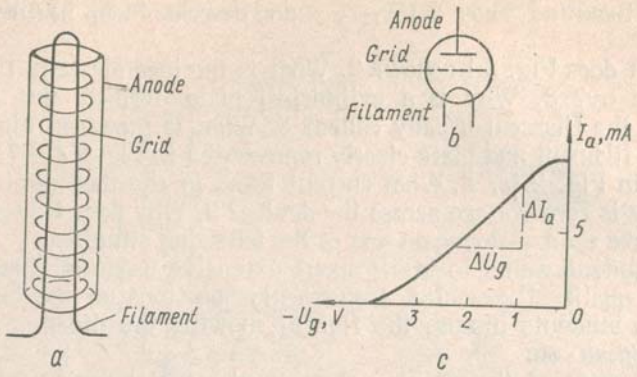

Fig. 2.2. The triode valve:
a a diagram; *b* the circuit symbol; *c* the typical transfer characteristics.

Amplification ratio коэффициент усиления; hi-fi [haifai] (high fidelity) высокая точность воспроизведения; triode valve триодная электронная лампа; audio frequency звуковая частота.

IV. a) Form new words with the following suffixes and define their functions. b) Translate them into Russian.

-al: addition, electric, magnetic; -ly: negative, positive, resistive; -er: rectify, amplify, receive; -ing: permit, act, allow; -tion: direct, add, amplify, rectify.

V. a) Put questions to the words and word-combinations in bold type. b) Translate the sentences.

1. A triode has three parts. 2. The additional part is called a grid. 3. The grid is used to control the electron flow from cathode to plate. 4. The current through the plate is a function of the grid voltage. 5. In radioreceiver, the signal that reaches the grid from an antenna is high frequency a. c.

VI. a) Find the verbs in the Passive Voice in the Text C. b) Translate sentences with them.

Text C

THE TRIODE

I. a) Read the text. b) Speak on the structure and function of a triode.

In 1907 a young American engineer, Lee De Forest, added a third part to the diode. Because it now has three parts, it is called a triode. This three-electrode device, or triode is shown in Fig. 2.2*a* and its circuit symbol in Fig. 2.2*b*.

The additional part is called a grid, since it looks like a piece of window screen. The grid is used to control the electron flow from cathode to plate. A negatively charged grid will repel some or all of the electrons emitted from the cathode. A positively charged grid will

attract more electrons from the cathode. The current through the plate is a function of the grid voltage. Not only does the grid play the role of a rectifier by permitting current flow only in one direction, but it also acts as an amplifier, allowing large currents to flow when the grid is positive and smaller currents when the grid is negative.

The amplification ratio for a triode tube is the ratio of the change in plate voltage per unit change in grid voltage. Thus amplification $= \frac{\text{change in plate voltage}}{\text{change in grid voltage}} = \frac{U_p}{U_g}$.

In the amplifier of a hi-fi, radio, or TV, the amplification is provided by a triode. In a radioreceiver, the signal that reaches the grid from an antenna is high frequency (radio frequency) a. c. The rectification or detection of the radio signal is accomplished by means of a triode. The triode changes high frequency a. c. to radiofrequency if the grid circuit contains the correct capacitance and resistance.

ASSIGNMENTS

VI. Read the Text C attentively and answer the following questions.

1. Who added a third part to the diode? 2. How many parts are there in a triode? 3. How is the additional part called? 4. What is the grid used to? 5. What attracts more electrons from the cathode? 6. What is the function of the grid voltage? 7. What is the amplification ratio for a triode?

II. a) Read the text again and ask additional questions embracing its contents. b) Combine your answers into a short summary of the text.

III. a) Find the part in the Text C containing information about grid. b) **Discuss it.**

IV. a) Read the **text closely and pick out the key sentences. b) Thanslate** them.

V. Pick out all technical terms from the Text C and translate them.

VI. Speak **on the triode according to the denotative plan:**

1. **Invention:** 1907; young American engineer Lee De Forest; add, third part to the triode; because; call; triode.

2. **Structure:** additional part; grid; look like; piece; window screen.

3. **Function:** control; the electron flow; cathode; plate; a negatively charged grid; repel; emit; positively charged grid; attract; current; through the plate; grid voltage; play the role; a rectifier; by permitting current flow; one direction; act; as an rectifier; allowing; smaller current, grid.

4. **The amplification ratio:** a triode tube, change, plate voltage, per unit charge, grid voltage.

5. **The provision of the amplification:** hi-fi; radio; TV; radioreceiver; signal; achieve; antenna; high frequency a. c.; audio frequency; contain; correct capacitance and resistance.

VII. Review the text in written form.

VIII. Translate the text to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

wire mesh	относительно
cut-off point	крутизна
transconductance	проволочная сетка
low tension	появляться
relative to	передача
appear	подсказывать
"hum" component	введение
eventually	в конечном счете
transfer	колебаться
fluctuate	точка отсечки
suggest	низкое напряжение
injection	фоновая составляющая

II. Pick out all technical terms from the Text D and translate the sentences with them.

III. Translate the following word-combinations from the Text D.

Held negative; with respect to; under which conditions; the emitted electrons; a certain fraction; through the space; the more negative ..., the more powerful ...; none of the emitted electrons; valve transfer characteristics; fluctuation in electrone current; relative to.

Text D

THE TRIODE CHARACTERISTICS

I. Read the text and say what it is about.

The grid in a triode normally held negative with respect to the filament, under which condition it repels some of the emitted electrons back to the filament, allowing only a certain fraction to reach the anode through the space in the wire mesh. The more negative the grid is made, the more powerful its repellent field becomes and the lower the anode current falls. Eventually, the cut-off point is reached when none of the emitted electrons reaches the anode and the current falls to zero. A typical triode valve transfer characteristics is shown in Fig. 2.2*c*. The transfer property of a valve is specified by its transconductance, g_m, where $g_m = \frac{\text{change in anode current}}{\text{change in grid voltage}} = \frac{\Delta I_a}{\Delta V_g}$ (usual units mA/V).

Early valve equipment used d. c., both for the high tension HT (anode supply) and for the filament supply (low tension or LT). It is very convenient, however, if the cathode can be heated by a. c. since this is readily available directly from a mains transformer. There are

two problems associated with a. c. heated filaments. Firstly, the temperature of the filament may fluctuate in sympathy with the a. c. frequency, giving rise to a 100 Hz fluctuation in electron current with 50 Hz a. c. Secondly, because the input grid voltage is applied relative to the cathode, a proportion of the a. c. filament voltage will appear in the input signal, producing a 50 Hz "hum" component.

These two problems are overcome in the indirectly heated cathode which is used in almost all small valves. As the name suggests, the cathode is electrically insulated from the heating filament, avoiding the direct injection of a. c. into the input circuit.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. How can a thermionic amplifying device be produced? 2. Who added the third part to the triode? 3. How is a three-electrode device called? 4. What is the potential of the grid? 5. How is the transfer property of a triode valve specified? 6.By what can the cathode be heated? 7. What problems are associated with a. c. heated filaments?

