The field windings are therefore composed of a few **turns** of thick wire. Starting under heavy **load**, a series motor will take a large current to provide the huge **torque** required.

The field coils of shunt motors are connected direct across the **brushes**, hence they have the full voltage of the **mains** applied to them. The shunt motor may be called a constant speed motor, and is suitable for driving **machine tools, lathes**, woodworking machines and any machines requiring a steady speed.

A compound motor has both shunt and series field windings and therefore **partakes** of the nature of both types of motors.

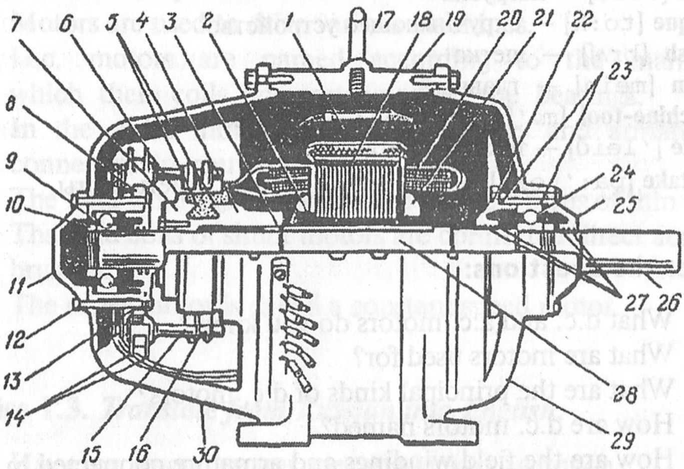

Figure 6. A Ball-Bearing Fully-Enclosed Fan-Cooled Direct-Current Motor:

1 — field coil; *2* — armature spider; *3* — commutator key; *4* — commutator sleeve; *5* — commutator mica V rings; *6* — commutator bars; *7* — commutator metal V ring; *8* — front inner bearing cap; *9* — bearing lock washer; *10* — bearing lock nut; *11* — front outer bearing cap; *12* — bearing assembly screw; *13* — brush yoke; *14* — brush stud insulation; *15* — brush holder stud; *16* — brush holder; *17* — eye bolt; *18* — armature laminations; *19* — frame; *20* — armature coils; *21* — armature end plate; *22* — back inner bearing cap; *23* — vellumoid gaskets; *24* — ball bearing; *25* — back outer bearing cap; *26* — armature shaft; *27* — grease seal; *28* — armature key; *29* — back bearing bracket; *30* — front bearing bracket

Memorize the pronunciation of the following words:

variety [və'raiəti] — разнообразие, множество
d.c. — постоянный ток
a.c. — переменный ток
shunt [ʃʌnt] — параллельный
series ['siəri:z] — последовательный
to drive [draiv] — приводить в движение
ball-bearing ['bεəriŋ] — шариковый подшипник
to fan-cool — охлаждать с помощью вентилятора
coil [koil] — катушка
armature ['a:mətjuə] — якорь
compound [kəm'paund] — смешанный
winding [waindiŋ] — обмотка
turn [tə:n] — оборот, виток
load [loud] — нагрузка
torque [to:k] — скручивающее устройство
brush [brʌʃ] — щетка
main [mein] — главный
machine-tool [mə'ʃi:n tu:l] — станок
lathe ['leið] — токарный станок
partake [pa:'teik] — принимать участие, иметь черты

Answer the questions:

1. What d.c. and a.c. motors do you know?
2. What are motors used for?
3. What are the principal kinds of d.c. motors?
4. How are d.c. motors named?
5. How are the field windings and armature connected in the series motors?
6. Where does the current pass?
7. What are the field windings composed of?
8. What is a series motor?
9. What is a shunt motor?
10. How is the shunt motor called?
11. What kind of motor is for driving machine-tools, lathes and woodworking machines used?
12. What field windings has a compound motor?

Exercise 1.1. ***Find the equivalents in the text:***

1. множество моторов постоянного и переменного тока
2. для приведения в движение различных машин
3. катушки подсоединены к якорю
4. проходит через катушки
5. виток проволоки
6. состоит из витков
7. имеет черты обоих типов
8. требующие постоянной скорости

Exercise 1.2. ***Find the wrong statements and correct them:***

1. There are only small amount of motors.
2. Motors are used to drive various machines.
3. D.c. motors are named according to the manner in which their coils are connected to the bearings.
4. In the series motors the field windings and armature are connected in shunt with each other.
5. The field windings are composed of a few turns of thin wire.
6. The field coils of shunt motors are connected direct across the brushes.
7. The series motor is called a constant speed motor.

Exercise 1.3. ***Translate from Russian into English:***

1. Имеется много видов электрических моторов.
2. Они используются для приведения в движение различных машин.
3. Моторы постоянного тока бывают трех типов.
4. Обмотка состоит из нескольких витков толстой проволоки.
5. Типы моторов постоянного тока различаются по способу подсоединения катушек к якорю.
6. Ток проходит через якорь и катушки.
7. Обмотка и якорь соединены друг с другом последовательно.

Exercise 1.4. ***Form sentences using the following word combinations:***

to drive various machines;
a few turns of thick wire;
to provide the huge torque required;
suitable for driving machine tools;
both shunt and series field windings.

22. Text B

A.C. ELECTRIC MOTORS

Motors for **alternating-current** circuits may be either single-phase or polyphase (two- or three-phase). They may again be divided into two kinds, named respectively: I. Synchronous; II. Non- or asynchronous, ordinarily called induction motors.

The most widely used a.c. motor is the induction motor shown in Figure. It has two main parts: (a) the **stationary** winding or **stator**, which **sets up** a **rotating** magnetic field, and (b) the rotating part of motor or the **rotor**. The rotor of a **commercial** a.c. motor consists of an iron **core** with large copper **bars** placed in **slots** around the **circumference** and connected at both ends to copper **rings**. This is called a **squirrel-cage** rotor. When a rotor is placed in a rotating magnetic field, a large current is **induced** in it.

A.c. motors are exactly **similar** in **construction** to a.c. generators and may be called **inverted alternators**, since the same machine may be used as either a generator or a motor.

Synchronous motors are very suitable for large powers, where the machine can be started up without load, and once started **run** for long periods.

For supplying direct-current power **networks**, the supply comes first from an alternating-current source and is **converted** to direct current by synchronous convertors or motor-generator sets.

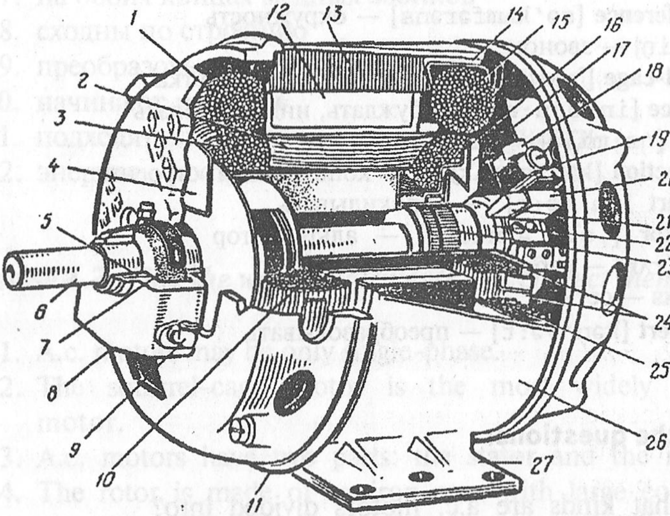

Figure 7. Cutaway Section of an Induction Motor:

1 — stator winding; *2* — winding in rotor slot; *3* — rotor winding; *4* — governor wieghts; *5* — bearing; *6* — shaft; *7* — wool yarn; *8* — oil well; *9* — oil cup; *10* — ID. governor rods; *11* — bearing bracket; *12* — slot in stator; *13* — stator core; *14* — insulation; *15* — stator winding; *16* — mica commutator ring; *17* — face of commutator; *18* — brush holder springs; *19* — brush lifting device; *20* — brush holder; *21* — carbon brush; *22* — spring barrel; *23* — short circuiting segments; *24* — leads from rotor coils to commutator bars; *25* — stator windings; *26* — frame; *27* — base

Memorize the pronunciation of the following words:

alternating-current — переменный ток
stationary [ˈsteiʃnəri] — неподвижный, стационарный
stator [ˈsteitə] — статор
to set up — устанавливать, налаживать
to rotate [rouˈteit] — вращаться
rotor [ˈroutə] — ротор, рабочее колесо
commercial [kəˈmə:ʃəl] — промышленного значения
core [ko:] — сердечник
bar [ba:] — брусок, штанга
slot [slot] — прорезь, паз

circumference [sə'kʌmfərəns] — окружность
ring [riŋ] — звонок
squirrel-cage ['skwirəlkeid'] — обойма, клетка
to induce [in'dju:s] — побуждать, индуктировать
similar ['similə] — подобный
construction [kən'strʌkʃən] — конструкция, строение
to invert [in'və:t] — опрокидывать
alternator [,o:ltə'neitə] — альтернатор
to run [rʌn] — работать
networks — сети
to convert [kən'və:t] — преобразовывать

Answer the questions:

1. What kinds are a.c. motors divided into?
2. How is the most widely used a.c. motor called?
3. What parts do a.c. motors consist of?
4. How is the rotating part of the motor called?
5. What parts does the rotor consist of?
6. How is the stationary winding called?
7. What kind of rotor is called a squirrel-cage rotor?
8. What is the difference between a.c. motors and d.c. generators?
9. Where are synchronous motors used?
10. What machines is an alternating current converted to direct current by?

Exercise 1.1. *Find the equivalents in the text:*

1. однофазовые моторы переменного тока
2. неподвижная обмотка
3. магнитное поле
4. железный сердечник
5. медные бруски
6. расположенные в прорезях

7. на обоих концах медных звонков
8. сходны по строению
9. преобразовывающие альтернаторы
10. начинают работать
11. подходят для станций большой мощности
12. энергия поступает

Exercise 1.2. ***Find the wrong statements and correct them:***

1. A.c. motors may be only single-phase.
2. The squirrel-cage motor is the most widely used a.c. motor.
3. A.c. motors have two parts: the stator and the rotor.
4. The rotor is made of an iron core with large copper rings placed in networks.
5. The rotor sets up a rotating magnetic field.
6. The stator is placed in a rotating magnetic field.
7. A.c. motors are not similar in construction to a.c. generators.
8. Synchronous motors can be started up without load.
9. The supply comes first from an a.c. source and is converted to d.c.

