

**МИНИСТЕРСТВО ОБЩЕГО И ПРОФЕССИОНАЛЬНОГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ**

**САМАРСКИЙ ГОСУДАРСТВЕННЫЙ
АЭРОКОСМИЧЕСКИЙ УНИВЕРСИТЕТ
ИМЕНИ АКАДЕМИКА С.П. КОРОЛЕВА**

**ГАЗОТУРБИННЫЕ И РЕАКТИВНЫЕ ДВИГАТЕЛИ
(АНГЛИЙСКИЙ ЯЗЫК)
ЗАДАНИЕ 2**

Методические указания

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Данные методические указания составлены в соответствии с требованиями программы по английскому языку для неязыковых специальностей вузов (1986 г.). Целью учебных заданий является совершенствование навыков чтения и понимания прочитанного по вышеназванной тематике, а также контроль сформированности лексико-грамматических навыков студентов.

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УРОК 6

Обзор грамматического материала: Сослагательное наклонение.

Придаточные предложения условия.

Сослагательное наклонение (The Subjunctive Mood) – выражает действие не реальное, а предполагаемое, условное или желаемое. На русский язык переводится сочетанием глагола в форме прошедшего времени с частицей «бы».

Сослагательное наклонение употребляется в простых предложениях и совпадает с формой Future in the Past: **should, would, could, might + инфинитив без частицы “to”**, если высказывание относится к настоящему или будущему времени ,

e.g. It's a pity you can't come tomorrow. Peter **would help** you. – Жаль, что вы не можете прийти завтра. Петр **помог бы** вам.

Или формой Future Perfect in the Past: **should, would, could, might + перфектный инфинитив без частицы “to”**, если высказывание относится к предшествующему периоду,

e.g. Why didn't you phone him yesterday? He **would have helped** you. – Почему вы не позвонили ему вчера? Он **помог бы** вам.

Сослагательное наклонение также употребляется:

- в придаточных предложениях-подлежащих после безличных оборотов типа: **it is necessary that, it is important that, it is desirable that.**

e.g. *It is desirable* that he **should be** here at five o'clock. – *Желательно, чтобы он был* здесь в пять часов.

Частица «бы» при переводе сливается с союзом «что».

- в дополнительных придаточных предложениях после глаголов, выражающих **приказание, совет, желание: advise, command, demand, order, propose, recommend, request, require, suggest** и др. После этих глаголов идет союз “that”,

e.g. He **suggested** that the question **should be discussed** at the next meeting.-

Он *предложил*, чтобы вопрос был обсужден на следующем собрании.

- в придаточных обстоятельственных предложениях цели после союзов: **so that** – так чтобы, **lest** – чтобы... не, **in order that** – для того, чтобы,

e.g. The students brought the dictionaries **so that they might use** them at the lesson.- Студенты принесли словари, чтобы они могли пользоваться ими на уроке.

- в обстоятельственных сравнительных предложениях после союзов: **as if, as though** (как будто бы, как если бы),

e.g. He spoke **as if he were** a specialist on the subject. – Он говорил, как если бы он был специалистом по этому вопросу.

Примечание: Глагол “to be” имеет форму “were” для всех лиц в сослагательном наклонении.

e.g. If I **were** you, I would accept their offer. – На вашем месте я бы принял

их предложение.

- в условных предложениях II и III типа,

e.g. **If he were here, he would help you.** – Если бы он был здесь, он помог бы вам.

Условные предложения (The Conditional Clauses)

Существует три типа условных предложений.

Условные предложения первого типа (Conditional I) употребляются для выражения возможности реального выполнения действия.

If + Present Simple, shall/will + base form of the verb

e.g. **If you leave before 10.00, you'll catch the train.** - Если ты выйдешь раньше 10.00, то успеешь на поезд.

He won't pass the exam if he doesn't do any work. – Он не сдаст экзамен, если не будет заниматься.

Запомните: 1. Будущее время употребляется только в главном предложении.

If it rains, I **will stay** at home.

2. Глаголы shall/will могут быть заменены на модальный глагол.

I **can** buy a new car if you lend me some money.

Союз "if" может быть заменен союзами unless- если не, in case – в случае, если, provided, on condition – при условии, если.

e.g. **I'll take my umbrella in case it rains.**

Условные предложения второго и третьего типов (Conditional II, Conditional III) употребляются в сослагательном наклонении.

Conditional II отражает нереальные (или маловероятные) условия, относящиеся к настоящему или будущему времени.

If + Past Simple, should/would + base form of the verb

e.g. **If I won some money, I would travel** around the world. - Если бы я выиграл деньги, я бы путешествовал по свету.

He could run faster if he stopped smoking. - Он мог бы бегать быстрее, если бы бросил курить.

Conditional III отражает нереальные (или маловероятные) условия, относящиеся к прошедшему времени.

If + Past Perfect, should/would + Perfect Infinitive

e.g. **If you hadn't told me, I would never have known** about it. - Если бы вы не сказали мне, я бы никогда не узнал об этом.

If he **hadn't** told me, I **might have made** a mistake. – Если бы он не сказал мне, я возможно сделал бы ошибку.

Примечания 1. Союз “if” в условных придаточных предложениях может опускаться, если сказуемое выражено глаголами “had” или “were”, причем эти глаголы ставятся перед подлежащим.

e.g. **Were** you more attentive, you'd never make such a mistake. – Если бы ты был более внимательным, ты бы не сделал такой ошибки.

Had he **had** enough, time he would have attended the lectures. – Было бы у него достаточно времени, он бы посещал эти лекции.

2. В сложном предложении с придаточным условия главное и придаточное предложения могут относиться к различным периодам времени: придаточное предложение может относиться к предшествующему периоду времени, а главное – к настоящему или будущему времени, и наоборот.

e.g. If the railway station **were** nearer, we **should have got** there long ago. – Если бы вокзал был ближе, мы бы давно туда добрались.

1. Раскройте скобки и поставьте глаголы в правильную форму.

1. I didn't feel good yesterday. If I (feel) better, I (come) to class yesterday. 2. I don't feel good today (feel) better, I (take) a walk in the park today. 3. I have a cold today, but I will probably feel better tomorrow. If I (feel) better tomorrow, I (go) to class. 4. I'm sorry that you didn't come to the party. If you (come), you (have) a good time. 5. I didn't know that Bob was sick. If I (know) that he was sick, I (take) him some chicken soup. 6. I'm tired. If I (be, not) tired, I (help) you. 7. Snow is predicted for tomorrow. If it (snow) tomorrow, I (stay) at home. 8. I may have a dollar. Let me look in my wallet. If I (have) a dollar, I (lend) it to you. 9. I didn't have any money yesterday. If I (have) a dollar yesterday, I (lend) it to you. 10. I didn't know it was your birthday yesterday. I (get) you a present if I (know) it. 11. Why didn't you tell me when your plane was supposed to arrive? If you (tell) me, I (pick) you up at the airport.

Основной курс

1. Запомните слова.

auxiliary [ə:q'zɪljəri]
propulsion [prə'pʌlʃn]

rate [reɪt]
to suppose [sə'pəʊz]
to burn [bɜ:n]
oxygen ['ɒksɪdʒən]
to consume [kən'sju:m]
to fit [fɪt]

вспомогательный
силовая установка, движение
вперед
скорость, темп, степень
предполагать, думать
гореть, сжигать
кислород
потреблять, расходовать
подходить, устанавливать,
оснащать

to convert	[kən'veɪt]	превращать
to rise (rose, risen)	[raɪz, raʊz, 'rɪzn]	подниматься
to descend	[dɪ'send]	опускаться, понижаться
out of	[aʊt əv]	из, вне
main	[meɪn]	главный, основной
altitude	[ˈæltɪtʃud]	высота
to occur	[ə'kɔː]	иметь место, происходить

2. Переведите предложения.