II. Examine Fig. 2.1, 2.2 and describe them.

III. Discuss the problems of a triode.

IV. Prepare a dialogue on one of the following situations:

1. The lecturer in electronics is asking his students about the simplest amplifying devices.

2. Two specialists in electronics are discussing the problem of using d. c. and a. c. in valve equipment.

V. Speak on:

1. The structure of a triode.

2. Valve equipment using d. c. and a. c.

VI. Look through the latest magazines, find information on a triode and annotate it.

III. GRAMMAR EXERCISES

I. a) Give the main forms of the verbs from the Text C and the Text D. b) Translate the sentences with them.

Add, have, call, show, use, flow, emit, attract, play, act, be, provide, accomplish, reach, change, repel, can, heat, may, apply, appear, overcome.

II. Transform the sentences according to the model.

Model. The first grid **is called** a control grid.
Первая сетка *называется* управляющей сеткой.
The first grid **was called** a control grid.
Первая сетка *называлась* управляющей сеткой.
The first grid **will be called** a control grid.
Первая сетка *будет называться* управляющей сеткой.

1. The filament is surrounded by a cylindrical plate. 2. As the anode is made positive, the current increases. 3. A valve with a grid

between the filament and anode is called a triode. 4. The second grid is termed a screen grid. 5. The screen grid is placed between the anode and control grid. 6. The tetrode is used for amplification at low frequences.

III. Determine the function of Participle II in the following sentences and translate them.

1. The filament is surrounded by a cylindrical plate, normally termed the anode. 2. The third grid is introduced between the anode and the screen grid. 3. The pentode is widely used for amplification at high and low frequencies. 4. The grid placed between the anode and control grid is called the screen grid.

IV. Put questions to the words in bold type.

1. **The thermionic diode** is a two-electrode valve. 2. It **consists** of a plate and filament. 3. **The tetrode** consists of the **anode, cathode** and two **grids.** 4. **The pentode** comprises the anode, cathode and three grids 5. The pentode is widely used **for amplification at high and low frequencies.**

V. Translate the following sentences and pay attention to the word-combinations in bold type.

1. The filament is usually held positive **with respect to** the filament. 2. **As the anode is made positive,** the current increases. 3. **Although obsolete for most small-scale amplification,** the valve **still** finds a place where high voltages must be handled. 4. **Similarly,** the filament is usually called the cathode. 5. The additional part is called a grid, **since it looks like** a piece of window screen. 6. The rectification or detection of the radio signal is accomplished **by means of** a triode.

VI. a) Find all verbs in the Text D and define their tense-forms. b) Translate the sentences into Russian.

Lesson 2. THE TETRODE AND PENTODE

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [u:] soon, good; [aɪ] desired, amplifier, triode, strike; [i:] deal; screen, beam, need, been, mean, peak; [ɔ:] nor, normally; [au] allow, out, output.

II. Spurious ['spjuərɪəs], yet [jet], through [θru:], bias ['baɪəs], automatic [ˌɔ:tə'mætɪk], inherently [ɪn'hɪər(e)ntlɪ], piezoelectric [paɪˌi:zəo(u)ɪ'lektrɪk].

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat them after the speaker.

Tetrode, triode, radio, kiloherz, signal, problem, electrostatic potential, anode, symbol, characteristic, emission, positive, electron, form, concentrated, pentode, alternative, piezoelectric.

III. Check if you know the meaning of these words and word-combinations.

Introduce вводить; similar to подобно чему-л.; to maintain поддерживать; tend стремиться; cause вызывать, быть причиной; extensively широко; performance характеристика; capacitance емкость; screen grid экранирующая сетка; undesirable «kink» нежелательный «изгиб» (излом); snag препятствие; leave a good deal to be desired оставляет желать лучшего; the gain fell rapidly коэффициент усиления резко уменьшался; generating spurious signal themselves автоматически образуя ложные сигналы; the main cause of the high-frequency shortcomings основная причина недостатков на высоких частотах; be connected to earth via a capacitor быть связанным с землей через конденсатор; as far as the a. c. signal is concerned что касается сигнала переменного тока; tend to dislodge стремиться выбить; thus robbing таким образом лишая.

IV. Convert the statements into questions according to the model.

Model. The screen grid is introduced to serve as an electrostatic screen between anode and grid.
What grid is introduced to serve as an electrostatic screen between anode and grid?
Is the screen grid introduced to serve as an electrostatic screen between anode and grid?
Why is the screen grid introduced?

1. The main cause of the high-frequency shortcomings of the triode is the capacitance between anode and grid. 2. A second grid or screen grid serves as an electrostatic potential. 3. Fig. 2.3 *a* shows the tetrode valve. 4. This is the four electrode valve. 5. An alternative solution to secondary emission is the introduction of a suppressor grid between screen grid and anode.

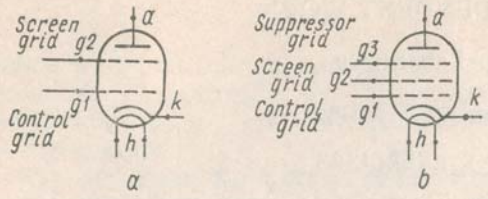

Fig. 2.3. Multigrid valves:
a tetrode; *b* pentode.

V. Give English equivalents to the following.

Широко использовать; желать много лучшего; для того, чтобы поддерживать; что касается сигнала переменного тока; таким образом; соединять обычно; за исключением; первоначально.

VI. Give initial forms of the following words.

Extensively, amplification, performance, rapidly, generating, electrostatic, robbing, overcoming, travelling, alternative.

Text A

THE TETRODE VALVE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

When the triode became extensively used for amplification in radio work in the 1920s, it was soon realized that its performance at high frequencies, above a few tens kilohertz, left a good deal to be desired. At these frequencies the gain fell rapidly and some amplifiers would oscillate, generating spurious signals themselves. The main cause of the high-frequency shortcomings of the triode is the capacitance between anode and grid. To overcome this problem, a second grid or screen grid serves as an electrostatic potential similar to that of the anode in order to maintain the electron flow, but is connected to earth via a capacitor so that, as far as the a.c. signal is concerned, it is an earthed screen. Thus we have the tetrode valve, its circuit symbol being shown in Fig. 2.3*a*.

2. Average Reading

Text B

THE SECONDARY EMISSION

I. a) Listen to the text. b) Read it (time limit is 2 min.). c) Find the part of it dealing with the function of the tetrode.

Fig. 2.3*a* shows the tetrode valve. This is the four electrode valve. The second grid or screen grid is introduced to serve as an electrostatic screen between anode and grid. It is held at a positive d.c. potential similar to that of the anode in order to maintain the electron flow. When electrons strike a valve anode, they tend to dislodge other electrons and cause what is known as secondary emission.