Exercise 1.3. ***Translate from Russian into English:***

1. Электрический мотор переменного тока состоит из ротора и статора.
2. Статором называется стационарная обмотка.
3. Вращающаяся часть мотора называется ротором.
4. Ротор состоит из железного сердечника с медными брусками.
5. Когда ротор помещают во вращающееся магнитное поле, в нем возникает ток.
6. С помощью синхронных моторов энергия превращается в постоянный ток.
7. Генераторы и моторы сходны по строению.

23. Text C

ELECTRIC MOTORS

The electric motor is a **device employed** for **transforming** electrical energy into mechanical energy. We know it to turn machinery and various **appliances**.

We have already seen the generator **converts** mechanical energy into electrical energy. Now, the process is **reversed**. It is electricity that is **supplied** to the machine and it is motion that we obtain. From all that has been said about our getting **magnetism** from electricity and about the generation of electric current by using magnetism, it is obvious that generators and motors are similar in certain respect. There is certainly some difference in detail but in both of them we find an **armature** with **windings**, a **commutator** and brushes **combined** with an electromagnet for producing the magnetic field. However, in an electric motor one shunt winding is not **sufficient** and a second one called a series winding should be **added**. "Why is it necessary?" one might ask. The fact is that the motor should have a **powerful** effect at the very moment when the current is switched on, as for instance, in an electric tram or a train. A very strong magnetic field is needed to obtain a so-called powerful starting **torque**. This is **achieved** by adding a series winding to the magnetic coils (Figure). It is connected not in shunt with the armature but in series with it. Thus, all of heavy starting current, passing through the armature winding, now passes through the series field coil and provides a strong field necessary for starting, the shunt field winding providing the running conditions.

No appliance ever created by man has probably such a wide **range** of size and such a variety of application as a motor. In fact, on the one hand, there are all kinds of mighty **giants** in the motor world. These giants are known to **perform innumerable** operations wherever required. On the other hand, there exist all kinds of small-sized and even minute motors, which are able to power various complex machines and operate **equally** well under any conditions.

So far nothing was said of what a motor does in our homes. In a modern home there are many different electric motors in machines and devices utilized to meet our daily requirements: to tell the time, to wash clothes, to cool the refrigerator, to clean or brush various things, to shave, to circulate air in warm room on a hot summer day, and so on. In effect, vacuum cleaner, washing machines, and modern refrigerators do work thanks to electric motors. It follows that in the electric motor we have the **valuable** and powerful appliance **capable** of fulfilling the required operations exactly and with just the desirable power and **rate** of motion. It is readily switched on, at will, and it continues running until we switch it off. There are often cases when it is simply impossible to replace it by any other means. In short, the motor finds application in industry and engineering, in agriculture and transport, in medicine and our homes.

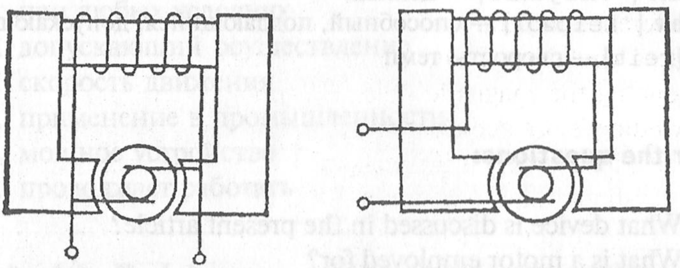

Figure 8. Shunt and Series Windings of Armature and Field Coils

Memorize the pronunciation of the following words:

device [di'vais] — прибор, устройство
to employ [im'ploi] — применять
to transform [træns'fo:m] — превращать, преобразовывать
appliance [ə'plaiəns] — приспособление, прибор
to convert [kən'və:t] — превращать
to reverse [ri'və:s] — переставлять, отменять, зд. обратный
to supply [sə'plai] — снабжать
motion ['mouʃn] — движение
magnetism ['mægnitizm] — магнетизм
similar ['similə] — подобный
armature ['a:mətjuə] — якорь
winding ['waindiŋ] — обмотка

commutator [ˈkomju:teitə] — коммутатор
to combine [ˈkəmˈbain] — сочетать
shunt [ʃʌnt] — параллельный
series [ˈsiəri:z] — последовательный
sufficient [səˈfiʃnt] — достаточный
to add [æd] — прибавлять
powerful [ˈpauəful] — мощный
torque [to:k] — вращающее устройство
to achieve [əˈtʃi:v] — достигать
range [reindʒ] — ассортимент
giant [ˈdʒaiənt] — гигант
to perform [pəˈfo:m] — выполнять, совершать
innumerable [iˈnju:mərəbl] — бесчисленный
equally [ˈi:kwəli] — одинаково
valuable [ˈvæljuəbl] — ценный
capable [ˈkeipəbl] — способный, поддающийся, допускающий
rate [reit] — скорость, темп

Answer the questions:

1. What device is discussed in the present article?
2. What is a motor employed for?
3. What kind of motors do you know?
4. Does the generator convert electrical energy into mechanical energy?
5. What parts of motor do you know?
6. What is a very strong magnetic field needed to?
7. What does the shunt field winding provide?
8. What does a motor do in our homes?
9. Do motors serve you energy every day?
10. Where does a motor find its wide application?
11. Why electric motors have both shunt and series windings?

Exercise 1.1. *Find the following equivalents in the text:*

1. применяется для превращения
2. различные приборы

3. преобразовывает механическую энергию в электрическую
4. генераторы и моторы сходны
5. по определенным аспектам
6. обмотка параллельного/последовательного подключения
7. сильное магнитное поле
8. магнитные катушки
9. достигается присоединением
10. проходящий через якорь обмотки
11. разные размеры
12. широкое применение
13. выполнять бесчисленное число операций
14. при любых условиях
15. допускающий осуществление
16. скорость движения
17. применение в промышленности
18. мощное устройство
19. продолжает работать

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The electric motor is a device for transforming mechanical energy into electrical energy.
2. Both generators and motors have an armature with windings, a commutator and brushes.
3. One shunt winding in an electric motor is sufficient and a series winding should not be added.
4. A very strong magnetic field is achieved by adding a series winding to the magnetic coils.
5. A powerful effect provides the running conditions.
6. A motor operates equally well in no conditions.

Exercise 1.3. ***Translate from Russian into English:***

1. Генераторы и моторы используются для превращения электрической энергии в механическую.

2. Мотор состоит из якоря с обмоткой, коммутатора и щеток.
3. Электромагнит в моторе используется для создания магнитного поля.
4. Обмотки с параллельным возбуждением недостаточно для электрического мотора.
5. Моторы-гиганты выполняют бесчисленные операции при любых условиях.
6. Мотор имеет разные формы и характеризуется широким применением.
7. Обмотка с последовательным возбуждением присоединяется к обмотке с параллельным возбуждением.

Exercise 1.4. ***Define the following terms:***

a transformer is a device which ... , a dynamo is a machine which ... , a battery is a device which ... , a switch is a device which ... , a thermometer is a device which ... , a generator is a device which ... , a motor is a device which ... , a generator is a machine which ...

24. Text B
THE COMPOUND MOTOR

The **features** of the **shunt** and **series** type of motors may be **combined** in one machine by providing both series and shunt **windings** for the field. This **arrangement** gives the **compound** motor. There are two windings on each field pole; a heavy or series winding for carrying the **armature** current, and a shunt winding connected to the supply. Each winding is formed by the series connection of the corresponding coils, and the fields due to the respective windings aid each other.

Speed control of a compound motor may be **obtained** by means of **resistance** in the field or armature circuit, as in the case of the shunt motor.

The compound motor may be regarded as having a higher starting **torque** than a shunt motor and a more constant speed under changing **load** conditions than the series motor. Either feature may be **emphasized** by **varying** the **proportion** of the total field strength due to each winding.

Memorize the pronunciation of the following words:

feature [ˈfi:tʃə] — черта, характерная особенность
shunt [ʃʌnt] — параллельный
series [ˈsiəri:z] — последовательный
to combine [kəmˈbain] — сочетать
winding [waindiŋ] — обмотка
arragement [əˈreindˈmənt] — устройство, расположение
compound [kəmˈpaund] — смешанный
armature [ˈa:mətjuə] — якорь
to obtain [əbˈtein] — получать
resistance [riˈzistəns] — сопротивление
torque [to:k] — вращающий момент
load [loud] — нагрузка
to emphasize [ˈemfəsaiz] — подчеркивать
to vary [ˈvɛəri] — изменяться
proportion [prəˈpo:ʃn] — соотношение

Notes:

by providing both series and shunt windings for the field — используя обмотки как последовательного, так и параллельного возбуждения для создания поля
connected to the supply — соединенный с источником питания
due to — благодаря
aid each other — дополняют друг друга
speed control — регулировка числа оборотов
by means of — посредством
as in the case of — как и в случае с
may be regarded as — могут рассматриваться как
either feature — каждая из этих характерных особенностей

Answer the questions:

1. How may the features of the shunt and series type of motors be combined?
2. What is a compound motor?
3. What windings are there in the compound motor?
4. How is each winding formed?
5. How is speed control of a compound motor obtained?
6. What is regarded as a higher starting torque?
7. What is the difference between a compound motor and other motors?

Exercise 1.1. ***Find the equivalents in the text:***

1. моторы с последовательным и параллельным соединением
2. соединены в одной машине
3. составляет мотор
4. обмотка последовательного возбуждения
5. обмотка параллельного возбуждения
6. последовательное соединение
7. соответствующая катушка
8. посредством сопротивления
9. изменение условий загрузки
10. изменение соотношения
11. общая сила поля

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The compound motor combines the features of both the shunt and series type of motors.
2. There is one winding on each field pole.
3. A shunt winding is used for carrying the armature current.
4. A series winding is connected to the supply.

5. A winding is formed by the shunt connection of the armatures and the fields.
6. A compound motor obtains speed control by means of pressure.
7. The compound motor is a higher torque than a shunt motor.
8. The features are emphasized by changing load conditions.

Exercise 1.3. ***Translate from Russian into English:***

1. Смешанный мотор использует обмотки как последовательного, так и параллельного возбуждения.
2. Расположение двух обмоток составляет смешанный мотор.
3. Обмотка образуется путем последовательного соединения соответствующих катушек.
4. Обмотки дополняют друг друга.
5. Обмотка с параллельным возбуждением соединена с источником питания.
6. Сопротивление оказывает влияние на регулировку числа оборотов.
7. Смешанный мотор характеризуется постоянной скоростью.