1. Auxiliary engines are often used in aircraft. 2. The main advantage of this design is its size. 3. The rate of fuel consuming is too high in this aircraft. 4. The fuel is usually burnt with oxygen. 5. Auxiliary installations are necessary in this case. 6. Everybody supposes that no burning can occur under these conditions. 7. Every engine must consume as little fuel as possible. 8. Burning can't occur without oxygen. 9. This type of wings doesn't fit our aim. 10. We suppose that this method completely fits them. 11. It is necessary to convert the energy of chemical reaction into power. 12. The airplane rises and descends at low speed. 13. Such operation rate doesn't fit our program.

3. А. Найдите слова-синонимы:

to convert, altitude, propulsion, main, to consume, to fit, rate, to occur
to take place, to use, speed, movement, to transform, to install, height, chief

В. Найдите слова-антонимы:

auxiliary, descend, out of, above, start, landing
below, take off, finish, into, rise, main.

4. Подберите подходящее по смыслу слово.

1. It is necessary to use a new type of (power, altitude, propulsion). 2. This engine consumes fuel at great (propulsion, rate, thrust). 3. The fuel is (descended, risen, burnt) in some minutes. 4. For any burning (oxygen, water, nitrogen) is necessary. 5. The German V-2 rocket (reached, consumed, carried) 9 tons of fuel in one minute. 6. During rising of the aircraft (ballistic, auxiliary, another) power plant is utilized.

5. Поставьте сказуемое в страдательный залог, переведите предложения.

1. Sometimes rocket motors (to use) in aircraft for auxiliary purposes. 2. The energy of fuel (to convert) into the energy of propulsion. 3. The fuel (to burn) in 1 minute. 4. The controls (to fit) on the unit. 5. The distance must (to cover) in 20 minutes. 6. A small turbojet engine may (to install) to ease the take off and the landing.

6. Переведите следующие предложения по образцу.

Образец: I should help you. – Я бы помог вам.

1. The engine should develop its maximum speed in some minutes. 2. They could use the main principle of the project. 3. The problem would not have been solved. 4. Such turbine design would not be installed in our case. 5. The engine would be repaired.

7. Переведите предложения, обращая внимание на условные предложения и способы их перевода.

1. If the engine is repaired, it will work for a long time. 2. Unless the design is adopted by our chief, it will not be realized. 3. If this engine didn't consume much fuel, it would be one of the best engine today. 4. Provided the main propellant for this rocket were nitrogen, it would be used for our purpose. 5. Provided the aircraft speed could be increased, the problem would be solved quite easily. 6. Unless the undercarriage had been installed, the landing would not have been so easy. 7. Provided this unit is removed, we shall immediately look for another one. 8. Unless the craft covered 150 miles per hour it could not arrive so quickly.

8. Выберите подходящий союз.

1. ... the rocket had suitable wings and controls, it would have the required trajectory. 2. ... there were enough atmosphere, the aircraft could operate in cosmos. 3. Manned rockets could not have been launched ... the problem of returning to the Earth had been solved. 4. ... the rocket would have suitable wings, one would be able to change its trajectory.

9. Переведите предложения.

1. Unless the propulsion consumes much fuel, they will take it for their project. 2. If they didn't fit the auxiliary engine, the operation would be impossible. 3. The process couldn't occur under these conditions. 4. If the rocket were fitted with wings and controls, it would be converted into a high-speed aircraft. 5. The rocket would follow a ballistic trajectory and descend to a height of 100,000 ft.

10. Прочтите и переведите интернациональные слова.

Rocket, control, impulse, ballistic, trajectory, atmosphere, horizontal, final, practically, normal, initial, total.

11. Прочтите и переведите текст А.

Text A

Rocket Motors

At present rocket motors are used in aircraft only for the three auxiliary purposes already mentioned; we have seen that the great difficulty about using them for main propulsion is the enormous rate at which they burn fuel and oxygen. But it must not be supposed that they will never be used for latter purposes. For example, the German V-2 rocket consumed 9 tons of fuel in 1 minute, but it reached a speed of 3,500 m.p.h. If this rocket were fitted with suitable wings and controls and so converted into high-altitude, high-speed aircraft, it could be made to have a flight-path as shown below. The fuel would all be burnt in about 1 minute and the aircraft would rise under the initial impulse to a height of nearly 300,000 feet, after this it would follow a ballistic trajectory until it had descended again to a height of about 100,000 ft., where there would be enough atmosphere for the controls to be used to pull the aircraft out of the dive into gliding altitude.

This would occur about 4 minutes after the start, when a horizontal distance about 150 miles had been covered. From here the craft would glide for nearly another 450 miles, making a total of 600 miles, covered in about 20 minutes. A small turbojet engine might be installed to ease the glide and final landing, which might be made under practically normal conditions.

12. Ответьте на следующие вопросы:

1. What engines is this article about?
2. Where were rocket engines used during the World War II?
3. How can you describe the German V-2 rocket?
4. Under what conditions would it be possible to utilize a rocket as a high-speed aircraft?
5. To what height would the aircraft rise under the initial impulse?
6. At what height would there be enough atmosphere for the controls using?
7. What distance would be covered in 4 minutes?
8. What engines might be installed to ease the glide and final landing?

13. Верно ли утверждение, что...

1. Rocket motors are traditionally used in ordinary aircraft.
2. German V-2 rocket consumed little fuel, but reached only low speed.
3. If this rocket were fitted with suitable wings, it couldn't be converted into high-altitude, high-speed aircraft.
4. After burning the fuel the aircraft would descend to a height of 2,000 kilometres.
5. In 4 minutes after the start only some miles of horizontal distance would be covered.

14. Переведите на русский язык.

1. If there were no vacuum in cosmos, ordinary aircraft could operate there.
2. Provided some disadvantages were removed, this propulsion could be utilized not only for auxiliary purposes.
3. Unless the design could be changed, the characteristics would remain the same.
4. Unless they had solved the problem, they would not have been able to complete the experiment.
5. If this rocket were fitted with suitable wings, it could be converted into a high speed aircraft.

15. Поставьте глагол в нужной форме.

1. If this engine (to be) of smaller sizes, it could be used for small helicopters.
2. Unless the new airport (to be completed), the number of airplane routes would have been lessened.
3. Provided there were not enough space in the cabin, this unit (to be installed) in it.
4. Provided you didn't change the fuel the rate of burning (not to be improved)

16. Переведите предложения.

1. Если бы этот двигатель имел меньший вес, мы бы использовали его.
2. Если бы самолет уже вернулся, мы бы знали об этом.
3. Если бы тяга была сильнее, скорость аппарата была бы больше.
4. Если бы ракета была оснащена крыльями, она бы превратилась в высокоскоростной самолет.
5. Это произошло бы через 4 минуты после старта.

17. Составьте предложение.

A, converting, motor, a, is, device, rocket, the, for, energy, of, thermochemical, one, propellants, or, into, more, exhaust, energy, jet, kinetic.

18. Образуйте глаголы при помощи данных суффиксов и переведите как исходные, так и полученные слова.

Образец: length – to lengthen

- en : strength, height, light, wide, broad, hard;
- ify: simple, intense, electric, quality;
- ize: magnet, revolution, crystal, character, special active

19. Найдите исходную форму глагола и переведите.

Образец: building – to build

Undertaking, drawing, equipment, designer, accelerator, classification, orientation, compressor, appearance, foundation, existence.

20. Дополните диалог.

A: Could rocket engines be used as the main airplane power plant unit?

B:

A:

B: The main disadvantage of the rocket motor is the great rate of consuming fuel and oxygen.

A: What thrust can rocket engine develop?

B:

A:

B: It would occur in about 4 minutes when a horizontal distance of about 150 miles had been covered.

21. Обратите внимание на перевод данных слов. Это поможет вам понять текст В.

to prevent – мешать

reason – причина

unlike – в отличие

supply – запас

hydrocarbon – гидроуглеродистый

value – значение

adoption - принятие

ratio – коэффициент, отношение

in spite of – несмотря на ...

climb – набор высоты

amount – величина, количество

in its favour – в его пользу

22. Просмотрите текст. Переведите вопросы и найдите в тексте ответы на них.