One disadvantage of the tetrode is that these electrons can be drawn to the screen grid, thus robbing the anode of current and giving rise

to an undesirable "kink" in the anode characteristic. One way of overcoming this snag is to form the electrons travelling towards the anode into a concentrated beam, using special beam-forming plates.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the disadvantage of the tetrode. b) Discuss the information with your fellow-students.

III. Answer the following questions embracing the contents of the Text A and the Text B.

1. When did the triode become extensively used for amplification in radio work? 2. Does the gain fell rapidly at the frequency above a few tens kilohertz? 3. What is the main cause of the high-frequency shortcomings of the triode? 4. What is introduced in the triode to overcome the main cause of the high-frequency shortcomings of the triode? 5. What is the function of the second or screen grid? 6. What advantages and disadvantages of the tetrode do you know? 7. What does Fig.2.3a show? 8. What is the tetrode? 9.Why is the second grid or screen grid introduced? 10. What potential is it held at? 11.What is known as secondary emission?

IV. Discuss the information obtained from the Text A and the Text B.

V. Be ready to discuss the information on the topic received at your lectures on speciality.

VI. Prepare a dialogue on one of the following situations:

1. Two specialists in electronics have a talk about the history of the development of thermionic valves.

2. The students are discussing the advantages and shortcomings of the tetrode and the pentode.

VII. Speak on:

1. How to overcome the main cause of the high-frequency shortcomings of the triode.

2. The structure and function of the tetrode and pentode.

VIII. Translate the question-answer units into English. Work in pairs.

1. В чем основная причина несовершенства триода на высоких частотах? (Основной причиной несовершенства триода на высоких частотах является емкость между анодом и сеткой.)

2. Что вводится в триод для того, чтобы устранить слабое место триода на высоких частотах? (Для преодоления этого недостатка между управляющей сеткой и анодом вводится вторая сетка.)

3. Какова функция второй или экранирующей сетки? (Вторая или экранирующая сетка служит электрическим экраном между анодом и сеткой.)

4. В чем слабое место тетрода? (Одним из слабых мест тетрода является то обстоятельство, что вторичные электроны могут проходить к экранирующей сетке, таким образом уменьшая поступление

на анод тока и приводя к нежелательному излому в анодной характеристике.)

5. Что называется пентодом? (Пентод — это пятиэлектродная электронная лампа.)

6. Как называется дополнительная сетка в пентоде? (Она называется защитной сеткой.)

7. К чему присоединяется защитная сетка? (Защитная сетка обычно присоединяется или к катоду, или к «земле».)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Introduction введение; connect v. соединять; normally обычно; earth земля; repel v. отталкивать; allow позволять, разрешать; pass проходить; initially первоначально; fulfill выполнять; need нужда; exception исключение; slightly слегка; extensively широко.

II. Memorize the words and word-combinations used in their specialized meanings.

Solution раствор; suppressor grid защитная сетка; screen grid экранирующая сетка; stream n. поток; amplification усиление; noise шум; low frequency низкая частота.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

Whilst allowing the more energetic electron stream to pass тем самым давая возможность потоку электронов с большей энергией проходить; with the exception of a slightly higher noise level за исключением немного более высокого уровня шума; the pentode has therefore been extensively used for пентод, следовательно, широко используется для.

Text C

THE PENTODE VALVE

I. a) Read the text. b) Find the part of it describing the suppressor grid. Translate it.

An alternative solution to secondary emission is the introduction of yet another grid — a suppressor grid between screen grid and anode. The supressor grid is normally connected either to the cathode or to earth so that it repels secondary electrons whilst allowing the more energetic electron stream to pass through from screen grid to anode. This five-electrode valve is the pentode; its circuit symbol is shown in Fig. 2.3*b*. Although the pentode was initially developed to fulfill the needs of high-frequency amplification, it turns out to have generally more useful characteristics than the triode, with the exception of a slightly higher noise level. The pentode has therefore been extensively used for amplification at high and low frequencies.

I. Read the Text C attentively and answer the following questions embracing its contents.

1. What is an alternative solution to secondary emission? 2. What is the suppressor grid connected to? 3. What is a five-electrode valve called? 4. Where is the circuit symbol of a pentode shown? 5. Does the pentode have generally more useful characteristics than the triode? 6. Where has the pentode been extensively used? 7. At what frequency is the pentode extensively used?

II. a) Divide the Text C into logical parts. b) Choose the key sentences and translate them.

III. Comment on the author's attitude to the pentode valve.

IV. Combine your answers into a short summary of the text.

V. Comment on the description of Fig. 2.3*b*.

VI. Compare standard symbols for tetrode and pentode, used in the USSR with those used in the USA.

VII. Speak on the text according to the denotative plan:

1. **The place of a suppressor grid in a valve:** an alternative solution; secondary emission; introduction; yet; another grid; suppressor grid; screen grid; anode; normally; connect; either ... or; cathode; earth; repel; secondary electron; allow; stream; pass through.

2. **Pentode, its function:** initially; develop; fulfill; need; high-frequency amplification; turn out; useful characteristics; with the exception of; slightly higher noise level.

3. **The usage of pentode:** extensively; use; amplification; high; low; frequency.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

voltage amplifier circuit	соответствующий
output voltage signal	смещение
load resistor	резистор нагрузки
biasing	обратная связь
circuit feature	особенность цепи
suitable	порядка
negligible	шунтирующий конденсатор
before serious distortion occurs	незначительный
approximately	приблизительно
short-circuiting a. c. signals to earth	до того, как произойдет заметное искажение
inherently high input impedance	закорачивание переменных сигналов на «землю»
feedback	сигнал напряжения
of the order of	цепь усиления напряжения
bypass capacitor	присущее высокое входное полное сопротивление

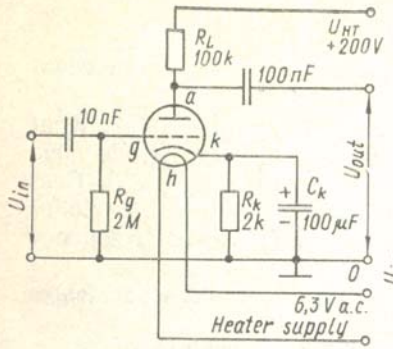

Fig. 2.4. The triode voltage amplifier.

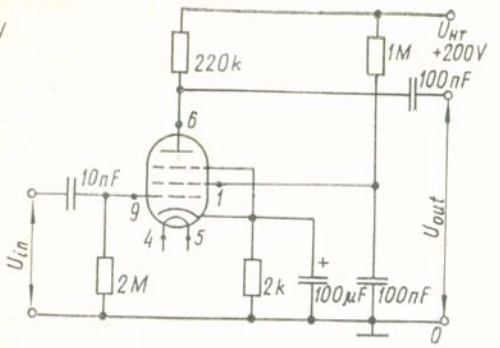

Fig. 2.5. The pentode voltage amplifier.

II. Give the main forms of the following verbs and translate them.

Show, give, find, use, develop, serve, know, prevent, appear, reduce, draw, have, supply, mean, handle, occur, can, produce.