25. Text A

TRANSFORMERS

A transformer consists of two **insulated coils** of wire **linked** with a ring of iron. The coils are called high-**voltage** and low-voltage **windings**, or primary and secondary windings. The primary winding is connected to the **source** of energy, and the secondary is connected to the load. The high-voltage winding is designed for the higher voltage, and has the greater number of **turns**. The ring of iron is called the **core**.

Each coil consists of a number of **loops** of round or **rectangular** wire. Several **strands** may be used in parallel but electrically insulated from each other, from the core and from the other coil.

The core consists of thin **sheets** of high-**grade silicon** steel. The thickness **depends** somewhat **on** the frequency at which the transformer is to **operate**. The thickness commonly used for 60 cycles is **approximately** 0.014 in.

The primary function of a transformer is to transform electrical energy from one alternating voltage to another. To transform large amounts of energy with maximum efficiency, many factors must be considered in **determining** the materials, design, and **arrangement** of the primary and secondary coils and the core.

Memorize the pronunciation of the following words:

to insulate ['insjuleit] — изолировать
coil ['koil] — катушка
to link ['link] — связывать
voltage ['voltidʒ] — напряжение
winding ['waindiŋ] — обмотка
source [so:s] — источник
turn ['tə:n] — оборот, виток
core ['ko:] — сердечник
loop [lu:p] — петля
rectangular [rek'tæŋgjulə] — прямоугольный
strand [strænd] — кабель
sheet [ʃi:t] — лист
grade ['greid] — качество
silicon ['silikən] — кремний
to depend on [di'pend] — зависеть
to operate ['opəreit] — действовать

approximately [ə'proksimeitli] — приблизительно
to determine [di'tə:min] — определять
arrangement [ə'reindʒmənt] — расположение

Answer the questions:

1. What parts does a transformer consist of?
2. How are coils called?
3. What is the primary winding connected to?
4. What is the secondary winding connected to?
5. What winding has the greater number of turns?
6. What is the core?
7. May several strands be used in parallel?
8. What does the coil consists of?
9. What does the core consists of?
10. What is the main function of a transformer?
11. What does the thickness of the core depend on?

Exercise 1.1. ***Find the following equivalents in the text:***

1. состоит из изолированных катушек
2. катушки проволоки
3. обмотки низкого напряжения
4. первичная обмотка
5. количество витков
6. источник энергии
7. прямоугольная проволока
8. изолированные кабели
9. тонкие листы
10. высококачественная сталь
11. зависит от частоты
12. главная функция
13. передавать энергию
14. переменное напряжение
15. расположение сердечника и катушки
16. большое количество энергии

Exercise 1.2. ***Find the wrong statements and correct them:***

1. A transformer consists of two insulated coils of winding.
2. The primary winding is connected to the source of energy.
3. The coils are called cores.
4. The winding is called the core
5. Several strands are used in series.
6. Each coil consists of a number of turns.
7. The core consists of thin sheets.
8. The secondary function of a transformer is to transform electrical energy from a direct voltage to another.

Exercise 1.3. ***Translate from Russian into English:***

1. Катушки называются обмотками.
2. Катушка состоит из определенного количества петель.
3. Петли могут быть из круглой или прямоугольной проволоки.
4. Трансформатор состоит из изолированных катушек и проволоки.
5. Первичная обмотка подсоединена к источнику энергии.
6. Обмотка состоит из витков.
7. Провода изолированы друг от друга.
8. На превращение энергии влияет расположение катушки и сердечника.
9. Сердечник изготовлен из высококачественной кремниевой стали.

26. Text B

TRANSFORMERS

One of the great **advantages** in the use of the alternating currents is the ease with which the **voltage** may be changed by means of a relatively simple device known as a transformer. Although there are many different types of transformers, and a great **variety** of different **applications**, the principles of action are the same in each case.

The basic **arrangement** consists of a **laminated** iron **core** forming a closed magnetic **circuit** on which two separate windings are **mounted**. One **winding**, called the **primary**, is connected to the **a.c. supply**, and the other winding, the **secondary**, produces a voltage, which can have any desired **value** if the respective windings are suitably designed.

The transformer relies for its action upon the fact that when a magnetic field passing through a **coil** is changed or varied, a voltage is produced in the coil. The amount of this voltage is proportional to the number of **turns** in the coil and to the **rate** at which the magnetic field **varies**.

In general, it is **approximately** true that the **ratio** of the primary to the secondary voltage is equal to the ratio of the number of primary turns to the number of secondary turns. This ratio is not **exact** because of **leakage** effects in the magnetic circuit.

Memorize the pronunciation of the following words:

advantage [əd'va:ntidʒ] — преимущество
voltage ['voltidʒ] — напряжение
variety [və'raiəti] — множество
application [,æpli'keiʃn] — применение
arrangement [ə'reind'mənt] — расположение
to laminate ['læmineit] — ламинировать
core ['ko:] — сердечник
circuit ['sə:kit] — цепь, схема
to mount [maunt] — держать, крепить
winding ['waindiŋ] — обмотка
primary ['praiməri] — первичный
secondary ['sekəndəri] — вторичный
value ['vælju:] — ценность, значение
coil ['koil] — катушка
turn [tə:n] — виток
rate [,reit] — скорость, норма, рост

to vary [ˈvɛəri] — отличаться
approximately [əˈproksimeitli] — приблизительно
ratio [ˈreiʃiou] — отношение, пропорция
exact [igˈzækt] — точный
leakage [ˈli:kidʒ] — утечка

Notes:

by means of — посредством, при помощи
in each case — в каждом случае
a.c. supply — источник переменного тока
primary winding — первичная обмотка
the transformer relies for its action upon the fact — работа трансформатора основана на
is proportional to the number of turns — пропорционален числу витков
it is approximately true — приблизительно верно
is equal to the ratio — равен отношению
because of leakage effects — из-за утечки

Answer the questions:

1. What is one of the great advantages in the use of the alternating current?
2. Are the principles of action of different transformers the same?
3. How may the voltage be changed?
4. What parts does the arrangement of a transformer consist of?
5. What is the primary winding connected to?
6. What are two separate windings mounted on?
7. Where is voltage produced?
8. Is a magnetic filed changed?
9. What is proportional to the number of turns?
10. Is the ratio of the primary to the secondary voltage equal to the ratio of the number of primary turns to the number of secondary turns?

Exercise 1.1. ***Find the following equivalents in the text:***

1. преимущества в использовании
2. напряжение может изменяться посредством
3. относительно простое устройство
4. принципы действия
5. железный сердечник
6. магнитное поле
7. проходящий через катушку
8. число витков
9. отношение не точно
10. возникает в катушке

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The voltage is changed by means of a transformer.
2. The principles of action of the transformers differ from each other.
3. Two separate windings are mounted on a core.
4. The primary winding is connected to the a.c. supply.
5. A voltage is produced in the core.
6. When a magnetic field is changed or varied, a voltage is decreased in the coil.
7. The amount of the voltage is proportional to the number of windings and the velocity at which the magnetic field produces heat.
8. The ratio is exact because of leakage effects in the magnetic field.

Exercise 1.3. ***Translate from Russian into English:***

1. Трансформатор меняет напряжение.
2. Железный сердечник образует закрытую цепь.
3. Первичная обмотка подсоединена к источнику переменного тока.

4. Магнитное поле пронизывает катушку.
5. Величина напряжения прямо пропорциональна количеству витков в катушке и скорости, с которой меняется магнитное поле.
6. Отношение неверно из-за утечки в магнитной цепи.

27. Text B

AUTO-TRANSFORMERS

The transformer effect can also be **obtained** with a **single** tapped winding **instead of separate** primary and secondary windings. The arrangement is called an auto-transformer. If the primary winding represents the whole coil, the secondary voltage will be substantially the same **proportion** of the applied voltage as the proportion between the turns up to the secondary tapping and the total number of turns. By **interchanging** the voltage so that the supply is connected to the smaller numbers of turns, a voltage larger than the supply voltage appears across the whole coil. The auto-transformer can thus be used to obtain a higher or lower voltage than the supply, as in the case of the conventional transformer with two separate windings.

In practice, the use of auto-transformers is **limited** to **fairly** small voltage **ratios**, one reason being that if a break **occurs** anywhere in the secondary section of the winding, the primary voltage is applied to the **apparatus** connected to the secondary. With a high primary voltage this would give **dangerous** conditions. The chief uses of auto-transformers are in a. c. voltage regulation and for infrequent service such as the low-voltage starting of induction motors.

Memorize the pronunciation of the following words:

to obtain [əb'tein] — получать, достигать
single [singl] — одна, отдельная

instead of [in'sted əv] — вместо
separate ['seprit] — изолированный
proportion [prə'po:ʃn] — пропорция, соотношение
to interchange [intə'tʃeindʒ] — взаимозаменять
to limit ['limit] — ограничивать
fairly ['fɛəli] — достаточно, довольно
ratio ['reiʃiou] — отношение, пропорция
to occur [ə'kə:] — случаться
apparatus [,æpə'reitəs] — прибор, аппарат
dangerous ['deindʒrəs] — опасный

Notes:

with a single tapped winding — на одной обмотке с отпайкой
up to — вплоть до
the total number of turns — общее число витков
across the whole coil — на всей катушке
one reason being — одной из причин является
if a break occurs — если происходит обрыв
low-voltage starting of induction motors — запуск асинхронных двигателей на низком напряжении

Answer the questions:

1. How can the transformer be obtained?
2. What is an auto-transformer?
3. What does the primary winding represent?
4. When will the secondary voltage be the same proportion of the applied voltage as the proportion between the turns up to the secondary tapping and the total number of turns?
5. Where is the supply connected to?
6. Where does the supply voltage appear?
7. Is the use of auto-transformers limited?
8. Where does a break occur?
9. What would give dangerous conditions?
10. What can you say about the use of auto-transformers?

Exercise 1.1. ***Find the following equivalents in the text:***

1. вместо отдельных (изолированных) обмоток
2. представляет собой целую катушку
3. получить напряжение
4. использование ограничено
5. во второй секции обмотки
6. случается поломка
7. опасные условия

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The transformer effect can be obtained only with both primary and secondary windings.
2. The supply is connected to the circuit.
3. In practice, the use of auto-transformers is increased to fairly small voltage ratios.
4. The primary voltage is applied to the apparatus connected to the secondary.
5. The arrangement of a single tapped winding is called an auto-transformer.