1. Что мешает использовать ракетный двигатель как основную силовую установку?
2. Какие преимущества имеет ракетный двигатель?
3. Для каких целей используется ракетный двигатель в наши дни,

Text B

The simplest form of jet-propulsion power units is the rocket engine, but enormous rate at which it consumes fuel has prevented its adoption as a power plant for continuous operation over periods as long as one hour.

The main reason for this is that, unlike other types of engines the rocket does not take the oxygen required to burn the fuel from the atmosphere, but carries its own supply. A hydrocarbon fuel, such as petrol, requires oxygen more than its own weight to burn it completely: so the weight of fuel that a rocket-propelled aircraft has to carry is much more than for other air-consuming engines. Another reason for the high fuel consumption is that the speed of the jet is much higher than that of the turbojet engines.

The rocket engine is on the whole rather simpler than the turbojet, but the outstanding points in its favour are thrust-weight and thrust-frontal area ratios and the fact that the thrust does not fall off at heights as does that of the turbojet.

In spite of the high fuel consumption of the rocket engine, the large thrust which it develops, makes it suitable for three applications. These applications are at present mainly of military value, namely assisted take off, increasing the rate of climb and increasing the speed in level flight.

The last two operations can, of course, only be performed for short periods limited by the amount of rocket fuel that can be carried. For assisted take off the required period of operation is short. Briefly the present duty of the rocket is to provide very large thrust for short periods.

23. Просмотрите текст еще раз и ответьте на вопросы.

1. What is the simplest form of jet-propulsion power units?
2. Why is it impossible to use a rocket engine as a main power plant?
3. What are the main advantages of rocket engines?
4. For what purposes are rocket engines used today?
5. How long can rocket engines operate?

24. Письменно переведите текст С.

Text C

The rate of climb of military aircraft can be appreciably increased by rockets. The rates of climb of present-day fighters have not been disclosed, but it is fairly certain that the rate is at least 10000 ft per minute if not more. With a rocket thrust equal to the static thrust of jet engine at sea level it has been estimated that a height of 45000 ft could be reached in one minute.

Acceleration in level flight depends on the excess thrust available. The thrust of turbojet engine falls off at altitude. This may be serious for a fighter for which high manoeuvrability, which implies rapid changes of speed, is essential. Hence rocket engines may play an important part in the equipment of high-speed interceptor aircraft operating at high altitudes.

Обзор грамматического материала: 1. *ing-form* глаголов (The Participle I, The Gerund)
2. Глаголы с *-ed* (The Participle II)

Причастие (Participle I, Participle II) и герундий (Gerund) являются неличными формами, т.е. они не изменяются по лицам и не употребляются самостоятельно в роли сказуемого.

Английское причастие (The Participle I) соответствует русским причастию и деепричастию.

e.g. The facts **illustrating** his theory sound convincing. - Факты, **иллюстрирующие** его теорию, звучат убедительно.

Illustrating his theory, he gave a lot of historical facts. **Иллюстрируя** свою теорию, он привел много исторических факторов.

Формы причастия I (The Participle I)

Participle I	Active	Passive
Non-perfect	sending	being sent
Perfect	having sent	having been sent

Неперфектная форма причастия I выражает действие, *одновременное с действием, выраженным глаголом-сказуемым.*

e.g. **Knowing** the English language well, he **can** translate newspaper articles without a dictionary. - **Зная** хорошо английский язык, он **может** перевести газетные статьи без словаря.

Также эта форма может выражать действие, *совпадающее с моментом речи, независимо от того, в каком времени стоит глагол-сказуемое.*

e.g. The man **sitting** at the window **came** from Moscow yesterday. - Человек, **сидящий** у окна, **приехал** вчера из Москвы.

The large building **being built** in our Street is a new school-house. - Большое здание, **строящееся** на нашей улице, новая школа.

Перфектная форма причастия I выражает действие, *предшествующее действию, выраженному глаголом-сказуемым.*

e.g. **Having collected** all the material, he was able to write a full report on the work of the commission. - **Собрав** весь материал, он смог написать подробный отчет о работе комиссии.

Having been sent to the wrong address, the letter didn't reach him. - **Так как** письмо было послано по неверному адресу, оно не дошло до него.

Причастия от глаголов hear, see, notice, understand, realize, come arrive и некоторых других имеют неперфектную форму, если выражаемое ими действие непосредственно предшествует действию глагола-сказуемого.

e.g. **Hearing** the news I called him at once. - **Услышав** эти новости, я сразу же позвонил ему.

Arriving at the station we went straight to the booking office.

- Приехав на вокзал, мы пошли прямо в кассу.

Функции Participle I

<p>Неперфектная (Non-Perfect)</p>	<p>- Перфектная (Perfect)</p>
<p>Определение The rising sun was hidden by the clouds. – Восходящее солнце было скрыто тучами. The man smoking a cigarette is my brother. – Человек, кура-щий сигарету, мой брат.</p> <p>Обстоятельство (времени, причины, образа действия – часто с союзами when, while) When going home I met my brother. – Идя домой, я встретил брата. Часть простого глагольного сказуемого He is carrying out the experiment now. – Сейчас он проводит эксперимент.</p>	<p>Не употребляется. В этом случае перевод дается придаточным предложением. At last they saw the man who saved their son. – Наконец-то они увидели мужчину, спасшего их сына.</p> <p>Обстоятельство Having lived in Moscow for many years he knew that city very well. - Прожив в Москве много лет, он знал этот город очень хорошо.</p>

The Participle II (The Past Participle) выражает действие, законченное по отношению к действию, выраженному сказуемым и соответствует русским причастиям настоящего времени на – **мый, -щийся** и прошедшего времени, оканчивающимся на – **нный, -тый, -вшийся**.

e.g. A **broken** cup was lying on the table.

- **Разбитая** чашка лежала на столе.

Функции Participle II

Функция	Пример
<p>Определение к существительному (левое и правое)</p>	<p>She mended the torn sleeve of her dress (левое). – Она починила порванный рукав своего платья. The books taken from the library must be returned next week (правое). Книги, взятые в библиотеке, должны быть возвращены на следующей неделе.</p>

<p>Обстоятельство (часто с союзами when, if, unless)</p>	<p>When treated by a good specialist, the sick man began to feel better. - Когда больного начал лечить хороший врач, он почувствовал себя лучше.</p>
<p>Часть простого глагольного сказуемого</p>	<p>They listened to a very interesting concert yesterday. Вчера они слушали очень интересный концерт.</p>

Независимый причастный оборот

Независимым причастным оборотом называется такой оборот, в котором причастие имеет свое **собственное** подлежащее, выраженное существительным в общем падеже (или местоимением в именительном падеже). Аналогичной конструкции в русском языке нет. Оборот переводится на русский язык придаточными предложениями, которые вводятся союзами **так как, поскольку, хотя, после того как, когда, причем, а, если.**

e.g. **The weather being fine**, they went for a walk. – **Так как погода была хорошая**, они пошли гулять.

1. Замените придаточные предложения причастными оборотами.
 1. While we were crossing the bridge, we saw D who was talking with an old man. 2. As we were very tired, we refused to go for a walk. 3. A large branch which had been broken by the wind, lay across the road. 4. At a conference of the Academy of Sciences which is now being held in Moscow, a number of important scientific problems are being discussed. 5. When we crossed the bridge, we saw a small village, which was situated at the foot of a hill. 6. I'll show you the article which has been written by my brother. 7. As he had been taught English by a good teacher, he knew the English language well. 8. The moon was invisible as it was hidden by a cloud.

2. Замените причастные обороты придаточными предложениями.
 1. A person bringing good news is always welcome. 2. While skating yesterday he fell and hurt himself. 3. Having lived in that town all his life, he knew it very well. 4. She showed the travellers into the room reserved for them. 5. When writing a telegram we must use as few words as possible. The leaves lying on the ground reminded us of autumn. 7. Books read in childhood seem like old friends.

3. Переведите на русский язык (обратите внимание на место причастия в английском и русском языке).
 1. The English spoken by most educated people in Britain is known as the Queen's English or Standard English. It is the English taught in universities and schools and the kind heard on the BBC. 2. I have looked through the list of prices sent. 3. Payment for the goods brought was made in Moscow. 4. Explained again, the rule became quite clear to everybody. 5. The man saved was a Norwegian sailor.

