I. a) Skim through the text and divide it into logical parts. b) Choose the key sentences and translate them.

II. Find the part of the text describing the reduction of the current gain.

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

1. What does Fig. 2.9*d* show? 2. When is the current gain reduced? 3. When are conditions healthier for the electrons? 4. When does gain begin to fall? 5. What electrons do not have any strong encouragement to reach the collector? 6. When do electrons reach the collector-base depletion layer? 7. What holes built up a slight electric field in the base? 8. What base helps to draw the electrons into the depletion layer? 9. Will a transistor exhibit higher current gain?

IV. Make up a plan of the text.

V. Discuss the problem of second-order effect.

VI. Make a short written summary of the text.

VII. Look through the latest magazines and find additional information about second-order effect.

VIII. Compare standard symbols used in the USSR for bipolar transistors with those used in the USA.

III. GRAMMAR EXERCISES

I.Translate the following words paying attention to the meanings of prefixes.

Bidirectional, biphase, biphone, bistable, bivalent; reconstruct, recombine, rewrite, recycle.

II. Translate the following sentences into Russian paying attention to «once».

1. Once the switch *S* is open no base current is flowing. Once the electrons reach the depletion layer, they have a "downhill run" through the potential barrier and are rapidly swept into the collector, thus establishing a collector current in the transistor.

III. Translate the following sentences into Russian paying attention to the functions of Participle I and Participle II.

1. The bipolar junction transistor consists of two p-n junctions formed by a sandwich of doped semiconductor material. 2. Fig. 2.9*b* shows a transistor connected into a simple common-emitter circuit. 3. No base current is flowing whilst the switch is closed, allowing the current to flow from battery into the base of the transistor. 4. 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. 5. Neglecting leakage, the current in the collector circuit is effectively zero with switch *S* open

IV. Translate the following sentences into Russian paying attention to Imperative Mood.

1. Consider Fig. 2.9. 2 Note the following phenomonon. 3. Avoid making mistakes. 4. Draw the graph and see the direction of electrons. 5. Examine the graph and explain it.

Lesson 5. THE FIELD-EFFECT 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.

Previously, emphasized, negligible, advantage, piezoelectric, variation, particular, unipolar, susceptible, nuclear, microphone, insulator, diagrammatic, ohmic, alternative.

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.

Ohmic, contact, normal, alternative, construction, type, negative, positive, unipolar, microphone, region.

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

Gate затвор; outline контур, очертание; current-controlled amplifying device усилительный прибор, управляемый током; field-effect transistor (FET) полевой транзистор; drawn by *зд.* поступающий в; transducer преобразователь; unable to supply не в состоянии создать; significant current значительный ток; junction field-effect transistor (JFET) полевой транзистор с p-n затвором; insulated gate field-effect transistor (IGFET) полевой транзистор с изолированным затвором; metal-oxide semiconductor field-effect transistor (MOSFET)

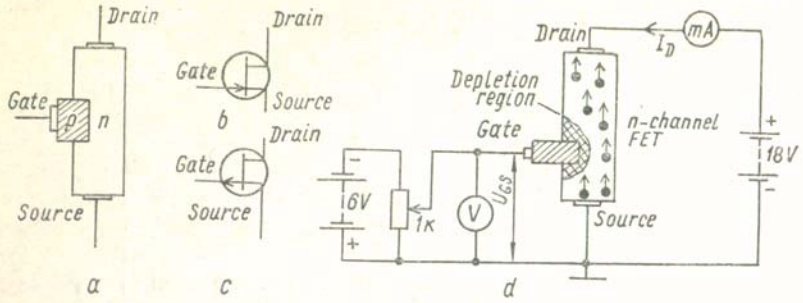

Fig. 2.10. The n-channel junction field-effect transistor (JFET):
a the structure; *b* its circuit symbols; *c* the circuit symbols for p-channel JFET; *d* a test circuit.

полевой транзистор типа металл-окисел-полупроводник (МОП транзистор); source исток; drain сток; as these names suggest как следует из этих названий; variations in the size варианты размера; test circuit испытательная цепь, схема; heavily doped сильно легированный; exist entirely in the bar существует почти по всему кристаллу.

IV. Pay attention to the meaning of the prefix uni- and translate the following words into Russian.

Unipolar, unilateral, uniphase, uniselector, uniform.

V. a) Listen to the following parts of sentences. b) Find sentences with them in the Text A and the Text B and translate into Russian.

1. The p-type gate is **much more** heavily doped **than** the n-type bar; 2. **The wider** the depletion layer, **the narrow** the channel; 3. The **lower** contact on the bar is called the source and the **upper** contact the drain; 4. The p-type gate is **much more heavily** doped than the n-type bar; 5. This is **wider** at the top **than** the bottom.

Text A

THE N- AND P-CHANNEL IN JFET

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

The n-channel junction field-effect transistor (JFET) is shown in Fig. 2.10*a* together with its circuit symbol in Fig. 2.10*b*.

An alternative type of construction is the p-channel device where the gate is made of n-type material. Fig. 2.10*c* shows the circuit symbol for a p-channel JFET.

Fig 2.10*d* shows as n-channel FET in a test circuit and includes an outline of the depletion layer. The p-type gate is much more heavily doped than the n-type bar, so that the depletion region exists almost entirely in the bar. The wider the depletion layer, the narrower the channel there is available for the flow of electrons from source to drain, since the depletion region itself behaves like an insulator.

2. Average Reading

Text B

THE JUNCTION FIELD-EFFECT TRANSISTOR ACTION

I. a) Listen to the text. b) Read it (time limit is 5 min.). c) Find the part of it dealing with the types of the field-effect transistors. Translate it.

It was previously emphasized that one of the main properties of the bipolar transistor is that it is a current-controlled amplifying device; the output current is controlled by a small input current. In the case of the field-effect transistor (FET) it is the input voltage which controls the output current. The current drawn by the input is usually negligible (it can be less than 1 pA). This is a great advantage where the signal comes from a device such as capacitor microphone or piezoelectric transducer, which is unable to supply a significant current.

FETs are basically of two types: the junction field-effect transistor or JFET and the insulated gate field-effect transistor or IGFET. The latter is more commonly known by a name metal-oxide semiconductor field-effect transistor (MOSFET) or MOS transistor.

The n-channel JFET is shown in diagrammatic form in Fig. 2.10*a* together with its circuit symbol in Fig. 2.10*b*. A bar of n-type silicon has an ohmic (non-rectifying) contact on each end. At a point along the bar a region of p-type silicon forms a p-n junction. In normal operation, the junction is reverse-biased. The lower contact on the bar is called the source and the upper contact the drain. As these names suggest, the electron current flows from source to drain and is controlled by the voltage applied to the p-region, called the gate.