Exercise 1.3. ***Translate from Russian into English:***

1. Автотрансформатор состоит из одной обмотки.
2. Первичная обмотка представляет собой целую катушку.
3. Источник тока подсоединен к небольшому числу витков.
4. Автотрансформатор можно использовать, чтобы получить напряжение большее, чем источник тока.
5. Поломка случается во второй секции обмотки.

28. Text C

TRANSFORMERS

The transformer is a device for changing the electric current from one voltage to another. As a matter of fact, it is used for increasing or decreasing voltage. A simple transformer is a kind of induction coil. It is well known that in its usual form it has no moving parts. On the whole, it requires very little **maintenance** provided it is not **misused** and is not damaged by lightning.

We may say that the principal parts of a transformer are two windings, that is coils, and an iron core. They call the coil, which is supplied with current, the "primary winding", or just "primary", for short. The winding from which they take the current is referred to as the "secondary winding" or "secondary", for short. It is not new to you that the former is connected to the source of supply, the latter being connected to the load.

When the number of turns of wire on the secondary is the same as the number on the primary, the secondary voltage is the same as the primary, and we get what is called a "one-to-one" transformer. In case, however, the number of turns on the secondary winding is

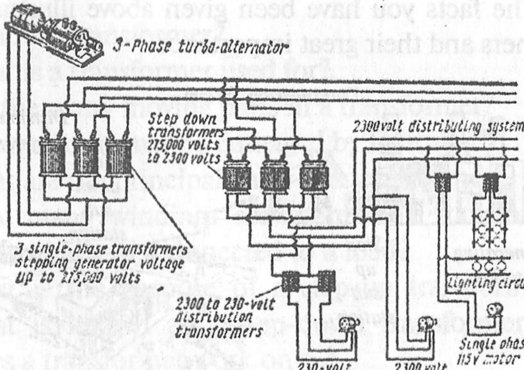

Figure 9. The Use of Transformers For Many Purposes in Transmission and Distribution Systems

greater than those on the primary, the output voltage is larger than the input voltage and the transformer is called a "step-up" transformer. On the other hand, the secondary turns being fewer in number than the primary, the transformer is known as a "step-down" transformer.

The transformer operates equally well to increase the voltage and to reduce it. By the way, the above process needs a **negligible** quantity of power. It is important to point out that the device under **consideration** will not work on d.c. but it is rather often employed in direct-current circuits.

Figure 1 shows how transformers are used in stepping up the voltage for **distribution** or transmission over long distances and then in stepping these voltages down. In this **figure**, one may see three large step-up transformers which are used to increase the **potential** to 275 000 volts for **transmission** over long-distance lines. At the **consumer's** end of the line, in some distant **locality**, three step-up transformers are made use of **to reduce** that value (i.e., 275 000 volts) to 2,300 volts. Local transformers, in their turn, are expected to decrease the 2300 volts to lower voltage, **suitable** for use with small motors and lamps. One could have some other transformers in the system that reduce the voltage even further. All radio sets and all television sets are known to use two or more kinds of transformers. These are **familiar** examples showing that electronic **equipment** cannot do without transformers. The facts you have been given above illustrate the wide use of transformers and their great importance.

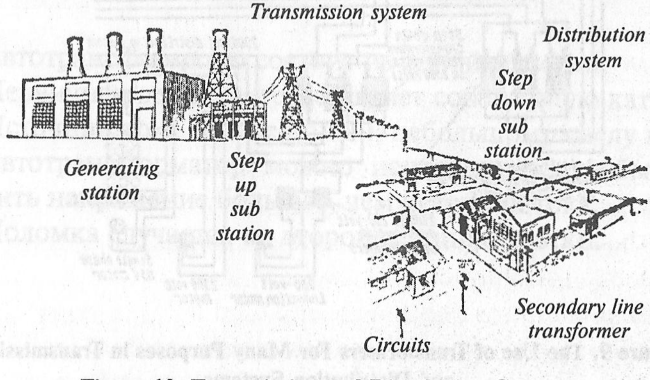

Figure 10. Transmission and Distribution Systems

Another alternating-current system of transmission and distribution is shown in Fig. 2. You are asked to follow the whole process, that is, to describe it from beginning to end.

Memorize the pronunciation of the following words:

maintenance [ˈmeintinəns] — техническое обслуживание, эксплуатация
to misuse [ˈmisˈju:s] — злоупотребление
negligible [ˈneglidʒəbl] — незначительный
distribution [ˌdistriˈbju:ʃn] — распределение, распространение
transmission [trænzˈmiʃn] — передача
potential [ˌpəˈtenʃəl] — потенциал
figure [ˈfigə] — изображение
consumer [kənˈsju:mə] — потребитель
to reduce [riˈdju:s] — уменьшать, сокращать
locality [ˈlouˈkæliti] — местность
suitable [ˈsju:təbl] — подходящий, годный
familiar [fəˈmiljə] — известный
equipment [iˈkwipmənt] — оборудование

Answer the questions:

1. What is a transformer?
2. What is a transformer used for?
3. Are there any moving parts in a transformer?
4. Can a transformer be damaged by lightning?
5. What are the principal parts of a transformer?
6. How many windings are there in a transformer?
7. What winding is connected to a load?
8. What is the purpose of a step-up transformer?
9. What is known as a step-down transformer?
10. Does a transformer work on d.c.?
11. What circuits is the transformer used in?
12. What purpose are step-down transformers used for?

13. Is your radio set equipped with a transformer?
14. Can we do without transformers?
15. Are transformers used both in industry and in our homes?

Exercise 1.1. ***Find the following equivalents in the text:***

1. для изменения напряжения
2. для повышения (понижения) напряжения
3. индукция катушки
4. называется вторичной обмоткой
5. подсоединен к источнику тока
6. количество витков проволоки
7. незначительная мощность
8. рассматриваемое устройство
9. применяется в цепях постоянного тока
10. передача на большие расстояния
11. линии передач
12. удобный для использования
13. отдаленная местность
14. известные примеры
15. электронное оборудование

Exercise 1.2. ***For the combinations given in (a) find the Russian equivalents in (b):***

a) 1. a number of; 2. as a matter of fact; 3. on the basis of; 4. for this reason; 5. it goes without saying; 6. at last; 7. on the whole; 8. to step up; 9. to increase current; 10. to offer resistance; 11. electrical engineering; 12. to step down

b) 1. наконец; 2. повышать (напряжение); 3. оказывать сопротивление; 4. понижать (напряжение); 5. ряд; 6. увеличить ток; 7. на основе чего-либо; 8. по этой причине; 9. в целом; 10. электротехника; 11. на самом деле; 12. само собой разумеется

Exercise 1.3. ***Arrange the following words in the pairs of synonyms:***

a) 1. amount; 2. big; 3. matter; 4. application; 5. at present; 6. tube; 7. research; 8. to step down; 9. appliance; 10. minute; 11. arrow

b) 1. investigation; 2. device; 3. needle; 4. quantity; 5. substance; 6. to lower; 7. small; 8. large; 9. new; 10. use; 11. pipe

Exercise 1.4. ***Arrange the following words in the pairs of antonyms:***

a) 1. left; 2. increase; 3. beginning; 4. d.c.; 5. above; 6. step-up; 7. at rest; 8. high; 9. short; 10. more

b) 1. end; 2. low; 3. long; 4. step-down; 5. in motion; 6. less; 7. decrease; 8. below; 9. a.c.; 10. right

Exercise 1.5. ***Find the wrong statements and correct them:***

1. The transformer is a device used to increase or decrease the electrical current.
2. The principal parts of a transformer are a coil and an iron core.
3. The coil is called the secondary winding.
4. When the number of turns of wire on the secondary is the same as the number on the primary, the primary voltage is the same as the secondary.
5. The transformer is known as a step-down transformer if the secondary turns being fewer in number than the primary.
6. The output voltage is smaller than the input voltage if the number of turns on the primary winding is greater than those on the secondary.
7. The transformer acts differently to increase the voltage and to reduce it.

Exercise 1.6. ***Translate from Russian into English:***

1. Трансформатор используется для повышения или понижения напряжения.

2. Трансформатор одинаково хорошо понижает и повышает напряжение.
3. Обмотка, генерирующая ток, называется вторичной.
4. Трансформатор подсоединен к источнику тока.
5. Трансформатор не может работать от постоянного тока.

Exercise 1.7. ***What is:***

1. step-up transformer;
2. step-down transformer;
3. "one-to-one" transformer.

Exercise 1.8. ***Compare:***

1. A solenoid and an electromagnet. 2. A direct current and an alternating current. 3.A step-up transformer and a step-down transformer. 4. A stator and a rotor. 5. A primary winding and a secondary winding.

29. Text B

PROTECTION AND CONTROL EQUIPMENT. AUTOMATIC VOLTAGE REGULATORS

In electrical system for the generation, **distribution** and use of electrical energy, considerable control **equipment** is necessary. It can be divided into two classes: a) equipment used at the generating and distributing end; b) equipment used at the receiving end of the system.

Safety switches are used at the point where the power enters a building. They are of the knife type and are usually enclosed in metallic boxes.

A **magnetic contactor** is used to make and break the circuit at the points where considerable power is used.

An **automatic starter** is a device, which is used to keep the current from being excessive while the motor is **obtaining** full speed. It is a kind of a resistance **inserted** in series with the direct current **armature**. As the motor obtains speed it gradually removes.

Automatic voltage regulators. In the generation and distribution of electrical energy it is important to keep the line voltage constant as the load or speed changes.

Where the **load** is changed gradually rheostats are used, in **installations** where the load may change rapidly automatic voltage regulators are used.

To protect electrical equipment and the wiring from damage due to short circuits and overloads, fuses or circuit breakers are usually used. The fuse is known to be a device for inserting in the circuit a **strip** of metal, which **melts** at **a relatively** low temperature. The fuse will melt if the current gets above a certain limit.

A **circuit breaker** is similar to the magnetic contactor.