4. Переведите независимый причастный оборот.

1. My sister having lost the key, I couldn't enter the house. 2. My task having been finished, I went to bed. 3. Peter being away, Alexander had to do his work. 4. It being very cold, they made a fire. 5. The rule explained, we started doing the exercises. 6. The preparations being completed, they began to climb up the mountain. 7. The negotiations between the American and British representatives were conducted behind closed doors, measures having been taken that no correspondent should receive any information. 8. The play being very popular, it was difficult to get tickets. 9. With the shipping strike in the United States still going on, arrivals of American cotton in Liverpool were rather small.

5. Переведите предложения на английский язык.

1. Я спросил человека, читавшего газету, который час. 2. Я вчера говорил с инженером, работавшим над этим проектом в прошлом году. 3. Он не заметил письма, лежавшего на столе. 4. Прочитав много материала по этому вопросу, он смог сделать очень интересный доклад. 5. Мне сказали, что женщина, сидевшая в коридоре, ждала директора. 6. Он принес мне несколько иллюстрированных журналов. 7. Его неожиданный ответ удивил нас всех. 8. Сказав это, он вышел из комнаты. 9. Студенты, окончившие перевод статьи, могут выйти из комнаты. 10. Узнав, что он все еще в Москве, я позвонил ему. 11. Вопросы, обсуждавшиеся на прошлом собрании, были очень интересными. 12. Переводя статью, мы пользовались словарем. 13. Железная дорога, соединяющая эту деревню с городом, была построена в прошлом году. 14. Я хочу прочитать ей книгу, так как мой приятель, читавший ее, говорит, что она очень интересная. 15. Сняв пальто и шляпу, он пошел наверх.

Герундий (The Gerund) – неличная форма глагола, которая, как и причастие I, образуется с помощью суффикса **-ing**, добавляемого к основе глагола. Герундий обладает как свойствами глагола, так и существительного. В русском языке аналогичной формы нет. По своему значению герундий приближается к русским отглагольным существительным, обозначающим процесс (*хождение, обсуждение, чтение и т.д.*)

Формы герундий

	Active	Passive
Non-perfect	writing	being written
Perfect	having written	having been written

Неперфектная форма герундия обозначает действие, одновременное с действием глагола-сказуемого или будущее по отношению к глаголу-сказуемому.

e.g. They accuse (accused) him of

- Они обвиняют (обвинили) его в том,

lying.

He dreams of **becoming** a doctor.

что он лжет.

-- Он мечтает о том, что станет доктором.

Перфектная форма герундия обозначает действие, предшествующее действию глагола-сказуемого.

e.g. He is proud of **having won** first prize. -- Он гордится тем, что завоевал первый приз.

Отрицательная форма образуется путем постановки частицы *not* перед герундием.

e.g. **Not knowing** her address, we couldn't go to see her. -- Не зная ее адреса, мы не могли навестить ее.

Герундий может иметь перед собой *предлог, определение, выраженное притяжательным местоимением или существительным в притяжательном падеже.*

e.g. **On seeing** his father, the boy ran up to him. -- Увидев своего отца, мальчик подбежал к нему.

Do you mind **our being** present? -- Вы не возражаете против того, чтобы мы присутствовали?

We were surprised at **Oscar's coming** so late. -- Мы были удивлены тем, что Оскар пришел так поздно.

Функции герундия в предложении

Функция	Пример
Подлежащее Именная часть составного сказуемого Часть составного глагольного сказуемого Прямое дополнение	Smoking is bad for you. Курение вам вредно. His hobby is collecting stamps. -- Его любимое занятие - коллекционирование марок. She stopped reading . -- Она кончила читать.
Предложное дополнение (используется после любого глагола или прилагательного, требующего предлога)	Excuse my interrupting you. -- Извините, что я прерываю вас. She insisted on our not being late. -- Она настаивала, чтобы мы не опаздывали.
Определение (с предлогом <i>of</i>)	I see no other way of doing it. -- Я не вижу другого способа сделать это.
Обстоятельство (всегда с предлогом)	At hearing his name he turned round. -- Услышав свое имя, он обернулся.

Герундий может переводиться на русский язык *существительным, инфинитивом, деепричастием и придаточным предложением.*

e.g. I like his method of **teaching**.

It's no use **talking** to him.

He left without **saying** a word.

He was suspected of **keeping** something from us.

Мне нравится его метод преподавания.

С ним бесполезно разговаривать.

Он ушел, не сказав ни слова.

Его подозревали в том, что он что-то от нас скрывает.

Герундиальный оборот

Герундиальный оборот состоит из существительного (в притяжательном или общем падеже) или местоимения (притяжательного или личного в объектном падеже) + герундий. Этот оборот часто вводится словами: что; то, что; того, чтобы; чтобы.

e.g. We were against **Mr. Bond's** (Mr. Bond, his, him) going to Switzerland.

I never heard of **him behaving** like that.

- Мы возражали против того, чтобы м-р Бонд (он) ехал в Швейцарию.

- Я никогда не слышал, чтобы он вел себя таким образом.

6. Переведите предложения. Правильно определите, к кому (к чему) относится действие, выраженное герундием.

1. I remember leaving a message for Mr. Howard. 2. I remember his leaving a message for Mr. Howard. 3. Mrs. Blank apologized for having caused trouble. 4. Mrs. Blank apologized for her children having caused so much trouble. 5. We didn't mind cooperating with that organization. 6. We don't mind you cooperating with that organization. 7. Huck Finn couldn't get used to being treated so kindly. 8. Huck Finn couldn't get used to the old woman treating him so kindly. 9. Jean doesn't like being spoken about. 10. Jean doesn't like anybody speaking about her. 11. He apologized for the question having been discussed in my absence. 12. He apologized for their having discussed the question in my absence. 13. He apologized for having discussed the question in my absence.

7. Замените придаточные предложения оборотами с герундием, поставив, где требуется, соответствующий предлог.

1. When I received the telegram? I started home at once. 2. When he entered the room, he greeted everybody. 3. He is proud that he has never been beaten at chess by his fellow students. 4. You can improve your knowledge of English if you read more. 5. Do you mind if I close the window? 6. The doctor insisted that I should stay at home. 7. You will excuse me if I ask you again.

8. Переведите на английский язык.

1. Мысль провести каникулы на Волге принадлежит моему брату. 2. Вы можете улучшить свое произношение, читая вслух каждый день. 3. Я думаю поехать туда осенью. 4. Дождь помешал мне прийти к вам вчера. 5. Я предпочитаю жить на севере летом. 6. Планируя вашу работу на будущий месяц, вы должны принять это во внимание. 7. Стоит ли читать эту книгу? 8. Она вышла из

комнаты, не посмотрев на нас. 9. Перестаньте разговаривать. 10. Я не возражаю, чтобы он поехал с вами. 11. Он потушил свет перед тем, как выйти из комнаты. 12. Я поблагодарил его за то, что он купил мне такие интересные книги. 13. Мы не могли не рассмеяться, когда услышали это. 15. Он ответствен за проведение эксперимента.

Основной курс

1. Запомните слова.

to discharge [dis'tʃɑ:dʒ]
h.p. = horsepower ['hɔ:s,paʊə]

rear [riə]

front [frʌnt]

to meet requirement [ri:k'waɪəmənt]

to push [puʃ]

sufficient [sə'fɪʃənt]

consumption [kən'sʌmpʃn]

to create [kri:'eɪt]

to differ [dɪfə]

efficiency [ɪfɪ'ɪʃnsɪ]

gasoline [gæ'səli:n]

to arrange [ə'reɪndʒ]

prime mover ['praɪm'mu:və]

blade [bleɪd]

weight [weɪt]

stroke [straʊk]

to raise [reɪz]

to solve [sɒlv]

lightness [laɪtnɪs]

airscrew [ɛə'skru:]

выбрасывать, разряжать
лошадиная сила, мощность в л.с.