An alternative type of construction is the p-channel device where the gate is made of n-type material. Fig. 2.10*c* shows the circuit symbol for a p-channel JFET.

The operation of the JFET depends upon variations in the size of the depletion layer at the reverse-biased gate junction. Fig. 2.10*d* shows an n-channel FET in a test circuit and includes an outline of the depletion layer. The p-type gate is much more heavily doped than the n-type bar, so that the depletion region exists almost entirely in the bar. The gate carries a negative bias voltage (V_{GS}) relative to the source which gives rise to the particular shape of the depletion region shown: this is wider at the top than the bottom, because the drain is held more positive than the source. The wider the depletion layer, the narrower the channel there is available for the flow of electrons from source to drain, since the depletion region itself being devoid of current carriers, behaves like an insulator. Hence, for a given drain-source voltage, the drain current is dependent upon the input voltage V_{GS}.

Unlike the bipolar transistor, the FET employs only majority carriers for its operation. It is therefore sometimes called the unipolar

transistor and is less susceptible than the bipolar type to temperature changes and nuclear radiation, since these chiefly effect minority carriers.

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. Skim through the Text B and find the part of it dealing with the p-channel device.

III. Find the part of the Text B containing information about two types of FET. Discuss it.

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

1. What type of material is the gate made? 2. Is the p-type gate much more heavily doped than the n-type bar? 3. Where does the depletion region exist? 4. How does the depletion region behave? 5. What is the main property of the bipolar transistor? 6. What are the types of FETs? 7. What is the other name of IGFET? 8.What does the operation of the JFET depend upon? 9. What is the difference between bipolar and unipolar transistors?

V. Describe Fig. 2.10 and discuss it with your fellow-students.

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

1. Two specialists in radioelectronics have a talk on the main types of FET.

2. The teacher is asking the student about the n-channel JFET in a test circuit.

VII. Prepare a dialogue on your own situation.

VIII. Speak on:

1. The main types of FET.
2. Construction and operation of FET.

IX. Make up a plan of the Text B.

X. Retell the text according to your plan.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Make sure that you know these words.

Layer слой; with respect to по отношению к; flow v. протекать; distinguish отличать; consider рассматривать; repel отталкивать; behind за (пределами); narrow узкий; provide обеспечивать; path путь; arrow стрелка; internally внутренне; indicate показывать; respectively соответственно; unfortunately к сожалению.

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

Substrate=substratum нижний слой, основа, подложка; reverse-biased обратно смещенный; source junction переход истока; insula-

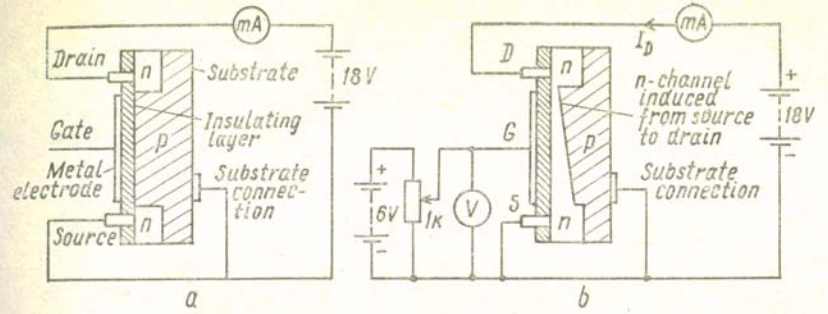

Fig. 2.11. The base structure of n-channel metall-oxide semiconductor field-effect transistor (MOSFET):
a with zero gate bias; *b* with positive bias.

ting layer изоляционный слой; back-to-back встречно включенный; depletion type n-channel n-канал с обеднением; enhancement-mode n-channel n-канал с обогащением; break *зд.* разрыв.

III. a) Find the following verbs in the text and define their tense-forms. b) Translate the sentences with them.

Show, form, draw, flow, reverse, reverse-biased, make, provide, connect.

Text C

THE MOSFET

I. a) Read the text. b) Find the part of it dealing with the conditions when no supply current flows.

Fig. 2.11*a* shows the basic construction of an n-channel MOSFET. The drain and source are the n-type region formed in the p-type silicon bar, which is known as the substrate. The gate is a metal electrode insulated from the silicon bar by a layer of silicon oxide.

The MOSFET is drawn connected in a simple circuit with the drain positive with respect to the source. Under these conditions, no supply currents flow, because the drain-substrate p-n junction is reverse-biased. Even if the supply polarity were reversed, there would still be no current flowing, since the source junction would then be reverse-biased.

Now consider Fig. 2.11*b* where the gate has been made positive with respect to the source. The field of the positive gate repels holes in the p-type substrate away from the insulating layer, leaving behind a narrow channel of n-type silicon. This narrow channel provides a conducting path from source to drain.

In this way, given a certain positive voltage on the gate to make the device conduct, the drain current is under the control of the gate voltage.

Circuit symbols for MOSFETs shown in Fig. 2.12*a* is a depletion-type n-channel device.The substrate connection (often marked «b» for «bulk») carries an arrow showing channel polarity. The

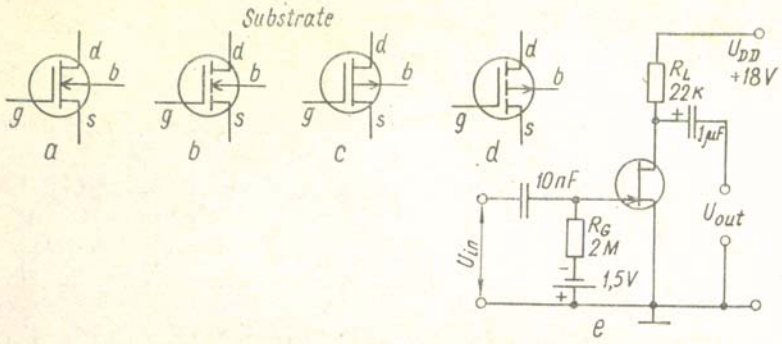

Fig. 2.12. MOSFET circuit symbols and its use:
a the n-channel depletion type; *b* the n-channel enhancement type; *c* the p-channel depletion type; *d* the p-channel enhancement type; *e* a simple FET voltage amplifier.

substrate is normally connected to the source, a connection sometimes made internally. Fig. 2.12*b* shows an enhancement-mode n-channel MOSFET and differs from Fig. 2.12*a* by showing breaks in the channel, indicating that there is normally no conducting path between source and drain. Fig. 2.12*c* and Fig. 2.12*d* show depletion- and enhancement-type p-channel MOSFETs respectively; notice the reversal of the substrate arrow to distinguish them from the n-channel device. In all the MOSFET symbols, the gate is clearly shown insulated from the channel.