Memorize the pronunciation of the following words:

distribution [,distri'bju:ʃn] — распределение, распространение
equipment [i'kwipmənt] — оборудование
to obtain [ob'tein] — получать, добывать, набирать
armature ['a:mətjuə] — якорь
to insert [in'sə:t] — включать (в цепь)
to load [loud] — загружать
strip ['strip] — полоска
to melt ['melt] — плавить
relatively ['relətivli] — относительно
installation [,instə'leiʃn] — проводка, устройство

Notes:

safety switch — аварийный выключатель, предохранительный выключатель
the knife switch — рубильник
to make and break the circuit — замыкать и размыкать цепь
to keep the current from being excessive — предохранять от сверхтоков, от перегрузки
is series — последовательно

gradually removes — постепенно выводится

to keep the line voltage constant as the load or speed changes — при изменении нагрузки или оборотов поддерживать линейное напряжение постоянным

due to short circuit and over-loads — из-за коротких замыканий и перегрузок

the fuse is known to be a device — известно, что плавкий предохранитель представляет собою приспособление

if the current gets above a certain limit — если ток переходит определенный предел

Answer the questions:

1. Why is control equipment used?
2. What classes can it be divided into?
3. When is a magnetic contactor used?
4. What is an automatic starter?
5. What aspect is important in the generation and distribution of electrical energy?
6. What are used when the load is changed gradually?
7. What are used when the load is changed rapidly?
8. What is the fuse?
9. What are fuses used for?
10. Does a circuit breaker differ from the magnetic conductor?

Exercise 1.1. *Find the following equivalents in the text:*

1. для генерирования, распределения и использования электрической энергии
2. набирает большую скорость
3. для защиты электрического оборудования
4. металл плавится
5. относительно низкая температура
6. магнитный замыкатель
7. автоматический стартер
8. включен последовательно
9. постоянное напряжение

Exercise 1.2. ***Supply the missing words or word combinations choosing among those given below:***

1. In electrical systems control equipment is necessary for ...
2. Safety switches are usually enclosed in ...
3. An automatic starter is used ...
4. Where the load is changed ... rheostats are used.
5. A magnetic contactor is used ... at the points where considerable power is used.
6. Fuses are used to protect ... from ...
7. Where the load may change ... automatic voltage regulators are used.
8. A circuit breaker is ... to the magnetic contactor.

rapidly; similar; metallic boxes; generating; distribution and use of electrical energy; to make and break the circuit; to keep the current; gradually; electrical equipment and the wiring ... damage.

Exercise 1.3. ***Translate from Russian into English:***

1. Оборудование используется для производства и распределения электрической энергии.
2. Аварийные выключатели в виде рубильников хранятся в металлических коробках.
3. Автоматический стартер предохраняет от перегрузки.
4. Магнитный замыкатель замыкает и размыкает цепь.
5. Мотор набирает скорость постепенно.
6. Плавкий предохранитель — прибор для включения в цепь металла, который плавится при низкой температуре.
7. Предохранитель плавится, если ток переходит определенный предел.
8. Загрузка в проводке происходит постепенно.
9. Предохранители защищают электрическое оборудование.

30. Text B

CARE OF THE ELECTRICAL EQUIPMENT

As a rule electrical **equipment operates reliably**. Still it does not mean that it deserves no attention. It is necessary to give the equipment frequent **inspections**, keep it well cleaned, **lubricated** and repaired. Undue heating, vibration, **sparking** should be **immediately removed**.

Heating may be due to overload or to a short circuit between turns, **lack** of oil in **bearings.** Vibration may be due to improper foundation, unbalance in the moving parts of the machine.

Conductors may get **heated** because of **overload** or by reason of damage of the **insulation** of the conductor.

An electrical machine of any kind requires certain conditions under which it may operate reliably: temperature and freedom of access of surrounding air, need for **protection** against dirt, dust type and **duration** of load, etc.

Rotating machines should be placed on solid foundations.

Conductors should be protected against mechanical damage.

All measures of **safety precaution** must be **undertaken**.

Memorize the pronunciation of the following words:

equipment [i'kwipmənt] — оборудование
to operate ['ɔpəreit] — действовать
reliably [ri'laiəbli] — надежно
inspection [in'spekʃn] — осмотр
to lubricate ['lu:brikeit] — смазывать
to spark [spa:k] — искриться, вспыхивать
immediately [i'mi:diətli] — немедленно, непосредственно
to remove [ri'mu:v] — передвигать
lack [læk] — недостаток, отсутствие
bearing ['b[əriŋ] — подшипник
conductor [kən'dʌktə] — проводник
to heat [hi:t] — нагреваться, плавиться
insulation [,insju'leiʃn] — изоляция

overload [ouvə'loud] — перезагрузка
to protect [prə'tekt] — охранять
duration [djuə'reiʃn] — продолжительность
to rotate [rou'teit] — вращать
safety ['seifti] — безопасность
precaution [pri'kɔ:ʃn] — предосторожность
to undertake [,ʌndə'teik] — предпринимать

Notes:

it does not mean that it deserves no attention — это не значит, однако, что он не требует никакого внимания
keep it well cleaned — держать в чистоте
undue heating — чрезмерное нагревание
may be due to — может быть из-за
a short circuit between turns — короткое замыкание между витками
or by reason of damage — из-за повреждения
on solid foundation — на прочном основании
measures of safety precaution — меры по технике безопасности

Answer the questions:

1. How does the electrical equipment operate?
2. Have we to keep the electrical equipment well cleaned, lubricated, and repaired?
3. When does heating occur?
4. What is the reason of vibration?
5. Why may conductors be heated?
6. What conditions does an electrical machine require?
7. What machines should be placed on solid foundation?

Exercise 1.1. *Find the following equivalents in the text:*

1. электрическое оборудование
2. работает надежно

3. частый осмотр
4. отсутствие масла в подшипниках
5. может возникнуть из-за перезагрузки
6. непрочное основание
7. изоляция проводника
8. требует определенных условий
9. свобода доступа воздуха
10. защита от грязи, пыли

Exercise 1.2. ***Find the wrong statements and correct them:***

1. The electrical equipment operates unreliably.
2. Heating may be due to overload or by reason of damage between turns.
3. Conductors may get heated because of lack of oil in bearings.
4. The electrical equipment requires certain conditions such as temperature, freedom of access of surrounding air, need for protection against dust and dirt and duration of load.
5. Drilling machines should be placed on unsolid foundation.

Exercise 1.3. ***Translate from Russian into English:***

1. Надежность — специфика работы электрического оборудования.
2. Однако оно требует внимания выполнения мер по технике безопасности.
3. Чрезмерное нагревание оборудования может привести к короткому замыканию.
4. Нагревание может быть из-за отсутствия масла в подшипниках.
5. Проводники могут нагреться из-за повреждения изоляции.
6. Электрооборудование необходимо подвергать частому осмотру, держать в чистоте, смазывать и ремонтировать.
7. Проводники следует защищать от механического повреждения.

31. Text B

USES OF ELECTRICITY

Electricity is the power that has made possible the engineering progress of today. **Wherever** we look around us, we can find this power serving us in some way. When we use a switch and have our room **instantly flooded with light**, we seldom think of what is happening to make it possible. **Probably** the important use of electricity in the modern home is producing light.

Do you know that the first ever man-made electric light illuminated the laboratory of the St. Petersburg **physicist** was Vasily Petrov in 1802? He had discovered the electric **arc**, a form of the gas **discharge**. But in Petrov's experiments the **arc flame** lasted for only a short time.

In 1876, Pavel Yblochkov invented an arc that burned like a candle for a long time and it was called "Yablochkov's candle". The source of light invented by Yablochkov won world-wide recognition. But while he and several other inventors were improving the arc light, some engineers were working along entirely different lines. They thought to develop an **incandescent lamp**. It was a young Russian engineer, Alexander Lodygin, who made the first successful incandescent lamp. The famous American inventor Thomas Edison improved the lamp having used a **carbon** filament. But it was again Lodygin who made another important improvement in the incandescent lamp, having invented a lamp with a tungsten filament, the lamp we use today.

Another electric light we use today is the light of the luminescent lamp — a **"cold" daylight lamp**. Artificial daylight lamps are much cheaper than incandescent lamps and last much longer. This is the lighting of the future.

The uses of electricity in the home do not end with lighting. There are more and more electric devices helping us in our home work.

But we should not forget that electricity is the most important source of energy in industry as well. A worker in a modern manufacturing plant uses on the **average** in the machines which he operates over 10 000 kilowatt-hours electrical energy a year.

Automation which is one of the main factors of technical progress today is impossible without electricity.

Our life can't be **imagined** without telephone, telegraph and radio communications. But it is also electricity that gives them life. In recent years has made a great contribution to radio communication between the spaceships and also between the astronauts and the Earth.

Little could be done in modern research laboratory without the aid of electricity. Nearly all of the measuring devices used in developing nuclear power for the use of mankind are electrically operated.

Memorize the pronunciation of the following words:

electricity [ilek'trisiti] — электричество
wherever [wɛər'əvə] — где бы ни, куда бы ни
instantly ['instəntli] — немедленно
flood [flu:d] — заливать (светом)
probably ['prɔbəbli] — вероятно
physicist ['fizisist] — физик
arc [a:k] — дуга
flame [fleim] — пламя
discharge [dis'tʃa:dʒ] — разряд
carbon ['ka:bən] — углерод
filament ['filəmənt] — нить накала
tungsten ['tʌŋstən] — вольфрам
average ['ævərid'] — средний
to imagine [I'mæd'in] — воображать

Notes:

flood with light — освещать
incandescent [,inkæn'dəsnt] **lamp** — лампа дневного накаливания
"cold" daylight lamp — «холодная» лампа дневного света

Answer the questions:

1. What is electricity?
2. Does electricity serve us?

3. What is the most important use of electricity?
4. Who was the first man-made electric light?
5. What had he discovered?
6. Did the arc flame in Petrov's experiment last for a long times?
7. What did P. Yablochkov invent?
8. Was "Yblochkov's candle" the last invention? What followed it?
9. Who made the first incandescent lamp?
10. How did Thomas Edison improve the lamp?
11. What did Lodygin invent?
12. What is another electric light we use today?
13. Is electricity the most important sourse of energy?
14. Is automation impossible without electricity?
15. Are measuring devices used in developing nuclear power electrically operated?

Exercise 1.1. ***Find the following equivalents in the text:***

1. немедленное освещение
2. электрическая дуга
3. разряд газа
4. пламя дуги
5. горела как свеча
6. источник свет
7. всемирное признание
8. вольфрамовая нить накала
9. искусственные лампы дневного света
10. снабжать энергией
11. исследовательская лаборатория
13. без помощи электричества
14. измерительные приборы
15. внести огромный вклад

Exercise 1.2. ***Find the wrong statements and correct them:***

1. V. Petrov discovered the electric arc, a form of the carbon filament.

2. In Petrov's experiments the arc flame lasted for a long time.
3. Thomas Edison invented an arc that burned like a candle.
4. A lamp with a tungsten filament was invented by Lodygin.
5. Artificial daylight lamps are more expensive than incandescent lamp.
6. Automation deals with electricity.
7. All of the measuring devices are not electrically operated.