III. a) Give initial forms of the following words and translate them. b) State the function of suffixes.

Amplifier, voltage, resistor, biasing, automatic, appear, opposing, independance, amplifying, bottoming, distortion, representative, equipment, connection, circuiting.

Text D

VOLTAGE AMPLIFIER

I. a) Read the text and say what it is about. b) Review the text.

The triode may be used in a voltage amplifier circuit. Fig. 2.4 shows such a circuit. The output voltage signal is developed across a load resistor R_L. The cathode resistor, R_k, serves a function for biasing. This circuit feature is known as automatic cathode bias. The 100 µF bypass capacitor prevents a. c. signals appearing across the cathode resistor; these would reduce gain by opposing the input signal (negative feedback).

The valve is a voltage-operated device which draws negligible input current. It therefore has an inherently high input impedance and is suitable for amplifying the output of piezoelectric and capacitor microphone. The need for a 200 V HT supply is a disadvantage, but it does mean that large amplitude signals can be handled before cut-off or bottoming occurs. A circuit such as Fig. 2.4 can produce output signals of the order of 100 V peak-to-peak before serious distortion occurs. A typical value for the voltage gain is 30.

A pentode voltage amplifier circuit is shown in Fig. 2.5. This circuit gives a voltage gain of approximately 300 and is representative of many circuits that are still to be found in valve equipment. Notice the connection between suppressor grid (g_3) and cathode, the screen

grid (g_2) and HT supply via a 1 M resistor, and the 100 nF screen grid bypass (decoupling) capacitor short circuiting a. c. signals to earth.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text C.

1. Where may the triode be used? 2. How is the output voltage signal developed? 3. What function does the cathode resistor, R_k, serve? 4. Is this circuit feature known as automatic cathode bias? 5. What draws negligible input current? 6. What input impedance has a voltage-operated device? 7. What can a circuit such as Fig. 2.4 produce? 8. What is a typical value for the voltage gain in triode amplifier? 9. What is shown in Fig. 2.5?

II. Prepare a dialogue on one of the following situations:

1. One of the engineers is explaining to the students the circuit feature known as automatic cathode bias.

2. Two students put questions to each other, using Fig. 2.4 and Fig. 2.5.

III. Speak on:

1. A voltage amplifier circuit.
2. The cathode resistor R_k as a function for biasing.
3. A voltage operating device.

IV. a) Examine Figs. 2.4, 2.5 and describe them. b) Discuss them with your fellow-students.

V. Make up a plan of the text.

VI. Give some additional informations about voltage amplifier.

VII. Look through the latest magazines and find additional information on the topic of the lesson. Discuss it.

III. GRAMMAR EXERCISES

I. a) Check if you know the function of the following suffixes and prefixes. b) Translate the words into Russian.

-tion: solution, introduction, amplification, exception, function, distortion, connection; **-ive:** alternative, representative; **-or, -er:** suppressor, amplifier, resistor, capacitor; **-ly:** normally, initially, generally, slightly, expressively; **-ing;** allowing, biasing, appearing, opposing, amplifying, using; **-ic:** energetic, characteristic, automatic, piezoelectric; **dis-:** disadvantage, disagreement, disappear, discharge; **un-** unknown, undesirable, unfortunately, unless.

II. a) Change the following sentences according to the model. Define the tense-forms of the verbs. b) Translate these sentences.

Model. The triode **is used** in a voltage amplifier circuit.
The triode **may be used** in a voltage amplifier circuit.

1. The output voltage signal is developed across a load resistor R_L. 2. This circuit feature is known as automatic cathode bias. 3. A large amplitude signals were handled before cut-off or bottoming

occurs. 4. A pentode voltage amplifier circuit is shown in Fig. 2.5. 5. Many circuits will be found in valve equipment. 6. The suppressor grid is normally connected either to the cathode or to earth. 7. The pentode was initially developed to fulfill the needs of high-frequency amplification.

III. a) Find Participle II in the Text C and in the Text D and state its function. b) Translate the sentences into Russian.

IV. Put questions to the words and word-combinations in bold type.

1. A **suppressor grid** is introduced between **screen grid and anode.** 2. The **suppressor grid** is normally connected either to the cathode or to earth. 3. The suppressor grid repels **secondary electrons.** 4. The suppressor grid allows the more energetic electron stream **to pass through from screen grid to anode.** 5. The pentode **turns out** to have generally more **useful** characteristics than the triode.

V. a) Translate the following sentences. b) Pay attention to the words and grammar-forms in bold type. Explain them.

1. Thus we have the tetrode valve, **its circuit symbol being shown in Fig. 2.3*a*.** 2. **To overcome** this problem, a second grid is introduced between the control grid and anode. 3. The second (screen) grid is held at a positive d. c. potential similar to that of the anode in order **to maintain** the electron flow, but is connected to earth via a capacitor so that, **as far as the a. c. signal is concerned,** it is an earthed screen.

VI. a) Find the sentences in the Text C and in the Text D containing the following verbs. Define their tense-forms. b) Translate the sentences into Russian.

Introduce, connect, repel, show, develop, turn out, use, serve, know, prevent, reduce, draw, handle, produce.

VII. a) Find attributes in the following word-combinations. Say by what parts of speech they are expressed. b) Translate them into Russian.

High frequency; a few tens kilohertz; generating spurious signals; the main cause; the high-frequency shortcomings of the triode; an electrostatic potential; an earthed screen; the tetrode valve; the circuit symbol; the four electrode valve; a positive d. c. potential; a concentrated beam; special beam-forming plate.

VIII. a) Write out all the verb-forms in the Passive Voice from the Text B and the Text C. b) Translate them.

IX. Complete the sentences and identify the verb-forms.

1. Fig. 2.3*a* shows ... 2. The second grid is introduced ... 3. When electrons strike a valve anode, they ... 4. One disadvantage of the tetrode is that these electrons can be drawn... 5. One way of overcoming this snag is to perform ...

Lesson 3. THE P-N JUNCTION

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

I. [ʃn] Operation, depletion, migration, junction; [ə:] occuring, external, reverse; [ʌ] junction, understand, result, underneath; [ıə] near, clear.

II. Classify [faı], valence ['veiləns], transistor ['trænsıstə], col'lector, com'pact, 'semicon'ductor, minimum ['mınımum], distribution [ˌdıstrıbjuʃn], classical [æ].

II. a) Listen and repeat after the speaker. b) State the function of the suffixes in the following words and translate them.

Operation, semiconductor, transistor, occurring, junction, placing, positive, negative, migration, relatively, typically, depletion, external, condition, breaking, temperature.