ASSIGNMENTS

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

II. Find the part of the text describing conditions under which no supply currents flow. Translate it.

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

1. What does Fig. 2.11*a* show? 2. What is known as the substrate? 3. Is the gate a metal electrode insulated from the silicon bar by a layer of silicon oxide? 4. How is the MOSFET drawn? 5. Does supply current flow under these conditions? 6. What does the narrow channel in Fig. 2.11*b* provide? 7. Where are circuit symbols for MOSFETs shown? 8. What does the substrate connection carry? 9. What is substrate normally connected to? 10. What does Fig. 2.12*b* show? 11. Is there conducting path between source and drain? 12. Where are the depletion- and enhancement-type p-channel MOSFETs respectively shown?

IV. a) Describe Fig. 2.12. b) Discuss it with your fellow-students.

V. Prepare a dialogue on your own situations.

VI. Make up a plan of the text.

VII. Retell the text according to your plan.

VIII. Review the text in written form.

IX. 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.

ability	обогащение
enhancement	пенный пластик (пенопласт)
low-leakage gate	зажим, фиксатор
vulnerable	уязвимый
clip	способность
foam plastic	затвор с малым током утечки
safely soldered	безопасно впаянный
break-down	разрыв

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

Electrometer, furthermore, low-leakage, break-down.

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

Make, work, show, connect, mean, remove, arise, incorporate, degrade.

Text D

USE OF MOSFETs

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

A MOSFET will make an even better electrometer than a JFET. Furthermore, because of its ability to operate in an enhancement as well as the depletion mode, an n-channel MOSFET will work well in amplifier circuits of the simple type shown in Fig. 2.12*e*, but without the bias battery, R_G being connected directly to earth.

The low-leakage gate insulation means that MOSFETs are very vulnerable to static charges, which can build up high gate voltages and break-down the insulation. For this reason, MOSFETs are supplied with the leads short-circuited by a metal clip or piece of conducting foam plastic. This short circuit should not be removed until the device is safely soldered into circuits. If there is a risk of excessive gate voltages arising in the circuit then a protection network (e.g. "back-to-back" Zener diodes) should be incorporated between gate and earth. This technique does unfortunately degrade the very high input resistance of the MOSFET. Some MOSFETs actually incorporate protection diodes and are not therefore as susceptible to break-down as the unprotected devices.

ASSIGNMENTS

I. Give the main idea of the Text D.

II. Skim through the text and find the part of it dealing with the low-leakage gate insulation.

III. Read the text attentively and answer the questions.

1. Does a MOSFET make a better electrometer than a JFET? 2. Where will an n-channel MOSFET work well? 3. What does Fig. 2.12*c* show? 4. What does the low-leakage gate insulation mean? 5. With what are MOSFETs supplied? 6. Should the short circuit be removed until the device is safely soldered into circuits? 7. When should a protection network be incorporated between gate and earth? 8. What does this technique degrade? 9. What do any MOSFETs actually incorporate?

IV. Prepare a dialogue on your own situation.

V. Make up a plan of the text.

VI. Speak on the text according to your own plan.

VII. Look through the latest magazines and find additional material about using of MOSFETs in the foreign and Soviet techniques. Discuss it with your fellow-students.

III. GRAMMAR EXERCISES

I. Define the tense-forms of the verbs and translate them.

1. The wider the depletion layer, the narrow the channel there is available for the flow of electrons from source to drain. 2. Even if the supply polarity were reversed, there would still be no current flowing, since the source junction would then be reverse-biased. 3. An n-channel MOSFET will work well in amplifier circuits of the simple type shown in Fig. 2.12*e*, but without the bias battery, R_G being connected directly to earth. 4. This short circuit should not be removed until the device is safely soldered into circuits. 5. Some MOSFETs actually incorporate protection diodes and are not therefore as susceptible to break-down as the unprotected device.

II. Give the initial forms of the verb from Participle II and translate them.

Shown, made, showed, doped, controlled, drawn, insulated, biased, called, applied, formed, known.

III. a) Pick out from the Text D and the Text C sentences with Infinitives and Participles. b) Define their functions and translate the sentences.

IV. Define the attributes in the following word-combinations, translate them into Russian.

Circuit symbol; alternative type of construction; depletion region; main property; bipolar transistor; a current-controlled amplifying device; output current; input current; field-effect current; capacitor microphone; significant current; junction field-effect transistor; metal-oxide semiconductor field-effect transistor.

V. Analyse the constituents the following words consists of.

Output, diagrammatic, outline, heavily, entirely, narrower, previously, significant, arising, voltage, resistance.

VI. Write out from the Text C and the Text D all the verb-forms in the Passive Voice and translate them.

Lesson 6. AMPLIFICATION AND THE 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.

[ʃn] function, amplification, application, junction; [aɪ] device, tiny, derive, diode; [ɪ] single, resistor, which, input, signal, simply, switch; [ʌ] function, such, under, junction, current, but, interrupt, bulb, much; [eɪ] base, make, operate; [æ] as, thanks.

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

Electronics, active, component, resistor, transistor, passive, signal, elements, battery, bipolar, base, voltage, product, symbol; but: control управлять.

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

Whereby посредством чего; tiny input signal очень слабый входной сигнал; aerial антенна; power involved введенная мощность; draw from *зд.* получать от; extinguish v. погашать; give rise to повышать что-л.; a. c. mains основной источник переменного тока; simple light-operated switch простой, работающий от света переключатель; cadmium-sulphate photocell фотоэлемент на сернистом кадмии; coil of a relay обмотка реле.

IV. a) Find the following word-combinations in the Text A and the Text B. b) Translate the sentences with them.

Under the heading of passive components под названием пассивные компоненты; in reasonably bright light при достаточно ярком свете; turning the cell to face the bulb поворачивание элемента «лицом» к лампе; remain lit оставлять зажженным, горящим; interrupt the light path прервать путь света; clip off voltage surge ограничить обратный выброс напряжения.

V. a) Define the part of speech of each word. b) Underline the suffixes and translate the words.

Amplification, electronic, generally, active, amplifying, resistance, turning, voltage, connections.

VI. Analyse the following words from the viewpoint of their structure and translate them.

Everyday, loudspeaker, bipolar, current-controlled, light-operated, photocell, base-emitter, collector-emitter, anything.

VII. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian.