Exercise 1.3. ***Translate from Russian into English:***

1. Наши дома освещаются.
2. В. Петров открыл электрическую дугу, пламя которой горело не долго.
3. Р. Яблочков изобрел дугу, которую назвали «свечой Яблочкова».
4. Т. Эдисон использовал углеродную нить накала.
5. Сегодня мы используем «холодную лампу» лампу дневного света.
6. Мы не можем себе представить наше существование без радио и телефона.
7. Электричество внесло огромный вклад в развитие радио коммуникаций.
8. Измерительные приборы работают от источника питания.
9. Невозможно жить без помощи электричества.
10. Искусственные лампы дневного света дешевле, чем лампы накаливания.

Part II

TEXTS FOR ADDITIONAL READING

1. FROM THE HISTORY OF ELECTRICITY

There are two types of electricity, namely, electricity at rest or in a static condition and electricity in motion, that is, the electric current. Both of them are made up of electric charges, static charges being at rest, while electric current flows and does work. Thus, they differ in their behaviour.

Let us first turn our attention to static electricity. For a long time it was the only electrical phenomenon to be observed by man. As previously mentioned at least 2,500 years ago, or so, the Greeks knew how to get electricity by rubbing substances. However, the electricity to be obtained by rubbing objects cannot be used to light lamps, to boil water, to run electric trains, and so on. It is usually very high in voltage and difficult to control, besides it discharges in no time.

As early as 1753, Franklin made an important contribution to the science of electricity. He was the first to prove that unlike charges are produced due to rubbing dissimilar objects. To show that the charges are unlike and opposite, he decided to call the charge on the rubber — negative and that on the glass — positive.

In this connection one might remember the Russian academician V. V. Petrov. He was the first to carry on experiments and observations on the electrification of metals by rubbing them one against another. As a result he was the first scientist in the world who solved that problem.

Who does not know that the first man to get the electric current was Volta after whom the unit of electric pressure, the volt, was named? His discovery developed out of Galvani's experiments with the frog. Galvani observed that the legs of a dead frog jumped as a result of an electric charge. He tried his experiment several times and every time he obtained the same result. He thought that electricity was generated within the leg itself.

Volta began to carry on similar experiments and soon found that the electric source was not within frog's leg but was the result of the contact of both dissimilar metals used during his observations. However, to carry on such experiments was not an easy thing to do. He spent the next few years trying to invent a source of continuous current. To increase the effect obtained with one pair of metals, Volta increased the number of these pairs. Thus the voltaic pile consisted of a copper layer and a layer of zinc placed one above another with the layer of flannel moistened in salt water between them. A wire was connected to the first disc of copper and to the last disc of zinc.

The year 1800 is a date to be remembered: for the first time in the world's history a continuous current was generated.

Volta's Short Biography.

Volta was born in Como, Italy, on February 18, 1745. For some years he was a teacher of physics in his home town. Later on he became professor of natural sciences at the University of Pavia. After his famous discovery he travelled in many countries, among them France, Germany and England. He was invited to Paris to deliver lectures on the newly discovered chemical source of continuous current. In 1819 he returned to Como where he spent the rest of his life. Volta died at the age of 82.

2. EARLY HISTORY OF ELECTRICITY

Let us now turn our attention to the early facts, that to say, let us see how it all started.

History shows us that at least 2,500 years ago the Greeks were already familiar with the strange force, which is known today as electricity. Generally speaking, three phenomena made up all of man's knowledge of electrical effects. The first phenomenon under consideration was the familiar lightning flash — a dangerous power, as it seemed to him, which could both kill people and burn or destroy their houses. The second manifestation of electricity he was more or less familiar with was as following: he sometimes found in the earth a strange stone, which looked like glass. On being rubbed, that yellow stone, that is to say amber, obtained the quality of attracting light objects of a small size. The third phenomenon was connected with the so-called electric spark, which possessed the property of giving more or less electric shocks, which could be obtained by a person coming into contact with the electric fish.

Nobody knew that the above phenomena were due to electricity. People could neither understand their observation nor find any practical applications for them.

As a matter of fact, all of man's knowledge in the field of electricity has been obtained during the last 370 years. Needless to say, it took a long time before scientists understood how to make use of electricity. In effect, most of the electrically operated devices, such as the electric lamp, the refrigerator, the tram, the lift, the radio, and so on, — in less one hundred years old. They play an important part in man's everyday life all over the world. In fact, we cannot do without them at present.

We have not named the scientists who contributed to the scientific research on electricity. However, famous names are connected with its history and among them we find that of Phales, the Greek philosopher. As early as about 600 B.C. (that is, before our era) he discovered that when amber was rubbed, attracted and held minute light objects. However, he could not know that amber was charged with electricity owing to the process of rubbing. Then Gilbert, the English physicist, began the first systematic scientific research on electrical phenomena. He discovered that various other substances possessed the property similar to that of amber or, in other words, they generated electricity when they were rubbed. He gave the name "electricity" to the phenomenon he was studying. He got this word from the Greek "electrum" meaning "amber".

Many learned men of Europe began to use the new word "electricity" in their conversation as they were engaged in research of their own. Scientists of Russia, France, and Italy made their contribution as well as the English men and the Germans.

3. ENERGY

In the language of science, energy is the ability to do work. There are various forms of energy, such as heat, mechanical, electrical, chemical, atomic, and so on. One might also mention the two kinds of mechanical energy — potential and kinetic, potential energy being the energy of position while kinetic energy is the energy of motion.

It is well known that one form of energy can be changed into another. A waterfall may serve as an example. Water falling from its raised position, changes energy from potential to kinetic energy. The energy of falling water is generally used to turn the turbines of hydroelectric stations. The turbines in their turn drive the electric generators, the latter producing electric energy. Thus, the mechanical energy of falling water is turned into electric energy. The electric energy, in its turn, may be transformed into any other necessary form.

When an object loses its potential energy, that energy is turned into kinetic energy. Thus, in the above-mentioned example when water is falling from its raised position, it certainly loses its potential energy, that energy changing into kinetic energy.

We have already seen that energy of some kind must be employed to generate the electric current. Generally speaking, the sources of energy usually employed to produce current are either chemical, as in the battery, or mechanical, as in the electromagnetic generator. Chemical sources of current having a limited application, the great quantities of electric energy generated today come from various forms of mechanical energy.

The rising standards of modern civilization and growing industrial application of the electric current result in an increasing need of energy. Every year we need more and more energy.

4. MATTER AND ENERGY

Before considering the modern views in regard to composition of atoms, it is advisable to review briefly the concepts of matter and energy, which are fundamental in all branches of science. A strictly accurate definition of matter is difficult to formulate. Our experience and common sense furnish us with a conception of matter. Matter occupies space; it has inertia, that is, it requires force to set it in motion; it is the stuff of which the universe is made. Energy, on the other hand, is nonmaterial; we become conscious of it only when it is associated with matter.

A stone held in the air is different from the same stone resting on the earth; for by allowing the former to drop we can obtain work from it, drive a nail, or crush grain. The stone held away from the earth is said to have potential energy, it gives it up when it falls; and to raise it from the earth back to its original position, work must be done upon it. Energy manifests itself in work. We are familiar with other forms of energy — heat, light, electrical energy, nuclear energy, and sound.

Matter and energy are always associated. When any change occurs, there is always a change in the energy; there may or may not be a change in the matter. From this point of view, we can define physical and chemical change; if the change consists solely in energy it is physical, if the matter changes it is chemical.

5. ELECTROMOTIVE FORCE AND RESISTANCE

As was previously stated, there is always a disorderly movement of free electrons within all substances, especially metals.

Let us assume that there is a movement of electrons through the wire, say, from point A to point B. What does it mean? It means that there is an excess of electrons at point A. Unless there were a flow of electric current be-tween A and B in any direction, it would mean that both the former and the latter were at the same potential. Of course, the greater the potential difference, the greater is the electron flow.

The electromotive force (e.m.f.) is the very force that moves the electrons from one point in an electric circuit towards another. In case this e.m.f. is direct, the current is direct. On the other hand, were the electromotive force alternating, the current would be alternating, too. The e.m.f. is measurable and it is the volt that is the unit used for measuring it.

One need not explain that a current is unable to flow in a circuit consisting of metallic wires alone. A source of an e.m.f. should be provided as well. The source under consideration may be a cell or a battery, a generator, a thermocouple or a photocell, etc.

In addition to the electromotive force and the potential difference, reference should be made here to another impor-tant factor that greatly influences electrical flow, namely, resistance. So, to resistance shall we turn our attention now? The student probably remembers that all substances offer a certain amount of opposition, that is to say resis-tance, to the passage of current. This resistance may be high or low depending on the type of circuit and the mate-rial employed. Take glass and rubber as an example. They offer a very high resistance and, hence, they are considered as good insulators. Nevertheless, one must not forget that all substances do allow the passage of some current provid-ed the potential difference is high enough.

Imagine two oppositely charged balls suspended far apart in the air. In spite of our having a difference of po-tential, no current flows. How can we explain this strange behaviour? The simple reason is that the air between the balls offers too great a resistance to current flow. However, the electrons could certainly flow from the negatively charged ball towards the positively charged one provided we connected them by a metal wire. As a matter of fact, it is not necessary at all to connect both balls in the manner described in order to obtain a similar result. All that we have to do is to increase the charges. If the potential differ-ence becomes great enough, the electrons will jump through the air forming an electric spark.

One should mention in this connection that certain fac-tors can greatly influence the resistance of an electric circuit. Among them we find the size of the wire, its length, and type. In short, the thinner or longer the wire, the greater is the resistance offered. Besides, could we use a silver wire, it would offer less resistance than an iron one.

6. WHAT IS HEAT?

What makes one thing hot and another cold? What do the terms "hot" and "cold" really mean?

Scientists are known to have worked for a long time to find an answer to the last question. They decided at last that the manifestation of heat was caused by a weightless substance or fluid called "caloric" which flowed from a hot body to a cold one. However, experience showed that cer-tain heat effects could not be explained by the above theo-ry, namely: the development of heat owing to friction as well as the temperature changes during the compression or expansion of a gas.