III. a) Listen, repeat and memorize the following word-combinations. b) Check if you know their meanings.

P-n junction p-n переход; semiconductor device полупроводниковый прибор; depletion layer обеднённый слой; external d. c. supply внешний источник питания постоянного тока; minority carriers неосновные носители; appropriate polarity соответствующая полярность; the same continuous crystal lattice такая же сплошная кристаллическая решетка; to fill some holes заполнить некоторые дырки;

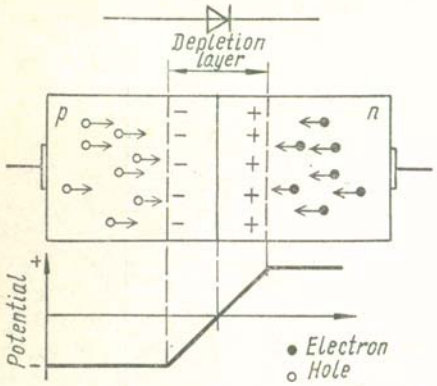

Fig. 2.6. The p-n junction with metallic contacts, its circuit symbol and variation of potential.

to leave behind a net positive charge оставлять (создавать) за собой общий положительный заряд; which opposes further migration которые противодействуют дальнейшему перемещению; a state of equilibrium is reached достигается состояние равновесия; relative clear of holes относительно свободный от дырок; due to thermal breaking of bonds in both p- and n-type materials обусловленный тепловым нарушением связей как в p-, так и в n-типах материала полупроводника.

IV. a) Find the verbs in the Text A and B and define their tense-forms. b) Translate the sentences with these verbs.

Text A

THE P-N JUNCTION DIODE

I. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The operation of a semiconductor device such as the transistor depends on the effect occuring at the junction between p- and n-type materials. It is essential at this stage to understand that a semiconductor junction is a change from p- to n-type material within the same continuous crystal lattice. Simply placing a piece of p-type material in contact with a piece of n- type material will not normally result in a p-n junction.

Fig. 2.6 shows a p-n junction diode with a metallic contact on each side. Underneath the junction diagram is a simple graph showing how the potential varies through the junction.

2. Average Reading

Text B

THE OPERATION OF A JUNCTION

I. a) Listen to the text. b) Find the part of it dealing with the increasing and decreasing of the potential barrier at the depletion layer. Discuss it.

As soon as the junction is formed, some of the free electrons near the junction in the n-type material cross over to fill some holes in

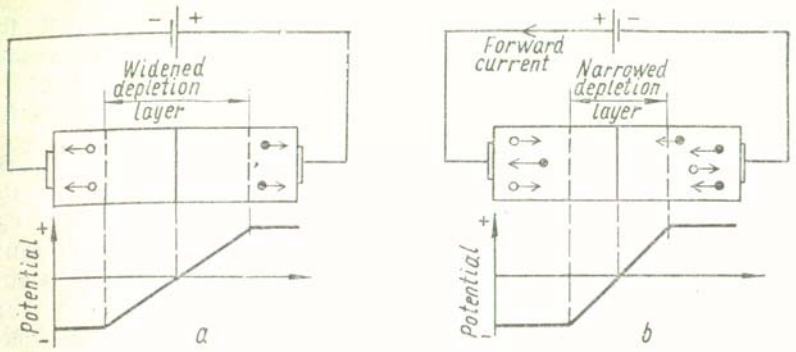

Fig. 2.7. The effect of the depletion layer of the p-n junction: *a* reverse bias; *b* forward bias.

the p-type; in doing so, they leave behind a net positive charge, whilst at the same time giving the p-type material a negative charge. These charges form a potential barrier which opposes further migration of electrons across the junction so that a state of equilibrium is reached. In this state the region near the junction is relatively clear of holes and free electrons as a result of the initial migration. This is called a depletion layer and is typically less than one micron wide.

If an external d. c. supply is connected to a p-n junction, the potential barrier at the depletion layer is either increased or decreased depending on the polarity of the external supply or bias. Fig. 2.7 shows the two conditions of (a) reverse bias, where the potential barrier is reinforced and the depletion layer widened, and (b) forward bias, where the effect of the barrier is decreased and the depletion layer narrowed. Under reversed biased conditions the only current flowing across the junction is the tiny one due to thermal breaking of bonds in both p- and n-type materials. The minority carriers are of the appropriate polarity to be drawn across the junction. At room temperature this reverse current is, however, so small in a silicon junction (typically 1 nA) as to be negligible for most practical purposes. When the junction is forward-biased, however, the potential barrier is decreased in height, equilibrium is upset and some electrons in the n-region and holes in the p-region are able to cross the junction. The greater the forward-bias voltage, the lower the potential barrier becomes and the more electrons and holes cross the depletion layer. Hence a net current flow is established across the junction.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B and find the part of it dealing with the minority carriers. b) Discuss the information with your fellow-students.

III. Find the part in the Text B containing information about the free electrons near the junction in the n-type material. b) Discuss it using the additional information from magazines and books on speciality.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What charges form a potential barrier which opposes further migration of electrons across the junction? 2. Is the region near the junction in this state relatively clear of holes and free electrons as a result of the initial migration? 3. What does the operation of a semiconductor device such as the transistor depend on? 4. What is a semiconductor junction? 5. What is called a depletion layer? 6. What is the current flowing across the junction under reversed-biased condition? 7. What is the magnitude of this reverse current at room temperature?

V. a) Examine Figs. 2.6 and 2.7. b) Answer the following questions.

1. What does Fig. 2.6 show? 2. What graph is underneath the junction diagram? 3. What does Fig. 2.7 show? 4. What is forward bias?

VI. Prepare a dialogue on one of the following situations:

1. A worker who worked with vacuum tubes in electronics wants to know about the function of a transistor. A specialist in the field is explaining to him the effect occurring at the junction between p- and n-type material.

2. Two students discuss what is shown in Fig. 2.6 and Fig. 2.7.

VII. Speak on:

1. The operation of a transistor;
2. Biased p-n junction.

VIII. Express your opinion of operation of a junction.

IX. Analyse the structure of the following word-combinations and memorize them.

A potential barrier потенциальный барьер; a state of equilibrium состояние равновесия; holes and free electrons дырки и свободные электроны; a depletion layer обеднённый слой; the polarity of the external supply or bias полярность внешнего источника или смещения; reverse bias обратное смещение; due to thermal breaking of bonds обусловленный тепловым нарушением связей; appropriate polarity соответствующая полярность.

X. Translate the question-answer units into English.

1. От чего зависит работа транзистора? (Работа транзистора зависит от явлений, происходящих в переходе между p- и n-типами материала.)

2. Что представляет собой полупроводниковый переход? (Полупроводниковый переход представляет собой изменение от p- до n-типа материала в одной и той же сплошной кристаллической решетке.)

3. Что называется обеднённым слоем? (Слой, в котором область около перехода относительно свободна от дырок и свободных электронов в результате первоначальной миграции, называется обеднённым слоем.)

4. Что представляет собой ток, проходящий через переход при условии его обратного смещения? (В случае обратного смещения

единственным током, проходящим через переход, является незначительный ток, обусловленный тепловым нарушением связей как в p-, так и в n-типах материала полупроводника.)

5. Какова величина этого обратного тока при комнатной температуре? (При комнатной температуре обратный ток так мал в кремниевом переходе, что им можно пренебречь для многих практических целей.)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words and word-combinations.