задняя часть
передняя часть

отвечать требованиям
толкать

достаточный
расход, потребление

создавать, творить
отличаться

эффективность
газолин, бензин

располагать, монтировать
основной источник движения,

двигатель
лопатка, лопасть

вес
такт, ход

поднимать
решать

легкость (о весе)
воздушный винт

2. Переведите предложения на русский язык.

1. The Russian mechanic Yagodinsky created the first four stroke gasoline engine.
2. The designers must combine efficiency and lightness in an engine
3. The engine is to have reduced weight per horsepower of the engine.
4. In the turbojet engines the jet of air and gases is discharged at high velocity and temperature.
5. Modern turbojet engines can meet all the requirements of today's aviation.
6. Engine development raises many problems which designers have to solve.
7. The fuel consumption must be as low as possible.

3. Найдите: а) слова-синонимы:

to discharge, rear, efficiency, mover, to create, to meet requirements, propeller
effectiveness, engine, to satisfy requirements, to develop, airscrew, back, exhaust

б) слова-антонимы:

to discharge, rear, to push, prime, sufficient, to raise
to charge, front, to drop, auxiliary, to pull, insufficient

4. Выберите нужное по смыслу слово.

1. One of the problems is to lighten the weight and to increase the (size, area, efficiency) of the engine. 2. Steam engine can produce only low (weight, fuel, power). 3. All types of engines receive their energy from chemical compounds which are called (power, fuel, efficiency). 4. Fuel (invention, increase, consumption) of steam engines was very high. 5. Turbojet engine has no (propeller, turbine, body).

5. Переведите следующие словосочетания.

Four-bladed airscrew, high fuel consumption, four-stroke cycle principle, as compared with, the engine couldn't meet all the requirements, low power developed,

6. Прочтите и переведите следующие интернациональные слова.

Propeller, gas, temperature, plane, problem, cycle, principle, combine.

7. Найдите в предложениях глаголы с ing-окончанием, определите их функцию, переведите предложения.

1. The fan accelerates the air passing through it. 2. The turboprop engine is very similar to the turbojet engine differing only in the use of a propeller. 3. The air is heated in passing through the compressor. 4. Landing on a planet and getting home again is a problem which scientists and designers had to solve. 5. The rocket needs no air for flying. 6. The idea of creating a multi-stage rocket belongs to Tsiolkovsky. 7. The engineer goes on pumping coolant through the installation. 8. There are two types of chemical rocket engines: those using liquid propellants and those using solid propellants.

8. Найдите предложения, в которых обстоятельство выражено глаголом с ing-окончанием, переведите их.

1. The hot gases generated by any heating process can be applied for propelling a body in a fluid. 2. The engine is used in moving aircraft. 3. The principle of the work consists in increasing the air pressure in the engine. 4. A coolant is used for preventing excessive temperature. 5. We have learned of his starting a series of new experiments on engines. 6. Before starting the engine you must carefully test it. 7. He began conducting the experiment last year.

9. Найдите глаголы с окончанием ed, определите их функцию. Переведите эти предложения.

1. The technique described received general approval. 2. The hot gases generated produced increasing of general temperature. 3. The propeller mentioned converted

the energy of the engine into thrust. 4. A force required propelled an airplane through the air. 5. Although applied for many purposes diesel engines have certain disadvantages. 6. When used, a jet engine produced high-pressure, high-temperature gas. 7. If required, the pressure will be increased. 8. As proved by engineers the devices must be changed. 9. Though finished, the work was not a success. 10. The power plant supplied much energy. 11. The air accelerated passed through the fan.

10. Переведите предложения, обращая внимание на перевод независимого причастного оборота в зависимости от его места в предложении:

а) так как; поскольку, когда; если; после того, как.

Модель: Everything being ready, we can start making experiments. – Так как (если, когда) все готово, мы можем приступить к экспериментам.

1. The mechanic repairing the engine, I went to the chief engineer instead of him. 2. The engine being repaired, we shall be able to use it in our work. 3. The mechanic having repaired the engine, the engineer examined it. 4. The engine having been repaired, we could use it in our work.

б) а, и, но, причем, или бессоюзно.

Модель: We have three lectures today, the last being on physics. - У нас сегодня три лекции, причем (и, а) последняя по физике.

1. New engines were brought to the plant, all of them being in good order. 2. The professor entered the lecture hall, the assistant following him. 3. The plan was discussed in detail? Many workers taking part in the discussion. 4. The lecturer spoke on the problem of space research, his lecture (being) illustrated by diagrams.

11. Прочтите текст А.

Text A

Aircraft Power Plant

A radically different power plant is a turbojet engine. This has no propeller, but instead discharges backward a jet of air and gases at high velocity and temperature, thus creating the forward thrust.

Today's engines developing several thousand h.p. greatly differ from those used 50 years ago. Thus the plane tested by Mozhaisky in 1884 was a monoplane provided with two engines developing 50 h.p., those being steam engines. Three four-bladed airscrews provided thrust, the main one being installed in the nose part. It was of a tractor type, the two others arranged in the rear being a pusher type.

Although tried as a prime mover, the steam engine could not meet all the requirements. The steam engine was not sufficiently light and powerful for propelling an airplane. Its heavy weight, high fuel consumption and low power developed raised many problems the designer had to solve.

One of the problems worked at by the designers was lightening the weight of the engine and increasing its efficiency. In 1880 the Russian mechanic Yagodzinsky designed and constructed a new engine type. The engine designed by him was the first gasoline engine working on the four-stroke cycle principle.

The engine attracted the attention of many designers as it was lighter and more powerful as compared with the steam engine. Still there remained an important

but unsolved problem: combining efficiency and lightness in an engine. Even nowadays aircraft engine designers are striving for more horsepower output and less engine weight.

12. Прочтите текст еще раз. Найдите предложения, в которых употребляются следующие слова:

- 1) самолет, испытывать, снабженный, паровые двигатели;
- 2) приводить в движение самолет, недостаточно легкий и мощный;
- 3) первый бензиновый двигатель, принцип четырехтактного цикла.

13. Ответьте на вопросы по содержанию текста.

1. What is the main characteristic of a turbojet engine?
2. How does a turbojet engine create a forward thrust?
3. How many engines were installed in the Mozhaisky aircraft?
4. What kind of engines were installed in the Mozhaisky aircraft?
5. What are the disadvantages of steam engines?
6. What engine was designed by Yagodzinsky?
7. On what principle did this engine work?

14. Заполните пропуски словами из активного словаря.

1. A turbojet engine ... backward a jet of air and gases.
2. A monoplane was provided with two engines developing 50
3. One airscrew of tractor type was installed in the ... part, the two others were ... in the
4. The steam engine could not meet all the
5. The engine was not ... light and powerful.
6. Its heavy ..., high fuel ... and low power developed ... many problems the designer had to
7. One of the problems was to increase the engine

h.p., rear, requirements, consumption, efficiency, to discharge, to arrange, weight, to solve, front, sufficiently, to raise.

15. Дополните диалог по содержанию текста.

A: What are the disadvantages of steam engines?

B:

A:

B: The designers were to lighten the weight of the engine.

A: What kind of engines was designed by Russian mechanic Yagodzinsky?

B:

A:

B: The gasoline engine attracted the attention of many designers.

A: What important problems remain unsolved?

B:

A:

B: All well known types of engines derive their energy from fuel combined with oxygen.

16. Переведите предложения с независимым причастным оборотом.

1. Other things being equal, the higher the temperature of a heat engine, the more efficient the machine.
2. A combustion chamber of a given size containing only a certain weight of a propellant, the thrust may be made large for a short time by providing a large burning surface.
3. Several servo systems are required, the signals being fed electrically to the control systems.
4. Certain other conditions affect the operation of the engine, the principal condition being air density.
5. All four variables being known, the gross thrust at nozzle can be calculated.

17. Переведите предложения, обращая внимание на сложный герундиальный оборот.

1. Tsiolkovsky's having led the foundation of a new science-theory of rocket flying is a well-known fact.
2. These turbofan engines couldn't be used in this design because of their being too heavy.
3. Due to the coolant being pumped through the reactor excessive temperatures are prevented.
4. Successful travelling of satellite depends on their having been set on a proper orbit.
5. Their heating the gas changed the results of their experiments.
6. He insisted on his machine being tested at once.