1. The bipolar junction transistor is (наиболее активно используемый прибор) in electronics. 2. If a small current (проходить) between the base and emitter, it (повышать) to a much larger current between collector and emitter. 3. To extinguish the «candle», it is only necessary (прервать) the light path between bulb and photocell. 4. The diode (соединенный) across the relay coil serves to clip off voltage surge in the coil inductance when the current (выключать).

Text A

ACTIVE DEVICES IN ELECTRONICS

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

The single most important function in electronics can be expressed in one word: amplification. This is the process whereby the power of a signal is increased in magnitude.

Electronic amplification devices are known generally as active components to distinguish them from non-amplifying circuit elements such as resistors, capacitors and inductors, which are grouped under the heading of passive components.

The most everyday application of electronic amplification is the ordinary radio, which receives a tiny input signal at its aerial (typically less than one microwatt) and yet can turn out a power of several watts to the loudspeaker. The extra power involved is drawn from a battery or the a. c. mains.

The bipolar junction transistor, better known simply as the transistor, is the most common active device in electronics. The transistor is a current-controlled amplifying device: if a small current flows between the base and emitter, it gives rise to a much larger current between collector and emitter. The name transistor is in fact derived

VIII. Speak on:

1. Amplification.
2. The transistor as an amplifying device.
3. Amplification in transistor stages.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

I. Be sure that you know these words.

Behave v. вести себя; like подобно, похоже; possess владеть, обладать; appear появляться; temporarily временно; store накапливать; change v. изменять; perform выполнять; double удваивать; roughly грубо; by half наполовину.

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

A reverse-biased p-n junction обратно смещенный p-n переход; a collector-base junction коллекторно-базовый переход; depletion layer обедненный слой; forward-biased p-n junction прямо смещенный переход; capacitance емкость; carrier носитель; signal frequency частота сигнала.

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

Finite speed of the minority carriers конечная скорость неосновных носителей; temporarily stored временно запоминаемые (сохраняющиеся; akin близкий, похожий; reactance of the base emitter capacitance реактивное сопротивление емкости эмиттерного перехода; "cut off" frequency частота среза (предельная частота транзистора); transition frequency граничная частота; logarithmic scale логарифмический масштаб; gain-band-width-product произведение коэффициента усиления на полосу пропускания.

IV. Pay attention to the meaning of the prefix semi- "полу"- and translate the following words.

Semiconductor, semioscillation, semiprotected, semiconductive, semicolonial.

V. Find in the Text C English equivalents to the following Russian word-combinations. Translate the sentences with them.

Емкость зависит от; скорость большинства носителей; внешне приложенный сигнал изменяется быстро; что касается внешнего сигнала; по мере того, как частота сигнала увеличивается; задача управления; уменьшить частоту, при которой h_{FE} падает до единицы.

Text C

HIGH FREQUENCIES AND THE BIPOLAR TRANSISTOR

I. a) Read the text. b) Find the part of it describing the effective capacitance of a forward-biased p-n junction. Translate it.

IV. a) Find the following word-combinations in the Text A and the Text B. b) Translate the sentences with them.

Under the heading of passive components под названием пассивные компоненты; in reasonably bright light при достаточно ярком свете; turning the cell to face the bulb поворачивание элемента «лицом» к лампе; remain lit оставлять зажженным, горящим; interrupt the light path прервать путь света; clip off voltage surge ограничить обратный выброс напряжения.

V. a) Define the part of speech of each word. b) Underline the suffixes and translate the words.

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VI. Analyse the following words from the viewpoint of their structure and translate them.

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3. Amplification in transistor stages.

II. CLASSWORK

3. Close Reading

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

A reverse-biased p-n junction обратно смещенный p-n переход; a collector-base junction коллекторно-базовый переход; depletion layer обедненный слой; forward-biased p-n junction прямо смещенный переход; capacitance емкость; carrier носитель; signal frequency частота сигнала.

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

Finite speed of the minority carriers конечная скорость неосновных носителей; temporarily stored временно запоминаемые (сохраняющиеся; akin близкий, похожий; reactance of the base emitter capacitance реактивное сопротивление емкости эмиттерного перехода; "cut off" frequency частота среза (предельная частота транзистора); transition frequency граничная частота; logarithmic scale логарифмический масштаб; gain-band-width-product произведение коэффициента усиления на полосу пропускания.

IV. Pay attention to the meaning of the prefix semi- "полу"- and translate the following words.

Semiconductor, semioscillation, semiprotected, semiconductive, semicolonial.

V. Find in the Text C English equivalents to the following Russian word-combinations. Translate the sentences with them.

Емкость зависит от; скорость большинства носителей; внешне приложенный сигнал изменяется быстро; что касается внешнего сигнала; по мере того, как частота сигнала увеличивается; задача управления; уменьшить частоту, при которой h_{FE} падает до единицы.

Text C

HIGH FREQUENCIES AND THE BIPOLAR TRANSISTOR

I. a) Read the text. b) Find the part of it describing the effective capacitance of a forward-biased p-n junction. Translate it.

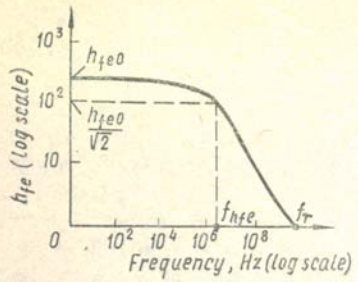

Fig. 2.14. The frequency characteristics of small signal current gain.

A reverse biased p-n junction, such as a collector-base junction, behaves like a capacitor, where the capacitance is dependent on the junction area and the width of the depletion layer. A forward-biased p-n junction such as a base-emitter junction also possesses capacitance, C_{be}, which appears in parallel with its normal forward resistance. The effective capacitance of a forward-biased p-n junction arises from two basic cases. The first is simply the capacitance of the depletion layer. The second components of capacitance arises from the finite speed of the minority carriers as they diffuse across the junction. These carriers, because the diffusion is relatively slow, appear to be temporarily stored in the semiconductor material when the external applied signal changes quickly; the effect as far as the external signal is concerned is akin to the storage of change by a conventional capacitor. The effective capacitance of the base-emitter junction of a small silicon transistor is typically of the order of 100 pF to 1000 pF.