M.V. Lomonosov was the first to state that heat phe-nomena were due to molecular motion. His statement proved to be correct years after his death.

At present, we know heat to be a form of energy. Be-sides, we are quite familiar with the fact that all substances are made up of little particles called molecules. These are so minute that a single drop of water, for example, con-tains millions of them. Although a drop of water left on the table may seem to be at rest, everyone of its molecules is really moving about, colliding with other molecules, pushing them, and changing direction. Of course, while one molecule is travelling, all the other millions of molecules in the drop of water are doing the same thing.

What process takes place when we place a kettle full of cold water on the fire, in other words, when we want to heat water? The molecules begin to move much faster then, so that every time there is a collision, they jump away from each other much farther than they did before. As a result, the drop of water becomes larger, that is to say, it expands. In scientific language this property is called ex-pansion.

The faster molecular movement makes the water first warm and then hot. On taking the kettle from the fire, we expect the molecules to slow down, and indeed the water begins to get cold. When the tea is said to be "hot", it really means that its molecules are travelling very fast. On the contrary, they are moving more slowly, when the tea is cold.

Heat and temperature are closely connected. To show that similar quantities of heat may produce different ef-fects in different substances is not difficult at all. Placing a needle on the fire at the same time as a kettle of cold water, we find that the needle is red-hot before there is any marked difference in the water temperature.

One must say here that a red-hot needle receives far less heat than a kettle full of boiling water but its temperature is nevertheless much higher. But if we place it in the boiling water, although the latter is certain to possess far more heat than the former, the needle gives up heat to the water and not vice versa. When two bodies at different tempera-tures are brought into contact, we expect the warmer body to get cold while the colder one will be warmed. In this case, heat is said to flow from one body to the other by conduction.

As for expansion caused by heating, it is useless and even dangerous in some cases while in others one cannot do without it. For example, to measure temperature we employ a thermometer that is the instrument based on the expansion of bodies when heated.

7. ATMOSPHERIC ELECTRICITY

Electricity plays such an important part in modern life that in order to get it; men have been burning millions of tons of coal. Coal is burned instead of its being mainly used as a source of valuable chemical substances, which it contains. Therefore, finding new sources of electric energy is a most important problem that scientists and engineers try to solve. In this connection one might ask: "Is it possible to develop methods of harnessing lightning?" In other words, could atmospheric electricity be transformed into useful energy?

Indeed, hundreds of millions of volts are required for a lightning spark about one and a half kilometer long. However, this does not represent very much energy because of the intervals between single thunderstorms. As for the power spent in producing lightning flashes all over the world, it is only about 1/10,000 of the power got by mankind from the sun, both in the form of light and that of heat. Thus, the source in question may interest only the scientists of the future.

It has already been mentioned that atmospheric electricity is the earliest manifestation of electricity known to man. However, nobody understood that phenomenon and its properties until Benjamin Franklin made his kite experiment. On studying the Leyden jar (for long years the only known condenser), Franklin began thinking that lightning was a strong spark of electricity. He began experimenting in order to draw electricity from the clouds to the earth. The story about his famous kite is known all over the world.

On a stormy day Franklin and his son went into the country taking with them some necessary things such as: a kite with a long string, a key and so on. The key was connected to the lower end of the string. "If lightning is the same as electricity," Franklin thought, "then some of its sparks must come down the kite string to the key." Soon the kite was flying high among the clouds where lightning flashed. However, the kite having been raised, some time passed before there was any proof of its being electrified. Then the rain fell and wetted the string. The wet string conducted the electricity from the clouds down the string to the key. Franklin and his son both saw electric sparks which grew bigger and stronger. Thus, it was proved that lightning is a discharge of electricity like that got from the batteries of Leyden jars.

Trying to develop a method of protecting buildings during thunderstorms, Franklin continued studying that problem and invented the lightning conductor. He wrote necessary instructions for the installation of his invention, the principle of his lightning conductor being in use until now. Thus, protecting buildings from strokes of lightning was the first discovery in the field of electricity employed for the good of mankind.

8. MAGNETISM

In studying the electric current, we observe the following relation between magnetism and the electric current, on the one hand magnetism is produced by the current and on the other hand the current is produced from magnetism.

Magnetism is mentioned in the oldest writings of man. Romans knew that an object looking like a small dark stone had the property of attracting iron. However, nobody knew who discovered magnetism or where and when the discovery was made. Of course, people could not help repeating the stories that they had heard from their fathers who, in their turn, heard them from their own fathers and so on.

One story tells us of a man called Magnus whose iron staff was pulled to a stone and held there. He had great difficulty in pulling his staff away. Magnus carried the stone away with him in order to demonstrate its attracting ability among his friends. This unfamiliar substance was called Magnus after its discoverer, this name having come down to us as "Magnet".

According to another story, a great mountain by the sea possessed so much magnetism that all passing ships were destroyed because all their iron parts fell out. They were pulled out because of the magnetic force of that mountain.

The earliest practical application of magnetism was connected with the use of a simple compass consisting of one small magnet pointing north and south.

A great step forward in the scientific study of magnetism was made by Gilbert, the well-known English physicist (1540–1603). He carried out various important experiments on electricity and magnetism and wrote a book where he put together all that was known about magnetism. He proved that the Earth itself was a great magnet.

Reference must be made here to Galileo, the famous astronomer, physicist and mathematician. He took great interest in Gilbert's achievements and also studied the properties of magnetic materials. He experimented with them to increase their attracting power. One of his magnets, for example, could lift objects weighing 25 times its own weight.

At present, even a schoolboy is guite familiar with the fact in magnetic materials, such as iron and steel, the molecules themselves are minute magnets. When iron and steel are magnetized, the molecules arrange themselves in a new way instead of the disarrangement it which they neutralize each other.

Dividing a bar magnet into two parts, one finds that the each of the two parts is a magnet having both a North Pole and South Pole. Thus, we obtain two magnets of a smaller size of having a single one of a larger size. Dividing one of these two smaller magnets into two will give us the same result. Thus, we could continue this process, always getting similar results.

On placing an unmagnetized iron bar near a strong magnet we magnetize it. Rubbing the magnet is not required for that process. In other words, our iron bar has been magnetized by the strong magnet without rubbing it.

9. VOLTAGE AND CURRENT

Electric power is generated at power stations, but it is usually needed for faroff places.[1] How is the current taken to these far-off places?

Thick wires usually carry it across the country, and steel pylons hold the wires above the ground. The pylons are so high that nobody can touch the wires at the top. The wires are not usually copper wires; they are made of aluminium, and thirty wires together form one thick cable. Aluminium is so light that the pylons can easily hold the cables up.

It would not be cheap to drive very large currents through these cables. Large currents need very thick wires. If thin wires are used, they get hot or melt, and so the currents ought to be as small as possible. Can we send a lot of power if we use a small current? We can do so if the voltage is high. We need a small current and a high voltage; or a large current with a low voltage. The small current is cheaper because the wires need not be thick.

The result is that the voltage has to be very high. The pressure in the aluminium cables may be 132,000 volts, and this is terribly high. The voltage of a small battery, which we carry in our pockets, is usually between 1 and 9 volts. A car battery has a voltage of 6 or 12 volts. In a house the pressure in the wires may be 230 volts, or something like that.[2] Even 230 volts is high enough to kill a person, so what would happen if we touched one of the aluminium cables? The high voltage would drive a heavy current through our bodies to the earth.

When the wires lead down to a house or a railway, the voltage is made lower. It can be changed easily; but if the voltage is lower, the current must be higher. If it is not, we shall lose power. So the wires have to be thicker.

The wires must never touch steel pylons. If they did that, the current would escape to the earth through steel. Steel is a good conductor of electricity, so are most met-als.[5] We have to separate the wires from the pylon, and we do this with insulators.

Notes:

far-off places — отдаленные районы
something like that — или около этого
so are most metals — а также и большинство металлов

10. POTENTIAL AND DIFFERENCE OF POTENTIAL

Two bodies oppositely charged have a difference of potential between them. A difference of potential or voltage is measured by the work required to carry a unit of positive charge from one body to another against the force of attraction or repulsion. The magnitude of the difference of potential depends upon the concentration of the charge and not the amount of the charge.

If a positively charged body and a negatively charged body are brought in contact, electrons from body with negative charge will move over to the body having the positive charge until an equilibrium of charge has taken place.

There is a very instructive analogy between the use of the word "potential" in electricity and "pressure" in hydrostatics. Just as water tends to flow from points of higher hydrostatic pressure to points of lower hydrostatic pressure, so electricity tends to flow from points of higher electrical pressure, or potential, to points of lower electrical pressure, or potential.

Notes:

are brought in contact — приводятся в соприкосновение
just as — точно так же, как
oppositely charged — разноименно заряжены
a unit of positive charge — единица положительного заряда
against the force — преодолевая силу
depends upon — зависит от
until an equilibrium of charge has taken place — пока не наступит равновесное состояние зарядов
instructive analogy — поучительная аналогия

11. POWER TRANSMISSION

About a hundred years ago, power was never carried far away from its source. Later on, the range of transmission was expanded to a few miles. And now, in a comparatively short period of time, electrical engineering has achieved so much that it is quite possible to convert mechanical into electrical energy and transmit the latter over hundreds of kilometers and more in any direction required.

Then in a suitable locality the electric energy can be reconverted into mechanical energy wherever it is desirable. It is not difficult to understand that the above process has been made possible owing to generators, transformers and motors as well as to other necessary electrical equipment.

It goes without saying that as soon as the electric ener-gy is produced at the power-station, it is to be transmitted over wires to the substation and then to the consumer. How-ever, the longer the wire, the greater is its resistance to current flow. On the other hand, the higher the offered re-sistance, the greater are the heating losses in electric wires. One can reduce these undesirable losses in two ways, namely, one can reduce either the resistance or the current. It is easy for us to see how we can reduce resistance: it is necessary to make use of a better conducting material and as thick wires as possible. However, such wires are calculat-ed to require too much material and, hence, they will be too expensive. Can the current be reduced? Yes, it is quite possible to reduce the current in the transmission system by employing transformers. In effect, the waste of useful ener-gy has been greatly decreased due to high-voltage lines. It is well known that high voltage means low current, low current in its turn results in reduced heating losses in elec-trical wires. It is dangerous, however, to use power at very high voltages for anything but transmission and distribu-tion. For that reason, the voltage is always reduced again before the power is made use of.