18. Переведите письменно текст В.

Text B

Jet Engines

Jet engines use the reaction force. It is worth mentioning that the jet engine is not a modern development. It utilizes air from the atmosphere together with the combustion of a fuel.

When used, a jet engine produces high-pressure, high-temperature gas which is ejected rearwards with great force named thrust. The thrust is the reaction of the stream or the jet of hot gases ejected from the rear. The jet is produced by combustion of the fuel in the compressed air which is supplied by the atmospheric air that enters through the front opening.

For getting the required air into the combustion chamber a compressor is mounted in the front opening. Air is sucked, compressed and then used to burn a fuel.

У Р О К И 9-10

Обзор грамматического материала: Инфинитив и инфинитивные обороты

Инфинитив (The Infinitive) (неопределенная форма глагола) представляет собой неличную глагольную форму, которая только называет действие, не указывая ни лица, ни числа.

Формальным признаком инфинитива является частица *to*. Однако в некоторых случаях частица опускается.

Формы инфинитива

Infinitive	Active	Passive
Indefinite	to ask	be asked
Continuous	to be asking	-
Perfect	to have asked	to have been asked
Perfect Continuous	to have been asking	-

Инфинитив в форме **Indefinite** употребляется, когда действие, выраженное им, *одновременно* действию, выраженному глаголом-сказуемым или относится к *будущему* времени (инфинитив в этих случаях употребляется после модальных глаголов **may, must, should, ought** и после глаголов **to expect** – ожидать, **to intend** – намереваться, **to hope** – надеяться, **to want** – хотеть и некоторых других).

e.g. I am glad **to see** you. - Я рад вас видеть.
 It was pleasant **to speak** to him. - Было приятно поговорить с ним.
 He may **come** tomorrow. - Он может быть, придет завтра.
 I hope **to see** him at the concert. - Я надеюсь увидеть его на концерте.
 He has a great desire **to be invited** to the party. - Он хочет, чтобы его пригласили на вечер.

Инфинитив в форме **Continuous** употребляется, чтобы выразить действие, *длющееся* в то время, когда происходит действие глагола-сказуемого.

e.g. The weather seems **to be improving**. - Погода, кажется, улучшается.
 It was pleasant **to be driving** the car - Было приятно снова вести автомобиль.
 again.

Инфинитив в форме **Perfect** употребляется для выражения действия, *предшествующего* действию, выраженному глаголом-сказуемым. После модальных глаголов **must** и **may** для выражения *предположения* о том, что действие уже совершилось. После модальных глаголов **should, would, could, might, ought** и **was (were)** для обозначения действия, которое *должно или могло совершиться*, но в действительности не совершилось.

e.g. I'm glad **to have spoken** to him. - Я рада, что поговорила с ним.
 There was no light in the windows. - В окнах не было света. Вероятно, все легли спать.
 Everybody **must have gone** to bed.
 I'm glad **to have been invited**. - Я рада, что меня пригласили.

Инфинитив в форме **Perfect Continuous** показывает, что выраженное им действие *началось* до действия глагола-сказуемого и *все еще продолжается*.

e.g. He is known **to have been working** on this problem for many years. - Известно, что он работает над этой проблемой в течение многих лет.

Функции инфинитива

Функция	Пример
Подлежащее	To skate is pleasant. – Кататься на коньках приятно.
Часть составного именного сказуемого	Your duty was to inform me about it immediately. – Вашей обязанностью было сообщить мне об этом немедленно.
Часть составного глагольного сказуемого	We decided to spend the summer in the Crimea. – Мы решили провести лето в Крыму.
В сочетании с модальными глаголами и их эквивалентами: to be sure (несомненно), to be certain (безусловно), to be likely (вероятно), to be unlikely (вероятно не, вряд ли).	He <i>must</i> know her address. – Он, должно быть знает ее адрес. She <i>is unlikely</i> to come. – Она вряд ли придет. It <i>is likely</i> to rain. – Вероятно, пойдет дождь.
Дополнение	I asked him to help me. Я попросил его помочь мне.
Определение	He expressed a desire to help me. – Он выразил желание помочь мне. They are always <i>the first</i> to come. – Они всегда приходят первыми.
Часто после слов: the first, the second, the third.	
Обстоятельство:	
цели:	I went to the station to see off my friend. – Я пошел на станцию, чтобы проводить друга.
следствия:	He is too young to understand it. – Он слишком молод, чтобы понять это.

Объектный инфинитивный оборот (Complex Object)

Объектный инфинитивный оборот состоит из существительного в общем падеже или личного местоимения в объектном падеже (me, him, her, you, them, us) и инфинитива. На русский язык переводится дополнительным придаточным предложением, вводимым союзами «что», «чтобы».

e.g. We know **this scientist to have made** an important discovery in electronics. Мы знаем, что этот ученый сделал важное открытие в электронике.
They want **us to stay**. Они хотят, чтобы мы остались.

Объектный инфинитивный оборот употребляется:

после глаголов: wish, want, would like. (Перед инфинитивом ставится частица to):

e.g. Do you really want **him to come**? Ты на самом деле хочешь, чтобы он пришел?

после глаголов, выражающих предположение: **expect, think, consider, believe, suppose, find (считать)**. (Инфинитив с частицей **to**):

e.g. We **expect him to arrive** tomorrow. Мы ожидаем, что он придет завтра.
после глаголов со значением «физического восприятия»: **see, watch, notice, hear, observe**. (Инфинитив без частицы **to**). После этих глаголов может употребляться как инфинитив (если действие завершено), так и причастие I (если действие продолжается):

e.g. He saw **me approach** the gate. Он видел, как я подошел к калитке.

He saw **me approaching** the gate. Он видел, как я подходил к калитке.

после глаголов, выражающих просьбу, совет, разрешение и побуждение к действию: **ask, allow, tell, order, make, let have**.

e.g. They asked **me to check** the facts. Они попросили меня проверить факты.

После глаголов **make, let have** инфинитив употребляется **без частицы to**.
e.g. What made **him give up** his hobby? Что заставило его бросить свое любимое занятие?

I'll have **her come** whether she wants to or not. Я заставлю ее прийти, хочет она этого или нет.

После глагола **to have** в качестве второго элемента сложного дополнения часто употребляется причастие II для обозначения действия, выполняемого не подлежащим, а другим лицом, причем в разговорной речи глагол **to have** часто опускается.

Сравните:

e.g. She **made a dress**. Она (сама) сшила платье.

She **had a dress made**. Она сшила (ей сшили, она отдавала шить) платье.

I've just **had my car repaired**. Мне только что отремонтировали машину.

Вопросительная и отрицательная формы образуются при помощи глагола **do**: When did you have your car repaired? He didn't have his car repaired last year.

Субъектный инфинитивный оборот (Complex Subject)

Субъектный инфинитивный оборот состоит из существительного в общем падеже (или местоимения в общем падеже) и инфинитива (всегда с частицей **to**). Перевод предложений следует начинать со сказуемого и, если требуется по смыслу, вводится союз **что**.

Между компонентами сложного подлежащего может стоять сказуемое, выраженное:

глаголом в форме страдательного залога: **to be said, to be reported, to be known, to be stated, to be supposed, to be considered, to be seen, to be expected, to be believed** и др.

e.g. She **is known to speak** three languages. Известно, что она говорит на трех языках.

глаголом в форме действительного залога: **to seem (казаться), to appear, to prove (оказываться), to happen (случаться, оказаться)**.

e.g. This substance **seems to possess** useful properties. Кажется, это вещество обладает полезными свойствами.

в сочетаниях: to be likely, to be unlikely, to be sure, to be certain.

e.g. **This is unlikely to be achieved.** Маловероятно, что это будет достигнуто.

Инфинитивный оборот с предлогом *for*

For + существительное в общем падеже или местоимение в объектном падеже + инфинитив. На русский язык чаще переводится придаточным предложением.

e.g. **For the decision to be correct,** Чтобы решение было правильным,

all facts must be considered. следует учесть все факты.