As signal frequency is increased, there comes a point where the reactance of the base-emitter capacitance is comparable with the base-emitter resistance h_{FE}, and much of the base current which should be performing the normal task of controlling the collector current is instead flowing in the base-emitter capacitance C_{be}. The result is a fall in current gain (Fig. 2.14). The "cut-off" frequency, $f_{h_{FE}}$, is reached when the reactance of C_{be} is equal to the input resistance, h_{ie}, and the current gain thus falls by the factor $\sqrt{2}$ (3 dB). Above $f_{h_{FE}}$ most of the "base" current is actually flowing in C_{be} and every time the frequency is doubled the current gain falls by half. Expressed on a logarithmic scale, h_{FE} falls by 6 dB for each octave (doubling) of frequency. If the graph is extrapolated, we can deduce the frequency at which h_{FE} falls to unity; this is termed the transition frequency, f_T, above which the transistor is of little use as an amplifier. Transition frequency f_T is also called the gain-band-width product, since, in the region between $f_{h_{FE}}$ and f_T, the product of current gain and signal frequency is roughly constant and equal to f_T, i. e.

$$f_T \approx h_{FE} \cdot f_{h_{FE}}.$$

ASSIGNMENTS

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

1. How does a reverse-biased p-n junction, such as a collector-base junction, behave? 2. From what basic causes does the effective capacitance of a forward-biased p-n junction arise? 3. What is the effective capacitance of the base-emitter junction of a small silicont

transistor? 4. When is the "cut-off" frequency, f_{hFE}, reached? 5. What is termed the transition frequency?

II. Describe Fig. 2.14 and discuss it.

III. Translate the following Russian questions and answers into English. Work in pairs.

1. Что показано на рис. 2.14? (На рис. 2.14 показан график зависимости коэффициента передачи тока h_{FE} от частоты.)

2. Какой масштаб использован здесь по обеим осям? (По обеим осям здесь использован логарифмический масштаб.)

3. Какие частоты отмечены на рис. 2.14? (На рис. 2.14 отмечены предельная частота транзистора $f_{h_{FE}}$ и граничная частота транзистора f_T).

4. Что такое частота f_T? (При частоте f_T, называемой граничной частотой усиления транзистора, коэффициент передачи тока равен 1.)

IV. Speak on:

1. Base emitter capacitance.
2. Transition frequency.

V. Prepare a dialogue on your own situation.

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

1. Как ведет себя обратно смещенный p-n переход, подобный переходу коллектор-база? (Обратно смещенный p-n переход, подобный переходу коллектор-база, ведет себя как конденсатор, емкость которого зависит от площади перехода и ширины обедненного слоя.)

2. Какая основная причина появления эффективной емкости прямо смещенного p-n перехода (Эффективная емкость прямо смещенного перехода возникает по двум основным причинам. Первая — это просто емкость обедненного слоя, вторая появляется вследствие конечной скорости движения неосновных носителей, когда они диффундируют через переход.)

3. Какая эффективная емкость базо-эмиттерного перехода малого кремниевого транзистора? (Эффективная емкость базо-эмиттерного перехода малого кремниевого транзистора в типичном случае порядка 100—1000 pF).

4. Когда достигается предельная частота транзистора $f_{h_{21Э}}$? Предельная частота транзистора $f_{h_{21Э}}$ достигается тогда, когда $x_{cэ}$ реактивное сопротивление становится равным входному сопротивлению $h_{11Э}$, и коэффициент передачи тока падает в $\sqrt{2}$ раз (на 3 dB.)

5. Как определяется граничная частота усиления транзистора? (Если график экстраполировать, мы сможем получить частоту, при которой $h_{21Э}$ уменьшается до единицы — она и называется граничной частотой усиления транзистора, выше которой транзистор как усилитель используется редко.)

VII. Analyse the sentences giving the main idea of the text.

VIII. Comment on the author's attitude to high-frequencies and the bipolar transistor.

IX. Express your own opinion of high-frequencies and the bipolar transistors.

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

4. Searching Reading

PRE-TEXT EXERCISES

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

high conductivity semiconductor material	достаточное количество энергии для преодоления потенциального барьера
enough energy to pass the potential barrier	полупроводниковый материал с высокой проводимостью
a pick value	заделка корпуса
acceptor and donor impurities	линейный малошумящий усилитель
mounting	акцепторные и донорные примеси
linear low-noise amplifier	наибольшая величина

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

Mechanical tunnelling phenomenon; a high concentration of acceptor; as the current through the diode increases; it assumes a negative resistance characteristics; the diodes are available with peak valley current ratios from 2—15; the frequency limitations of the tunnel diode are due to parasitic capacitance and inductance.

Text D

TUNNEL DIODE

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

The tunnel diode is a semiconductor device that depends for its operation on a quantum mechanical tunnelling phenomenon and provides a set of electrical characteristics that are unique. It is a two terminal single p-n junction that is fabricated with very high conductivity semiconductor material having a high concentration of acceptor and donor impurities. The width of the depletion layer is so small (of the order of 10^{-6} inch) that is posssible for electronics to "tunnel" through the junction even though they don't have enough energy to pass the potential barrier across it. The electrical characteristic of a typical 1 mA germanium tunnel diode is shown in Fig. 2.15. As the current through the diode increases, it reaches a pick value called the "pick current" at a voltage called the "peak voltage", after which it assumes a negative resistance characteristic until it draws a current called the "valley current" at a voltage called the "valley voltage". From the point the characteristic is that of a normal forward biased diode. In germanium, the peak and valley points occur at 50 mV and 350 mV respectively, the diodes are available with peak valley current ratios from 2—15. The actual peak current depends on the junction area, and diodes are available with peak currents of anything between

10 mA to 10 A. Silicon and gallium arsenide tunnel diode are also available with peak and valley voltages that are slightly higher.

Quantum mechanical tunnelling has theoretical frequency limit of 10^7 Mc/s and is inherently higher frequency mechanism than the diffusion mechanism in conventional transistor and diode operation. In practice, the frequency limitations of the tunnel diode are due to parasitic capacitance and inductance. The peak point is theoretically very stable, though practical measurements on commercially available diodes seem to indicate a considerable variation of peak currents with temperature. This is presumably due to the limitations in the methods of manufacture and mounting.

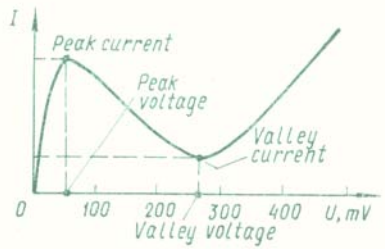

Fig. 2.15. The volt-ampere characteristics of a typical germanium tunnel diode.

The two major applications of the tunnel diode are in switching and logical circuits, where device is switched from the peak to the valley point by an input current, and in linear low-noise amplifier and oscillators for extremely high frequency, where the tunnel diode is biased in its negative resistance region.

ASSIGNMENTS

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

1. What is the tunnel diode? 2. What is the tunnel diode fabricated with? 3. What does the tunnel diode depend on? 4. Does the tunnel diode provide a set of electrical characteristics that are unique? 5. What is the width of the depletion layer? 6. What is shown in Fig. 2.15? 7. What does the actual peak current depend? 8. What are the frequency limitations of the tunnel diode due to? 9. What are the two major applications of the tunnel diode?