Explanation объяснение; depend on (upon) зависеть от чего-л.; distribution распределение; comprise включать, содержать; immediately немедленно; size размер; nearby близлежащий; separation отделение, разделение; bottom дно; низ; top вершина, верх; overlap перекрывать; sense смысл; refer относиться; behind за, позади; both ... and и ... и.

II. Memorize these words and word-combinations used in their specialized meanings.

Band зона, полоса; property свойство; solid твердое тело; jump переходить; hole дырка; carrier носитель; insulator изолятор; empty position свободное расположение.

III. Find these terms in the Text C and translate the sentences containing them.

Conduction band зона проводимости; valence band валентная зона; energy gap энергетическая щель; energy level энергетический уровень; band gap запрещенная зона.

IV. a) State the function of the suffixes in the following words. b) Translate them.

Explanation, distribution, highest, conduction, immediately, separation, insulator, reaching, classical, position, leaving.

Text C

ENERGETIC BANDS IN SOLIDS

I. a) Read the text. b) Find the part of it describing band's forms, insulators, semiconductors and holes.

The modern explanation of the different electrical properties of solids depends upon the distribution of the electrons in a solid into energy levels, called bands. The highest energy levels in a solid comprise the conduction band. The energy levels immediately below this band comprise the valence band. The properties of a material depend on the size of the energy separation between the bottom of the conduction band and the top of the valence band, called the band or energy gap. Materials that have large band gaps are insulators. If

the two bands overlap, there is no band gap and the material is a conductor. When the band gap is small, the material is classified as a semiconductor.

Because the band gap in semiconductors is small, it is possible for a small quantity of energy, supplied by light, heat or a low voltage, to cause electrons to jump from the valence band to the conduction band. Electrons reaching the conduction band become free electrons, in a classical sense of the phrase. The empty position left behind by the electron in the valence band is called a hole. A nearby valence electron can jump into this hole, leaving behind an other hole. Thus a series of holes flow toward the negative terminal while electrons flow in the opposite direction. The holes are referred to as positive charge carriers. Semiconductors, therefore, have both negative and positive charge carriers.

ASSIGNMENTS

I. Divide the text into logical parts. Choose the key sentences and translate them.

II. Look through the text and find the part of it dealing with the electrons reaching the conduction band.

III. Read the Text C attentively and answer the following questions.

1. What does the modern explanation of the different electrical properties of solids depend upon? 2. What are called bands? 3. What do the valence bands comprise? 4. What do the properties of a material depend on? 5. What materials are called insulators? 6. What is a conductor? 7. What is classified as a semiconductor? 8. Why is the flow of holes equivalent to a positive current opposite to the electron flow? 9. Why is it possible to cause electrons to jump from the valence band to the conduction band? 10. When do electrons become free electrons? 11. What is called a hole? 12. Where do a series of holes flow? 13. Are the holes referred to as positive charge carriers? 14. What carriers do semiconductors have?

IV. Find in the Text C English equivalents for the following Russian words and word-combinations.

Возможно для небольшого количества энергии; побудить электроны переходить; электроны, достигая зоны проводимости; близлежащие валентные электроны; серия дырок; относиться к положительным зарядам; как отрицательные, так и положительные носители зарядов.

V. Speak on the following problems:

1. Distinguish between conductors and insulators in terms of their conduction and valence bands.

2. Explain the difference between holes and electrons in a semiconductor.

VI. Make a short written summary of the Text C.

VII. Find the verbs in the Text C and state their tense-forms.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

apply v.	благодаря
increase v.	производить
reduction	проявлять, представлять
owing to	применять
produce	прямое напряжение
forward voltage	увеличивать
exhibit v.	значительно
nearly	вкратце
significantly	уменьшение
in brief	почти
conversion	точка
point	превращение, переход

II. Find the following word-combinations in the Text D and translate the sentences containing them.

The forward e. m. f.; the effective resistance; owing to the reduction; the potential barrier; applied voltage; forward direction; forward voltage; the forward and reverse characteristics; a silicon junction; germanium junction; a potential drop; infinite resistance.

III. a) Give the initial forms of the following words from the Text D and translate them. b) State the function of suffixes.

Junction, effective, resistance, reduction, potential, direction, typically, freely, rectification, conversion.

IV. Find the following verbs in the Text D and state their tense-forms.

Increase, decrease, result, produce, show, begin, exhibit, allow, present, point.

Text D

VOLT-AMPERE CHARACTERISTICS OF A DIODE

I. Read the text and say what it is about.

It is important to note that, as the forward e. m. f. applied across the junction is increased, so the effective resistance at the junction is decreased owing to the reduction of the potential barrier. The result is that a very small increase in applied voltage in the forward direction results in a large increase in current. Typically, in a small silicon diode, a forward voltage of 0.6 V produces a current of 1 mA, and a forward voltage of 0.8 V produces a current of 100 mA. The forward and reverse characteristics of a typical small silicon diode are shown on a graph of current against applied e. m. f. in Fig. 2.8. It is clear

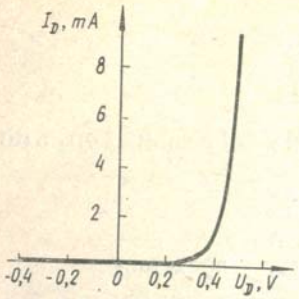

Fig. 2.8. Volt-ampere characteristics of a diode.

from the graph that a silicon junction does not begin to conduct significantly until a forward e. m. f. in the region of 0.5 V is present. Germanium junctions exhibit a smaller potential drop, in the region of 0.2 V.

In brief, a diode allows current to flow freely in one direction but presents a nearly infinite resistance the other way. This oneway characteristic points to an important use of diodes: rectification, the conversion of a. c. to d. c.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D.

1. What happens as the forward e. m. f. applied across the junction is increased? 2. What does a very small increase in applied voltage in the forward direction result in? 3. What is shown in Fig. 2.8? 4. What does germanium junction exhibit in the forward direction? 5. What does this one-way characteristic point?

II. Prepare a dialogue on your own situation.

III. Make up the plan of the Text D.

IV. Retell the text according to your plan.

V. a) Read the Text D closely. b) Discuss information about volt-amperes characteristics of a diode.

VI. Look through the latest magazines on the topic of the lesson and discuss it with your fellow-students.

VII. Make a short written summary of the topic.

III. GRAMMAR EXERCISES

I. Give the main forms of the following verbs and translate them.

Depend, comprise, become, leave, call, flow, refer, have, increase, decrease, result, produce, begin, exhibit, allow, present, point.

II. Compare the pairs of sentences, explain the use of tenses and translate them into Russian.

Indefinite Tenses	Continuous Tenses
1. We **build** new radio station every year.	1. They **are building** a new telecentre in our town.
2. That year the Moscow workers **built** a new TV tower.	2. They **were** still **building** the TV tower when you came to live in Moscow.
3. Next year they **will build** one more section of the TV studio.	3. What section of the studio **will** they **be building** next month?