It is necessary **for her to be patient.** Ей нужно быть терпеливой.

1. Переведите на русский язык.

1. I called every morning to see if there was any news. 2. We stopped to have a smoke. 3. He came here to speak to me, not to you. 4. The car was waiting at the door to take them to the station. 5. This doesn't seem to be the right key. 6. To meet the increased demand for industrial goods, a great number of new shops have been opened in the town. 7. He was the first to raise the question. 8. There is no need for the steamer to call at Tuapse. 9. It was necessary for him to return immediately. 10. There is no reason for us to change the terms of payment. 11. There was no time for them to examine the goods that day. 12. It's too late for you to go there. 13. Tell me what would you like me to do. 14. Seeing her enter the room he rose to greet her. 15. Hearing the bell ring he went to see who was at the door. 16. Did you feel the bridge shake? 17. We lay in the shade of the tree, waiting for our friends to come. 18. I don't like you to say such words. 19. His childhood is said to have been very difficult. 20. We knew him to be very brave. 21. He asked for a telegram to be sent to his son. 22. They are expected to send a reply today. 23. I'll have the secretary call up the embassy. 24. She is unlikely to forget it. 25. What makes you think so? 26. We watched the plane take off. 27. Why don't you have your assistant do the job? You said you could rely on him. 28. Steve was believed to be very good at this sort of thing. 29. He is sure to expose himself sooner or later.

2. Переведите на английский язык.

1. Я хотел бы, чтобы вы объяснили мне это правило еще раз. 2. Что вы хотите, чтобы я сделал для вас? 3. Вы слышали когда-нибудь, как он поет? 4. Я слышал, что он приехал в Москву. 5. Они не видели, как он вошел. 6. Никто не ожидал, что они уснут так скоро. 7. Его считают честным человеком. 8. Я увидел, как машина завернула за угол и исчезла. 9. Я считаю, что он ответственен за это. 10. Вряд ли он это сделает. 11. Хочет ли он, чтобы мы помогли ему? 12. Вы слышали, как он выступал (говорил) вчера на собрании? 13. Я видела, как она подошла к письменному столу и взяла письмо, лежащее там. 14. Слыша, что его дочь плачет, он встал и вошел в соседнюю комнату. 15. Я полагаю, что он опытный доктор. 16. Я считаю его лучшим инженером на нашем заводе. 17. Он не хочет, чтобы его дочь ехала в Москву. 18. Предполагается, что в этом районе будет построен новый город. 19. Я хотел бы, чтобы вы пригласили его на вечер. 20. Мы стояли у ворот, ожидая, когда придет машина. 21. Мы ожидаем, что товары будут доставлены через три

недели. 22. Нам трудно сделать работу в такой короткий срок. 23. Текст был слишком трудный, чтобы он мог перевести его без словаря. 24. Сейчас слишком поздно, чтобы дети шли гулять. 25. Не смешите меня. (Не заставляйте меня смеяться). Не разрешайте детям играть на открытом воздухе. Сегодня очень холодно и ветрено. 26. Директор велел секретарю напечатать документ в трех экземплярах. 27. Вероятно пойдет дождь. 28. Известно, что черный цвет поглощает световые лучи наиболее интенсивно. 29. Кажется, что мужчина не узнал вас. 30. Мне почистили костюм. (Я отдавал его в чистку). 31. Я отдам машину в ремонт (Мне отремонтируют машину) в будущем месяце.

Основной курс

1. Запомните следующие слова и выражения.

to bypass	['baɪpɑ:s]	обходить обходным путем
bypass turbojet engine	{tə:'bɑ:dʒet .endʒɪn}	двухконтурный турбо- реактивный двигатель
to operate	{ɒpə'reɪt}	работать
subsonic	{sʌb'sɒnɪk}	дозвуковой
to seam	{si:m}	казаться
to be well suited	{sju:tɪd}	хорошо подходить, соответствовать
to utilize	{ju:'tɪlaɪz}	использовать
tailpipe	{'teɪlpaɪp}	выхлопная труба
reheat	{ri'hi:t}	подогрев
augmentor	{ɔ:g'mɛntə}	форсажная камера
propulsion	{prə'pʌlʃn}	двигатель, силовая установка
excess	{ɪk'ses}	избыток, излишек

2. Переведите предложения.

1. The bypass turbojet engines are utilized for subsonic speed airplanes.
2. The subsonic engines are well suited for civil aircraft.
3. The length of the tailpipe varies with each airplane.
4. Any aircraft propulsion system must meet certain requirements.
5. The excess air enters the tailpipe.
6. Augmentor is an installation increasing thrust.

3. Прочтите и переведите интернациональные слова.

Diagram, type, propeller, characteristic, effective, modern, principle, concentrate.

4. Найдите слова с одинаковым значением:

operate, utilize, propulsion, propellant, force, significant, aim, attain
power plant, fuel, power, important, use, get, work, task.

5. Найдите слова с противоположным значением:
subsonic, solid, civil, excess, various, initiate, accelerate
military, lack, the same, liquid, finish, slow-down, supersonic.

6. Переведите предложения, обратите внимание на место и перевод инфинитива в функции обстоятельства.

Образец: To find more information about the flow in the compressor we must determine its angle velocity. – Для того, чтобы получить дополнительные сведения о потоке в компрессоре, мы должны измерить его угловую скорость.

1. To propel an airplane through the air a certain force is required.
2. Both solid and liquid fuel rockets are used to attain a highly concentrated power.
3. To drive the fan a turbofan has additional turbine stages.
4. In the turbojet engine the turbine is designed to drive the compressor.
5. In order to generate thrust of its own the fan accelerates the air passing through it.

7. Переведите предложения, обращая внимание на место и перевод инфинитива в функции подлежащего.

Образец: To utilize bypass engines for civil and military aircraft is desirable. – Желательно использовать двухконтурный турбореактивный двигатель для гражданских и военных самолетов.

1. To know jet propulsion principle is necessary for every pilot.
2. To predict the behaviour of the engine is significant for our future work.
3. To ensure high propulsion efficiency is our aim.

8. Переведите предложения, обращая внимание на перевод инфинитива в функции определения.

Образец: The engines to be used in space are very powerful. – Двигатели, которые должны применяться в космосе, очень мощные.

1. Tests to determine properties of propellants are currently in preparation at the laboratory.
2. Propellant properties are the main factors to be considered.
3. The reciprocating engine probably will be retained for many years to come for use in low-speed airplanes.

9. Переведите предложения, обращая внимание на перевод инфинитива в составном именном сказуемом.

Образец: The main function of the turbine is to provide power for the mechanical compressor. – Основная функция турбины – давать энергию для механического компрессора.

1. The function of a diffuser is to convert the kinetic energy of the entering air into a pressure rise.
2. The function of the injector is to receive the liquid propellants and direct them in the liquid streams.
3. The aim of the igniter is to initiate combustion.

10. Переведите предложения, обращая внимание на перевод инфинитива в функции части составного глагольного сказуемого и дополнения.

Образец: The weight of the propulsion system is to be divided between fuel and engine. – Вес силовой установки должен быть поделен между топливом и двигателем.

1. The total weight of the airplane can be divided among the airplane, the propulsion system and payload.
2. The engineer wanted to ensure the successful operation of bypass turbojet engine.
3. We should like to utilize the subsonic engines for civil aircraft.

11. Переведите предложения, определив функцию инфинитива.

1. To build a new engine in time is essential.
2. To build a new engine it is necessary to make various calculations.
3. The engine to be built is of great importance.
4. Our aim is to built a new engine.
5. The engine has to be built as soon as possible.

Объективный Инфинитивныйоборот

12. Переведите предложения, обращая внимание на перевод объектного инфинитивного оборота.

Образец: We know **him to be** an aircraft engine designer. – Мы знаем, что он конструктор авиационных двигателей.

1. We know the bypass engine to operate at high subsonic speeds.
2. The scientists consider engines to be well suited for aircraft.
3. The designers suppose the bypass engines to approach the favourable jet characteristics of the propeller.
4. We suppose this engine to be a thrust-augmentor.