Lasers. Scientists are successfully developing quantum generators, called lasers, for emitting light ampli-tude radio waves. Theoretical calculations have shown that lasers are very likely to transform the energy of light radio waves into electrical energy with an efficiency amounting to about 100 per cent. It means that electrical power might be transmitted over considerable distances with negligible losses and what is very important without the use of trans-mission lines.

12. NUCLEAR RADIATION

Nuclear radiation is not a new phenomenon. From the beginning of time, man has always been subjected to natural, or background, radiation from radioactive elements such as uranium, thorium, radium, and other substances which are everywhere in the earth. This radiation is present in small amounts in the air we breathe, the food we eat, the water we drink, and the earth under our feet.

Cosmic rays are also part of this natural radiation to which everyone is constantly exposed. Cosmic rays are nuclear particles of very high ener-gy, which strike the earth from outer space.

Man-made radiation, while highly beneficial, can be extremely dange-rous if not used under careful control. But in this respect, it is not essen-tially different from man-made electricity, a familiar and indispensable household and industrial servant, but one which can be a formidable ene-my when out of control. One easy way to understand radiation and its place in our economy, as a matter of fact, is to continue this comparison with electricity. Nuclear radiation cannot be seen, heard, felt, tasted, or smelt. Electricity, though it can be felt, likewise cannot be seen, heard, tasted, or smelt during its normal operation and use.

Nuclear radiation is a new force in our daily lives, as electricity was less than a century ago.

13. J.J. THOMSON'S EXPERIMENTS

Knowing cathode rays to be negatively charged particles the question immediately arose as to whether they were all alike. To determine this it was clear that two things would to be done: one, to measure the mass of the particles, and the other, to measure the amount of their charge. Although the first attempts to do this were not entirely successful, J.J. Thomson did succeed, in 1897, in determining the velocity of the rays and in measuring the ratio between their charge *e* and their mass *m*. The discharge tube designed for these experiments is drawn in Figure.

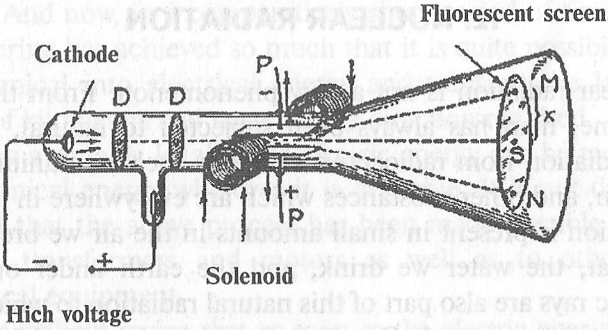

Figure 11. Diagram of Discharge Tube used by J.J. Thomson to Measure the Velocity of Cathode Rays

Cathode rays originating at the left-hand electrode and limited to a thin pencil of rays by two pinholes in diaphragms *D* are made to pass between two parallel metal plates *P* and the magnetic field of two external sole-noids to a fluorescent screen at the far side. When the two metal plates *P* are connected to a high potential, the particles experience a downward force and their path is bent to strike the screen at the point *N*. Without a charge on the plates the beam passes straight through undeviated and strikes the screen at the point S.

14. LIGHTNING

The lightning flash is certainly the earliest manifestation of electricity known to man, although for a long time nobody knew that lightning and atmospheric electricity are one and the same thing. Indeed, for thousands of year people knew nothing about thunderstorms. However they saw long sparks falling from the dark sky and heard thunder. They knew that these sparks could kill people or strike their houses and destroy them. Trying to understand that dangerous phenomenon, they imagined thing and invented numerous stories.

Take the early Scandinavians as an example! They thought that thunderstorms were produced by Thor, the god of thunder. Besides his throwing both thunder and lightning at some people, he was a hammer-thrower. According to the story, his powerful hammer had the property of always coming back to his hands after it had been thrown. The fifth day of the week, that is Thursday, was named after him. A story like that invented by those early Scandinavians could be also heard from other peoples.

However, time files. Thunderstorms have long stopped being a problem that scientists tried to solve. Now everybody knows that lightning is a very great flash of light resulting from a discharge of atmospheric electricity either between charged clouds.

Even now some people do not like being out during a thunderstorm. Dark clouds appear in the sky, turning day into night. There are lightning flashes followed by thunder, which can be heard for kilometers around. Needless to say, there is always some danger in a thunderstorm for a very high building or a man standing in the open field.

Many years ago people learned to protect their houses from thunderstorms. Coming down from a charged cloud to the earth, lightning usually strikes the nearest conductor. Therefore, it is necessary to prove an easy path along which electrons are conducted to the earth. That Benjamin Franklin invented the lightning conductor is a well-known fact. The lightning conductor, familiar to everybody at present, is a metal device protecting buildings from danger of lightning by conducting the electrical charges to the earth.

Franklin's achievements in the field of electricity were known to Lomonosov who, in his turn, made experiments of his own. He made numerous experiments and observations without thinking of the possible danger. The first measuring device in the world was constructed by professor Rihman. Making experiments of that kind was dangerous and professor Rihman was killed by a stroke of lightning while he was making one of his experiments.

15. IF THERE WERE NO ELECTRICITY

At present it is difficult even to imagine the time when there was no electricity, when people had to do without it.

What would our everyday life be like if there were no electricity?

Can you imagine a situation when all devices producing electricity would stop operating?

If this happened in the evening while you were in the cinema, you would be sitting in the dark without light. Then you would walk along dark streets. You would try to take a trolley-bus or a tram, it would be impossible. As there would be no light at home, you should use either a smoking kerosene lamp or a candle.

You would like to use the telephone or to watch TV but they would not work because they both depend upon electric current. This example shows the importance of electricity in everyday life.

16. TRANSMITTING PICTURES BY TELEPHONE

Pictures can now be sent over telephone by sound signals. A new machine does this by looking at a picture and telling what it sees over the telephone to a similar machine at the receiving end, which then translates the sound signals it hears back into the form of a picture.

At the sending end, the photograph, drawing business form or document is placed in the machine. At the receiving end, the reproduction appears on ordinary paper. An illustration of ordinary letter size takes six minutes to be received and reproduced.

This is how the machine works.

Inside the machine optical devices rotate and pick up reflected light, which is focused on and passed through a filter to a photocell or "electronic eye". The photocell generates a signal, which is amplified to produce voltages of varying strength.

The voltages are converted into sound, and it is this audible signal, which is transmitted over the telephone, just as music or voice is transmitted.

At the receiving telephone, the sound is reconverted to an electronic signal and then into a varying voltage. This voltage is applied to a drive mechanism. The mechanism is activated to extend and print out a corresponding dark area of the transmitting picture. The length of the document determines the needed for transmission.

17. TELECOMMUNICATIONS AND TV CENTRE

Different ways of sending messages over long distances have been known and employed for thousands of years. But most important developments in the field of telecommunications have been made over the last hundred years.

Most modern methods of telecommunication employ electricity. In 1820 it was discovered that an electric current could deflect a magnetic needle to the left or to the right. This discovery made possible the invention of the telegraph.

The telephone, which transmits speech, was a later invention. All sources of sound vibrate the air in different ways. The varying current is carried along a wire to a receiver, in which a thin metal plate vibrates in the same way as the original voice.

Moving pictures can be sent by television. Originally only black-and-white pictures could be transmitted, and the distances over which they could be sent were relatively short. But colour television has now been developed, and telecommunication satellites have made inter-continental television transmission possible.

Television now plays an important part in many people's lives. Television informs people about current events, the latest developments in science and politics, and offers different programmes, which are both interesting and instructive.

Notes:

in the same way — таким же образом
moving pictures — (движущиеся) изображения

18. UNDERGROUND HYDROELECTRIC POWER-STATION

In about 1889 what may have been the world's first underground hydroelectric power-station was installed in one of the mines in America. This plant comprised six 40 in. impulse wheels operating under a vertical head of 1,680 ft, each runner being connected to a generator supplying power to the mill a short distance away. Designs and techniques have gradually improved during the past years and there are now 300 underground hydroelectric power-stations either in service or under construction.

19. MAGNETIZED WATER

Physicists have discovered that treatment of water solutions with a magnetic field changes the crystal formation. It was also noted that upon being withdrawn from the magnetic field, water retains its newly acquired qualities for a few days. The water "remembers" the magnetic field.

Under the influence of a magnetic field water changes its basic physical and chemical properties, namely, density surface tension and electric conductivity. Salt solubility changes to an especially remarkable extent. These new properties were used for practical purposes. For instance, magnetized water forms almost no scales on boiler wall.

What is behind this interesting and unusual effect of magnetized water on living and non-living matter? Scientists explain this by a change in the geometrical structure of molecules under the influence of magnetic field. The magnetic field orientates and rearranges the molecules of water, thus causing changes in its physicochemical properties.

20. ELECTRIC CURRENT SERVES US IN A THOUSAND WAYS

The electric current was born in the year 1800 when Volta constructed the first source of continuous current. Since that time numerous scientists and inventors, Russian and foreign, have greatly contributed to its development and practical application.

As a result, we cannot imagine modern civilization without the electric current. We can't imagine how people could do without electric lamps, without vacuum cleaners, refrigerators, washing machines and other electrically operated devices that are widely used today. In fact, telephones, lifts, electric trams and trains, radio and television have been made possible only owing to the electric current.

The student reading this article is certainly familiar with the important part which the electric current plays in everyday life. From the moment when he gets up in the morning until he goes a bad at night, he widely uses electric energy. Only when going to the institute either on foot or by bicycle, he can do without electricity. In fact, it is well known that electric current is necessary for the operation of trolley-buses, trams, buses and modern trains.

During the day the student will also use some electrical devices working in the laboratory, making use of the telephone, the lift, the tram and so on. As for the evening, if he studies or reads by an electric lamp, watches television, goes to the theatre or cinema, he certainly uses electricity.

Some people are more familiar with the various application of the electric current in their everyday life than they are with its numerous industrial applications. However, electric energy finds its most important use in industry. Take, for example, the electric motor transforming electric energy into mechanical energy. It finds wide application at every mill and factory. As for the electric crane, it can easily lift objects weighing hundreds of tons.

A good example, which is illustrating an important industrial use of the electric current, is the electrically heated furnace. Great masses of metal melted in such furnaces flow like water. Speaking of the melted metals, we might mention one more device using electricity, that is the electric pyrometer. The temperature of hot flowing metals can be easily measured owing to the electric pyrometer.

These are only some of the various industrial applications of the electric current serving us in a thousand ways.

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