II. Describe Fig. 2.15 and discuss it.

III. Speak on:

1. The tunnel diode as a semiconductor device.
2. Quantum mechanical tunnelling.
3. The application of the tunnel diode.

IV. Prepare a dialogue on your own situation.

V. Look through the latest magazines and find additional information on tunnel diode. Discuss it.

III. GRAMMAR EXERCISES

1. a) Analyse the structure of the following words and give their initial forms. b) Translate them.

Operation, conductivity, concentration, resistance, voltage, diffusion, theoretically, measurement, limitation, application.

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

Behave, possess, appear, arise, change, concern, increase, flow, reach, fall, explorate, call, depend, show, assume, occur, switch, bias.

III. Translate the following sentences paying attention to the structure of the terms in bold type and their meanings.

1. The tunnel diode is a two terminal single p-n junction that is fabricated **with very high conductivity semiconductor material** having a high concentration of acceptor and donor impurities. 2. In germanium **the peak and valley points** occur at 50 mV and 350 mV respectively. 3. In practice, the frequency limitations of the tunnel diode are due to **parasitic capacitance and inductance.**

IV. a) Analyse the functions of ing- forms and the Infinitive. b) Translate the sentences into Russian.

1. Electronic amplifying devices are known generally as active components to distinguish them from non-amplifying circuit elements such as resistors, capacitors and inductors which are grouped under the heading of passive components. 2. To extinguish the "candle", it is only necessary to interrupt the light path between bulb and photocell. 3. In Fig. 2.13*b*, the collector current is used to operate the coil of a relay. 4. The circuit of Fig. 2.13*a* shows the amplification stage with using the transistor to make a simple light-operated switch. 5. Fig. 2.13*c* shows a way of further increasing the current gain of a circuit.

V. a) Analyse the following sentences. b) Translate them.

1. These carriers appear to be temporarily stored in the semiconductor material. 2. Much of the base current which should be performing the normal task of controlling the collector current is flowing in the base emitter capacitance C_{be}. 3. As signal frequency is increased, there comes a point where the reactance of the base-emitter capacitance is comparable with the base-emitter resistance h_{ie}. 4. Expressed on a logarithmic scale, h_{FE} falls by 6 dB for each octave (doubling) of frequency.

Chapter III. COMPUTER TECHNOLOGY

Lesson 1. THE TRANSISTOR AS A SWITCH

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.

[ɑ:] start, part, car, far; [ə:] inverter, referred, terminal, third, circuit, turn, curve; [ɔ:] short, perform, form, for, nor; [ɛə] compare, declare, fare, care; [aɪ] high, design, sign, acquire; [au] out, output, ground, found.

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

Basic, element, system, logic, voltage, general, bipolar, transistor, resistor, inverter, fabrication, emitter, electrical, diode, schemetic, configuration, potential, collector, relay, impedance.

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

Logic inverter логический преобразователь; require требовать; input вход; output выход; vice versa наоборот; receive получать; usage использование; to receive general usage получить общее применение; to yield a NOR gate образовать элемент ИЛИ-НЕ; with as many as eight с максимумом до восьми; relay реле; impedance импеданс, сопротивление; turn on (off) включить (выключить) lack недостаток; various различный; output current выходной ток; emitter lead эмиттерный вывод (провод); conventional current обычный ток; saturation насыщение; terminal зажим, вывод; forward voltage drop прямое падение напряжения; common-emitter circuit схема с общим эмиттером; basic circuit configuration конфигурация базовой схемы; common-collector circuit схема с общим коллектором; to operate out of saturation работать без насыщения; manual switches ручные ключи, переключатели; speed of operation скорость работы; cutoff отсечка; diode AND function функция И на диодах; grounded-emitter circuit схема с заземленным (общим) эмиттером.

IV. a) Analyse the constituents the following words consist of. b)Translate these words into Russian.

Connection, usage, development, bipolar, fabrication, multi-emitter, operation, input, output, electrical, electronics, arrowhead, direction, designer, respectively, appearing, switching, saturation, representation, monolithic, schemetic.

V. a) Repeat the following word-combinations after the speaker. b) Memorize these abbreviations.

IC integrated circuit;
RTL resistor-transistor logic;
DTL diode-transistor logic;
TTL transistor-transistor logic.

VI. Make up sentences using the English equivalents of the following word-combinations.

Это означает; наоборот; с тех пор как; так ... и; спустя некоторое время; широко используемые; соответственно; как показано; обычно.

Text A

FORMS OF DIGITAL INTEGRATION CIRCUITS

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

A basic element of most digital systems we start with is a switch so called the logic inverter.

The logic inverter requires that with the input in one logic state, the output is in the opposite state. That is, with a logic 0 at the input, the output is a logic 1, or vice versa. Using voltage levels and positive logic that means that with a low voltage at the input, the output is at a high voltage level, or vice versa.

The first form of digital integrated circuits (digital ICs) to receive general usage when they were introduced in 1962 was a simple connection of bipolar transistor inverter circuit to yield a NOR gate. Since the circuit consisted of only resistors and transistors, it was named resistor-transistor logic (RTL). An IC development a short time later consisted of a diode AND circuit followed by a bipolar transistor inverter. This was called diode-transistor logic (DTL). Both RTL and DTL were IC versions of logic circuits made with discrete diodes, transistors, and resistors that had long been popular with digital circuit designers.

The first "new" digital design made possible by the IC fabrication process was transistor-transistor logic (TTL). In these circuits the diode AND function of DTL was performed by a multi-emitter transistor, a bipolar transistor with as many as eight emitters. The output of TTL circuit was from a transistor inverter.

2. Average Reading

Text B

TRANSISTOR CIRCUIT CONFIGURATIONS

I. a) Listen to the text. b) Read it (time limit is 3 min.). c) Find the part of it dealing with the switches in electrical circuits.

Various types of computer and control operations can be performed with switches which have two distinct levels of output current or voltage. In electrical circuits, these switches may be relays, manual switches, or electronic switches. The electronic switches are the transistor and the diode. These two devices, compared to the relay and manual switch offer less impedance to the flow of current when turned off and have a larger forward voltage drop when turned on. Two advantages of these electronic switches are their speed of operation and their lack of moving parts. Widely used schemetic representations for the n-p-n and p-n-p transistors are shown in Fig. 3.1*a*. The emitter lead of each transistor type is seen to have an arrowhead which points in the direction of conventional current flow in the emitter lead.