Perfect Tenses	Perfect Continuous Tenses
1. The TV tower **has** recently **begun** to function.	1. Colour television in our country **has been functioning** since 1967.
2. The Moscow TV studio **had produced** a great number of colour TV films by 1970, when the Ostankino tower was built.	2. The Moscow TV studio **had been producing** colour TV films for three years before the Ostankino tower was built.
3. The new TV studio in our town **will have transmitted** its first program by the end of this year.	3. By 1977 our telecentre will **have been transmitting** programs for six years.

III. Pay attention to the compound pronouns in the following sentences and translate the sentences into Russian.

1. Whenever energy in any form is released, a force is developed. 2. Whenever an e. m. f. is developed, there is also a field of energy called an electrostatic field. 3. Anyone working in the field of electricity must be familiar with the principles of magnetism. 4. Everybody knows that the achievements of Soviet mathematics and physics have had a great effect upon the acceleration of scientific and engineering development. 5. Whenever an e. m. f. is present, free electrons are moved from atoms. 6. Whenever the two conducting bodies are separated by a dielectric they possess capacity and a combination is called a condenser. 7. Whenever an electric charge is at rest, it is spoken of as static electricity. 8. Whenever a current is induced, its magnetic field opposes the change of flux.

IV. Translate the following sentences paying attention to the grammar forms in bold types.

1. As soon as the junction **is formed** some of the free electrons near the junction in the n-type material cross over **to fill** some holes in the p-type; **in doing so,** they leave behind a net positive charge, whilst at the same time **giving** the p-type material a negative charge. 2. Under reverse-biased conditions, the only current **flowing** across the junction is the tiny one due to thermal **breaking** of bonds in both p-n-type material. 3. At room temperature this reverse current is, however, so small in a silicon junction as **to be negligible** for most practical purposes.

Lesson 4. THE BIPOLAR TRANSISTOR

I. INDEPENDENT WORK

In the Laboratory

1. Skimming Reading

PRE-TEXT EXERCISES

I. a) Listen and repeat after the speaker. b) Practise the pronunciation of the following.

[ɪ] in, since, consist, is, thin, which, trip; [ou] hole, most, whole, dope, no, close; [ɔ] also, offer, opposite, consist, cross, not; [aɪ] device, time, five, divide.

reverse [rɪ'və:s], barrier ['bærɪə], roughly ['rʌflɪ], typical ['tɪpɪkəl], junction ['dʒʌnkʃn], biasing ['baɪəsɪŋ], compensate, recombination.

II. a) Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker.

Bipolar [baɪ'poulə], micron ['maɪkrən], 'concentrate [s], minority [maɪ'nɔrɪtɪ], combine [kəm'baɪn], base [beɪz], battery ['bætərɪ], compensate [ˌkɔmpən'seɪt], recombination ['rɪkəmbɪ'neɪʃn].

III. a) Listen, repeat and memorize the following words and word-combinations from the Text A and the Text B. b) Check if you know their meanings.

Sandwich of doped semiconductor material слоистая структура легированного полупроводникового материала (с примесями); common arrangement типовое устройство (слоев); common-emitter circuit схема (включения транзистора) с общим эмиттером; reverse-biased обратно смещенный; forward biased прямо смещенный; cross пересекать; «downhill run» «скатывание с горы вниз»; be rapidly swept быстро втягиваться, устремляться; gate ворота, вентиль, затвор; readily available широко использоваться.

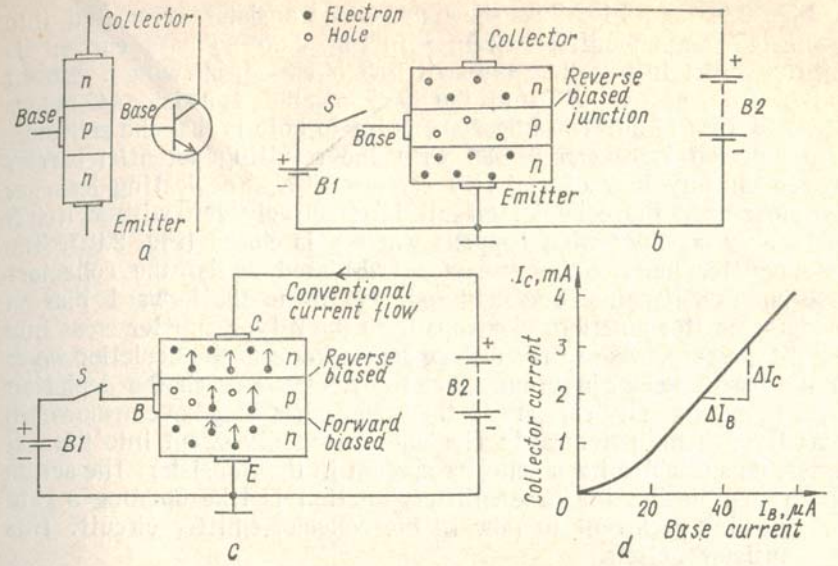

Fig. 2.9. The bipolar n-p-n transistor:
a the structure and its circuit symbol; *b* the simple common-emitter circuit with no base current; *c* the common-emitter circuit with base current flowing; *d* the collector-base current characteristic.

Text A

N-P-N AND P-N-P DEVICES

1. a) Listen to the text, mind the English intonation. b) Read the text to yourself and grasp the main idea of it.

The bipolar junction transistor consists of two p-n junctions formed by a sandwich of doped semiconductor material. Fig. 2.9 shows the most common arrangements, the n-p-n transistor. A thin layer of slightly doped p-type material (the base) is sandwiched between two thicker layers of n-type material (emitter and collector); the p-type base layer may be as thin as one micron.

N-p-n devices are the most common. P-n-p devices are also readily available and are very useful in a whole range of complementary circuits since they offer characteristics identical to n-p-n transistors but with the opposite polarity of supply voltage. Whereas in the n-p-n transistor current consists of electrons, in p-n-p transistor it consists of holes. Likewise, the base current is an electron-flow instead of a hole-flow.

2. Average Reading

Text B

THE TRANSISTOR ACTION

1. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of the text dealing with electrons which reach the depletion layer. Translate it.

Fig. 2.9*b* and Fig. 2.9*c* show a n-p-n transistor connected into a simple common-emitter circuit. In Fig. 2.9*b* no base current is flowing whilst in Fig. 2.9*c* the switch *S* is closed, allowing a current to flow from battery B_1 into the base of the transistor. Consider Fig. 2.9*b* first of all. The important point to note is that the collector-base junction is reverse-biased with the resulting potential barrier preventing any flow of majority carriers. Thus, neglecting leakage, the current in the collector circuit is effectively zero with switch *S* open. Now consider what happens when *S* is closed (Fig. 2.9*c*). The base emitter junction becomes forward-biased whilst the collector-base junction remains reverse-biased. Owing to the forward bias on the base-emitter junction, electrons from the n-type emitter cross into the p-type base, where they diffuse across towards the depletion layer at the base-collector junction. Once the electrons reach the depletion layer being minority carriers in the base region, they have a «downhill run» through the potential barrier and are rapidly swept into the collector, thus establishing a collector current in the transistor. The action of forward-biasing the base-emitter junction is like opening a gate and allowing a current to flow in the collector-emitter circuit. This is transistor action.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about.