Transistors have three terminals and may be connected into a circuit in one of several different configurations. Input connections may be made to any two terminals, with the output appearing across the third terminal and one of the input terminals. Fig. 3.1 shows three basic circuit configurations. Circuits shown in Fig. 3.1 *b* to *d* are designated common-emitter, common-base, and common-collector (or emitter-follower) circuits, respectively. When the common input-output terminal is connected to ground potential, as shown in the figure, the three circuit configurations are often referred to as grounded-emitter, grounded-base, and grounded collector circuits, respectively.

The switching circuits are of the type in which the transistor is in saturation when ON and at, or close to, collector-current cutoff when OFF.

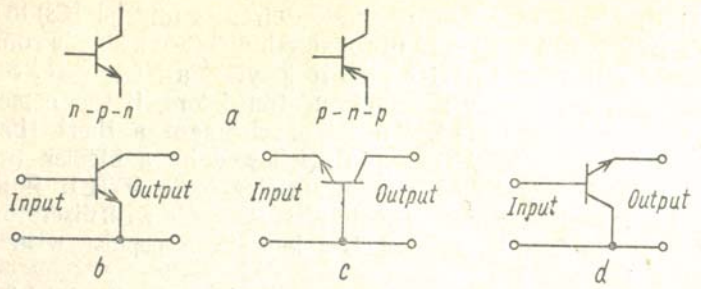

Fig. 3.1. Transistor symbols and basic circuit configurations: *a* n-p-n and p-n-p; *b* a common emitter; *c* a common base; *d* a common collector.

The grounded-emitter and grounded-base switching circuits can be made to operate from saturation to cutoff.

The grounded-collector switch is usually designed to operate out of saturation.

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. Skim through the Text B and find the part of it dealing with the terminals of transistors. Discuss it.

III. Find the part of the Text B containing information about the switching circuits. Translate it.

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

1. What does the logic inverter require? 2. What is the output with the logic 0 at the input? 3. What is the first form of digital ICs to receive general usage? 4. Why was the circuit named RTL? 5. What was called DTL? 6. What was both RTL DTL? 7. What was the diode AND function of DTL in TTL circuits performed by? 8. What levels have switches? 9. What type may these switches be in electrical circuits? 10. What are the electronic switches? 11. What are the advantages of these electronic switches? 12. What is it necessary in order to provide the two distinct signal levels? 13. What are shown in Figs. 3.1*a* and 3.1 *b*. 14. How many terminals have transistors? 15. In what way may input connections be made to any two terminals? 16. How is the grounded-collector switch usually designed?

V. Examine Fig. 3.1 and comment on:

1. N-p-n and p-n-p.
2. A common emitter.
3. A common base.
4. A common collector.

VI. Make up a dialogue on your own situation using Fig. 3.1.

VII. Speak on:

1. The transistor as a switch.
2. Basic circuit configurations.

VIII. Retell the text according to your own plan.

IX. Make a short written summary of the Text B.

II. CLASSWORK

3. Close Reading

PRE-TEXT EXERCISES

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

Conversely обратно, наоборот; plot наносить (на схему); invert инвертировать, преобразовывать; voltage drop падение напряжения; aid помощь; relationship зависимость; vary отличаться; comprise включать; magnitude величина.

II. Memorize these words and word-combinations pertaining to switches.

Collector current коллекторный ток; base-current базовый ток; collector-emitter voltage напряжение коллектор-эмиттер; input voltage напряжение на входе; base terminal of the transistor базовый вывод транзистора; transistor collector characteristics коллекторные характеристики транзистора; ground potential потенциал заземления; collector leakage current коллекторный ток утечки; base-input signal базовый входной сигнал.

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

Loop equation уравнение контура; collector supply voltage напряжение коллекторного питания; load resistor сопротивление нагрузке; infinite impedance бесконечно большое сопротивление; quiescent operating point of the circuit статическая рабочая точка схемы.

Text C

COMMON-EMITTER SWITCH

I. a) Read the text. b) Speak on common-emitter switch.

A simple transistor switching circuit is shown in Fig. 3.2*a*. The input signal varies between ground potential and U_1 as shown. A loop equation can be written that portion of the circuit comprising the collector supply voltage, load resistor and transistor to give

$$U_{CC} - I_C \cdot R_L - U_{CE} = 0 \qquad (3.1)$$

This equation schows that if there were no voltage drop across the transistor, the collector current would become $I_{C_{max}} = \frac{U_{CC}}{R_L}$. Conversely, if collector current were equal to zero, there would be no voltage drop across R_L and, from Eq. (3.1) $U_{CE_{max}} = U_{CC}$, when the transistor is at cutoff.

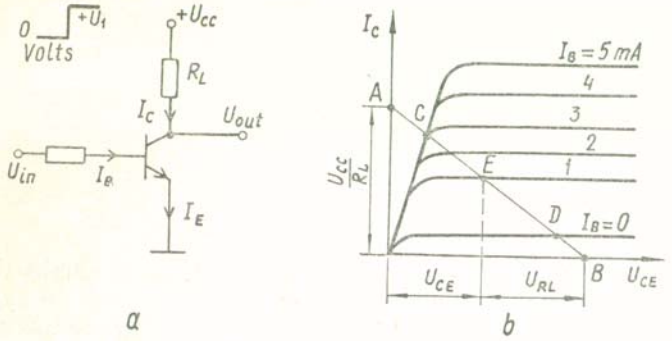

Fig. 3.2. The common emitter switch:
a a simple switching circuit; *b* operating curves of switch.

Operation of the circuit of Fig. 3.2*a* is explained with the aid of the transistor collector characteristics curves given in Fig. 3.2*b*. These curves show the relationship between base-current, collector-current, and collector-emitter voltage.

The magnitude of collector-current $I_{C_{max}}$ and the collector-emitter voltage $U_{C_{max}}$ are plotted in Fig. 3.2 *b* as points *A* and *B*, respectively.

When the input voltage of Fig. 3.2*a* rises to U_1, current flows into the base terminal of the transistor, and the device is turned on. In order for the transistor to be in saturation when in the ON state, an adequate magnitude of base current must be supplied to cause the circuit to operate at point *C*.

When the input voltage in Fig. 3.2*a* falls to ground potential, the transistor base is connected to ground through a resistor: the transistor is at cutoff, collector leakage current is equal to I_{CEO}, and the quiescent operating point of the circuit is at point *D* of Fig. 3.2*b*. The collector characteristic curves show that although the transistor is off, it does not present an infinite impedance to current flow in the circuit. The magnitude of collector leakage current is dependent upon operating temperature of the transistor and the value of series resistance in the base circuit.

For the base-input signal at ground potential, only a small collector leakage current flows, and the collector voltage is close to the U_{CC} potential. The maximum positive level of base-input signal causes the collector-emitter voltage to be at its minimum value. Thus, the transistor switch of Fig. 3.2*a* inverts an input signal and is properly referred to as an «inverter». Inversion is always obtained when the transistor operates as a grounded-emitter switch.

ASSIGNMENTS

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

1. What is shown in Fig. 3.2*a*? 2. How is operation of the circuit in Fig. 3.2*a* explained? 3. What do the curves in Fig. 3.2*b* show?

4. When does current flow into the base terminal of the transistor? 5. When is the transistor base connected to ground through a resistor? 6. What do the collector characteristic curves show? 7. What is the magnitude of collector leakage current dependent upon? 8. What causes the collector-emitter voltage to be at its minimum value? 9. When is inversion obtained?

II. Read the Text C again and ask additional questions.

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

IV. Find the part of the text containing information about the transistor base connected to ground through a resistor. Translate it.

V. Examine Fig. 3.2 and comment on:

1. A simple switching circuit.
2. Operating curves of switch.

VI. Pick out the key sentences from the Text C and translate them.

VII. Speak on operating curves of switches and discuss it.

VIII. Review the text in written form.

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

X. Compare standard symbols for common-emitter switch used in the USA with those used in the USSR.

4. Searching Reading

PRE-TEXT EXERCISES

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

assure	уместный, подходящий
suitable	окончательный выбор
final choice	в меньшей степени
pertinent	ухудшать, портиться
performance	паразитная емкость схемы и проводов
circuit wiring capacitance	предположительно
negative-going edge	перераспределение
positive-going edge	утверждать
conceivably	«раскачка» напряжения (изменение напряжения)
to a lesser extent	пригодный
redistribution	характеристика
deteriorate v.	спад
voltage swing	нарастание

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

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

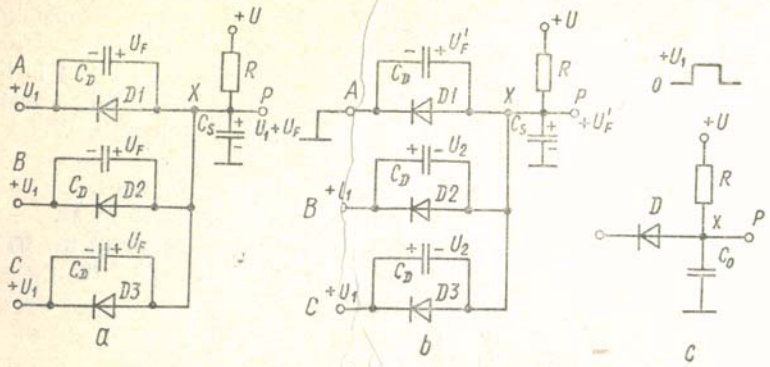

Fig. 3.3. The diode AND/OR gate:
a voltage distribution when all input signals are positive; *b* when one input signal of ground potential; *c* equivalent circuit for one varied input.

Both d. c. and a. c. considerations; most suited for a. c. operation; so that; together with; slightly larger; instantaneously increased; hence.

Text D

DIODE GATES

I. Read the text and give short information about voltage destribution in diode gates.

Design of a logical circuit involves both d. c. and a. c. considerations. The final choice of circuit parameters is often a compromise between values most suited for a. c. operation and different values which give optimum d.c. performance. Pertinent d. c. and a. c. design considerations are presented below for the AND diode circuit.

Output voltage of the above AND gate is clamped to one diode drop above the lowest input signal level. If an external-load current flows from the output terminal of the gate, the current causes a voltage drop across R. The circuit parameters are selected so that output voltage remains at the clamped level.

Capacitive effects limit operating speed of a diode gate. Fig. 3.3*a* shows the diode gate together with diode capacitance C_D and circuit wiring capacitance C_S. For all input terminals are $+U_1$ volts, output voltage of the circuit is at $(U_1 + U_F) = U^1$ volts, and each diode capacitance is charged to U_F volts; this voltage is determined by the diode type, i. e., silicon or germanium, and, to a lesser extent, by the magnitude of current flowing through the diode. Consider that input voltage at terminal A decreases from $+U_1$ to $U^0 = 0$ volts. Fig. 3.3*b* shows the steady-state circuit conditions which are established some time after terminal A is connected to ground potential. The grounded cathode of diode D_1 causes increased forward current flow in this diode, and voltage drop U'_F is slightly larger than U_F. Output voltage of the circuit has decreased to the $U'_F = U^0$ level, and voltage drops

across diodes D_2 and D_3 have reversed polarity. However, as D_1 presents a relatively low impedance path to ground when terminal A is grounded, the negative-going edge of the output voltage waveform is generally deteriorated only slightly by capacitive effects.

Capacitance of the above circuit has a pronounced effect upon the positive-going edge of the output-voltage waveform. If voltage at input terminal A is instantaneously increased from ground potential to $+U_1$ volts, the various capacitance must charge to the polarities and levels shown in Fig. 3.3*a*. Hence, the capacitance are in parallel with each other and can be represented by a single equivalent capacitance C_0 from node X to ground. Output voltage of the gate rises to the steady-state level at a rate determined by $+U$, R and C_0.

Fig. 3.3*c* shows an equivalent circuit of the above diode gate; this circuit is useful for both a d. c. and an a. c. analysis. The one diode shown has an input-voltage level which varies from 0 to $+U_1$ volts. Total circuit capacitance is represented by capacitance C_0. Diode leakage currents are neglected, as they are not significant in the present discussion.

ASSIGNMENTS

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

1. What considerations does design of a logic circuit involve? 2. What is the final choice of circuit parameters? 3.Where are pertinent d. c. and a. c. design considerations presented? 4. What is clamped to one diode drop above the lowest input signal level? 5. What does the current cause if an external-load current flows from the output terminals of the gate? 6. How are the circuit parameters selected? 7. Do capacitive effects limit operating speed of a diode gate? 8. What does Fig. 3.3*a* show? 9. What does the grounded cathode of diode D_1 cause? 10. When does D_1 present a relatively low impedance path to ground? 11. What can the capacitance in parallel with each other be represented by? 12. At what level does the output voltage of the gate rise?

II. Examine Fig. 3.3 and comment on:

1. Voltage distribution when all input signals are positive.
2. When one input signal of ground potential.
3. Equivalent circuit for one varied input.

III. Discuss the problem of diode gates.

IV. Prepare a dialogue on your own situation.

V. Speak on:

1. Design of a logical circuit.
2. Capacitance effects limit operating speed of a diode gate.
3. Capacitance of the circuit.
4. An equivalent circuit of the diode gate.

VI. Look through the latest magazines, find some articles on a diode gate and make a summary of it.