II. a) Skim through the Text B. b) Discuss the main idea of it.

III. Skim through the Text B, choose the key sentences and translate them.

IV. Answer the following questions embracing the contents of the Text A and the Text B.

1. What does the bipolar transistor consist of? 2. When is the current in the collector circuit in Fig. 2.9*b* effectively zero? 3. What happens when *S* is closed? 4. What is the action of forward-biasing the base-emitter junction like? 5. Is the n-p-n transistor the most common arrangement? 6. What does Fig. 2.9 *a* show? 7. What is sandwiched between two thicker layers of n-type material (emitter and collector). 8. What size may the p-type base layer be? 9. What characteristics identical to n-p-n transistors do p-n-p devices offer? 10. What does p-n-p transistor consist of? 11. What is the base current?

V. Prepare a dialogue on one of the following situations:

1. Two students compare the function of thermionic valves and that of transistors in electronics.

2. A teacher in electronics is explaining to the students the transistor action and answer their questions.

VI. Prepare a dialogue on your own situation.

VII. Prepare dialogues using the figures of the Text A and the Text B.

VIII. Speak on:

1. The bipolar junction transistor.

2. Transistor action.

IX. Translate the question-answer units into English. Work in pairs.

1. Из чего состоит биполярный плоскостной транзистор? (Биполярный плоскостной транзистор состоит из трех легированных слоев полупроводникового материала p-n-p типов.)

2. Когда ток в коллекторной цепи на рис. 2. 9*b* практически равен нулю? (Ток в коллекторной цепи практически равен нулю тогда, когда ключ *S* разомкнут.)

3. Что происходит, когда ключ *S* замкнут? (Переход база-эмиттер становится прямо смещенным, в то время как коллекторно-базовый переход остается обратно смещенным.)

4. Что напоминает действие базо-эмиттерного перехода при прямом смещении? (Действие базо-эмиттерного перехода при его прямом смещении напоминает открывание ворот и позволяет току проходить в коллекторно-эмиттерную цепь. В этом заключается сущность работы транзистора.)

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Upset смещать, нарушать; capture захватывать; lightly слегка; at the same time в то же самое время; waylaid блокировать, преградить путь; supply обеспечивать; constitute составлять; equal равный; the number of ряд; successful trip успешный переход; region область; of the order of порядка.

II. Memorize these words and word-combinations used in their specialized meanings.

Be waylaid быть блокированным; holes дырки; low concentration of holes низкая концентрация дырок; doped легированный; ratio отношение.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them.

current gain коэффициент усиления по току; base current базовый ток; current-controlled device управляемое током устройство; collector current коллекторный ток; silicon transistor кремниевый транзистор.

Text C

THE CURRENT GAIN

I. a) Read the Text C. b) Describe recombination of electrons in the base region.

Why do the electrons not recombine with holes in the p-type base region as they diffuse to the collector? The answer is that, by making the base of very lightly doped p-type material, that is with a low con-

centration of holes, and at the same time using a very thin base, there is only a small chance of an electron being waylaid by a hole and recombining. When an electron does recombine in the base region, it upsets for a moment the equilibrium, because the base has captured a negative charge. This is corrected by a hole supplied by base battery B_1. It is supply of holes to compensate for recombination in the base which constitutes the base current of the transistor. Thus the transistor is a current-controlled device. The current gain (h_{FE}) is the ratio of collector current to base current.This must be equal to the number of electrons per second making a successful trip from emitter to collector, dividing by the number which recombine. In a typical small silicon transistor, an electron in the base region has roughly a 1 in 100 chance of recombining, so that the current gain is of the order of 100.

ASSIGNMENTS

I. a) Divide the text into logical parts. b) Choose the key sentences and translate them.

II. Look through the Text C and find the part of it dealing with the transistor as a current-controlled device. Translate it.

III. Read the text attentively and answer the following questions.

1. Why has the base captured a negative charge? 2. What is corrected by the hole supplied by base battery B_1? 3. What is the transistor? 4. What does the base current of the transistor constitute? 5. What is the current gain (h_{FE})? 6. What must the current gain be equal to? 7. What chance of recombining has an electron in the base region?

IV. Prepare a dialogue on one of the following situations:

One of the students looking at Fig. 2.9 asks questions, the other answers them.

V. Make up a plan of the text.

VI. Retell the text according to your plan.

VII. Review the text in written form.

VIII. Translate the Text C to be sure you understand it well.

4. Searching Reading

PRE-TEXT EXERCISES

I. Match the following English words and word-combinations with the Russian ones.

plot	сильная поддержка
plot against	искажение
relationship	наносить (на чертеж)
strong encouragement	инжектированные
injected	изображенный
	(в функции) от
distortion	взаимоотношение
sweep up by the field	случайным образом
the hole population	дырочная популяция

significant fraction	облегчаться
in random fashion	*зд.* пока не рекомбинируют
prey to recombination	захватывать полем
complementary circuit	существенная часть
be healthier	втягивать
build up	тратить впустую, зря расходовать
«waste»	дополнительная схема
draw	создавать

II. Give initial forms of the following words and translate them.

clearly, relationship, considering, encouragement, depletion, layer, diffusing, recombination, healthier, electric, population, heavily, fraction.

III. Give the main forms of the verbs from the Text D.

Plot, reduce, explain, cross, reach, sweep, diffuse, prey, encounter, inject, help, exhibit, begin, behave, dope, consist, go, lead.

Text D

SECOND-ORDER EFFECT

I. Read the following text and say what it is about. Review the text.

Fig. 2.9*d* shows a graph of collector current plotted against base current for a small silicon transistor; there is clearly a linear relationship between I_C and I_B over most of the collector current range. At low values of base current, however, the current gain is somewhat reduced. This is explained by considering the behaviour of electrons in the base: at very low base currents the electrons which cross from the emitter to the base region do not have any strong encouragement to reach the collector. It is only when they reach the collector-base depletion layer that they are swept up by the field; before this they are simply diffusing across the base in random fashion, prey to recombination with any hole they may encounter of the way. At higher values of base current, conditions are healthier for the electrons. The holes injected by the base current built up a slight electric field in the base which helps to draw the electrons into the depletion layer. Thus, at moderate collector currents of about 10 mA, a transistor will exhibit higher current gain than at low collector currents around 1.0 mA.

At very high collector current, when the hole population in the base is very high, gain begins to fall. The base behaves as if it were more heavily doped than it realy is, so that a significant fraction of the current across the base-emitter junction consists of holes going from base to emitter as well as the useful electrons going the other way towards the collector. Thus, more and more of the base current is «wasted» and the current gain falls. The effect of importance in power amplifier, where it can lead to waveform distortion at high collector currents.