Субъективный Инфинитивныйоборот

13. Переведите предложения с субъектным инфинитивом.

Образец: **This machine is known to operate** with great speed. – Известно, что эта машина работает с большой скоростью.

1. Bypass engines are known to operate at high subsonic speeds.
2. Such engines are certain to be well suited for civil aircraft.
3. The subsonic engines seem to be well suited for civil aircraft.
4. Bypass engines are also supposed to be utilized for military aircraft.
5. The bypass engine is considered to approach the favourable jet characteristics of the propeller.
6. Such engine is regarded to be a thrust-augmentor.

14. Прочтите и переведите текст А.

Text A

The Bypass Turbojet Engines

Bypass turbojet engines are designed to operate at high subsonic speeds. Therefore the subsonic engines seem to be well suited for civil aircraft. Sometimes these engines may be utilized for military aircraft, particularly for airplanes intended to operate at these speeds. To enable them to achieve higher speed, the large amount of excess air in the tailpipe is used for reheat. It means to burn extra fuel to increase the thrust to a greater extent. Usually the propeller becomes less efficient at speeds higher than 450-500 m.p.h. But the bypass is considered to approach the favourable jet characteristics of the propeller. Therefore we suppose the bypass engine to be a thrust augmentor and effective means for propulsion of modern aircraft vehicles.

15. Ответьте на вопросы по содержанию текста.

1. What do you know of bypass turbojet engines?
2. What advantages have the bypass engines over the other types of turbojets?
3. Why are they well suited for civil aircraft?

16. Заполните пропуски словами из активного словаря.

1. Most turbojets ... best at relatively high altitude. There is no simple explanation for the fact that they are so ... to high-altitude ...
2. Bypass engines may be ... both for civil and military aircraft.
3. The cold temperature of the air at high altitude gives an engine extra ...
4. A large amount of ... air in the ... is used for reheat.
5. The bypass engine is supposed to be a ...

17. Найдите в тексте два случая употребления слова "means". Объясните, какой частью речи оно является в том и другом случае.

18. Обратите внимание на перевод следующих слов. Это поможет вам понять текст.

fluid - жидкость

acquire - получать

heat exchanger - теплообменник

impulse turbine - активная турбина

reaction turbine - реактивная турбина

shaft - вал

smooth - ровный, гладкий

streamlined - обтекаемый

consideration - соображение

19. Прочтите и переведите текст В.

Text B

The Turbine Nozzle

The turbine nozzle performs two functions:

1. It transforms a portion of the energy of the fluid, acquired in the heat exchanger, into kinetic energy.

2. a) in the impulse turbine it directs the high-velocity fluid jet against blades which are free to move in order to convert the kinetic energy into shaft work;
b) in the reaction turbine the nozzles, which are free to move, discharge high-velocity fluid. The reaction force of the fluid against the nozzles produces motion, and the work is done.

For the first function to be performed efficiently, the nozzle walls must be smooth, streamlined and so proportioned as to satisfy the changing conditions of the stream of gas flowing through the nozzle.

For the second function the nozzle should discharge the fluid at the correct angle with the direction of blade motion to allow a maximum conversion of kinetic energy into work.

The main consideration in nozzle design is expected to provide a nozzle of proper wall contour. For nozzle design the engineer is sure to have at his disposal four fundamental tools or relations: 1) the first law of thermodynamics; 2) the equation of continuity of flow; 3) the characteristic equation of state of the fluid; 4) the equation of process.

20. Просмотрите текст, правильно переведите и объясните употребление:

- a) слова “against” во 2-ом абзаце текста;
б) различие в переводе слова “for” во 2-ом и 3-м абзацах текста.

21. Найдите в тексте:

a) синонимы к словам:

to convert, part, to get, speed, movement, flow, chief, necessary, main;

б) антонимы к словам:

give, low, occupied, minimum, rough, constant, to forbid.

22. Найдите в тексте все случаи употребления инфинитива. Определите его функции и правильно переведите предложения с ним.

23. Найдите в тексте предложения, в которых говорится о том:

- 1) какова функция лопаток в активной турбине;
2) какова функция сопла в реактивной турбине;
3) какими должны быть стенки сопла в активной турбине.

24. Письменно переведите последний абзац текста В.

25. Переведите текст С без словаря.

Text C

The Ramjet

The ramjet engine is an air-breathing engine which operates on the same principle as the turbojet engine. Its basic operating cycle is similar to that of the turbojet. It compresses the incoming air by ram pressure, adds heat energy at a high pressure, converts the heat energy to velocity, and produces thrust. By converting the kinetic energy of incoming air into pressure, the ramjet is able to operate without a

mechanical compressor. Therefore, the engine requires no moving parts and is mechanically the simplest type of jet engine which has been devised. Since it depends on the velocity of the incoming air for the needed compressor the ramjet will not operate statically, that is when it is not moving. For this reason, it requires a turbojet or rocket assist to accelerate it to operating speed.

УРОК 11

Обзор пройденного грамматического материала

1. Запомните следующие слова и выражения.

due to	[dju:]	из-за, вследствие, обусловленный
essentially	[ɪ'senʃ(ə)li]	по существу
to store	[stɔ:]	хранить
tank	[tænk]	бак
advantage	[əd'vɑ:ntɪdʒ]	преимущество
extremely	[ɪks'tri:mli]	крайне, чрезвычайно
altitude	[æltɪtju:d]	высота
extensive	[ɪks'tensɪv]	обширный, большой
booster	[ˈbu:stə]	ускоритель
guided	[ˈgaɪdɪd]	управляемый
auxiliary	[ɔ:g'zɪljəri]	вспомогательный
to enable	[ɪneɪbəl]	давать возможность

2. Переведите предложения.

1. Its great velocity is due to high power.
2. A rocket engine is essentially a tube.
3. Oxygen is stored in a separate tank.
4. The rocket engine can be used at extremely high altitudes.
5. Rockets find extensive use.
6. They are used as boosters for missiles.

3. Найдите слова с одинаковым значением:

motion, essentially, rapidly, velocity, extensive, primary, auxiliary
secondary, quickly, great, main, movement, mainly speed.

4. Найдите слова с противоположным значением:

forward, auxiliary, primary, solid, rapid, high, separate
secondary, liquid, slow, low, mutual, main, backward.

5. Просмотрите текст А и объясните:

- 1) как переводится слово "means" в 4-ом абзаце текста;

2) как перевести выражение "a rocket driven vehicle" (4 абз.). К чему относится слово "driven" в этом выражении?

6. Найдите в тексте и переведите:

- а) предложения в страдательном залоге;
- б) 2 предложения с инфинитивом в функции обстоятельства;
- в) 1 предложение с инфинитивом в функции определения.

7. Переведите текст А.

Text A

The Rocket Engine

A rocket is a jet-propelled vehicle. Its motion forward is due to the reaction of the motion of the gases backward.

A rocket engine is essentially a tube in which propellants are burnt rapidly at great pressure. The propellants give large amounts of heat energy, so that the resulting gases are directed rearward at great velocities to produce the reactive force of propulsion.

In order to burn, fuel requires oxygen. The rocket carries its own oxygen supply. It is stored in a separate tank or combined with the fuel itself. This fact is an advantage. The rocket engine can be used at extremely high altitudes where there is no oxygen.

Rockets find extensive use. They are used as boosters for missiles and research rockets, and as main power plants of guided missiles. A rocket propulsion system may be used as a primary or as an auxiliary power plant of an airplane. The rocket engine provides a possible means of propulsion for interplanetary vehicles. In 1903 K.Tsiolkovsky described a rocket driven vehicle for space travel. Today his dream has become a reality. The rocket develops high velocity. The stem principle enables them much higher velocities to be achieved.

There are two basic types of rocket engines: the solid propellant and the liquid propellant types.

8. Переведите вопросы на английский язык и ответьте на них.

1. Что представляет собой ракета?
2. С чем связано ее движение вперед?
3. Как создается реактивная сила движения в ракетном двигателе?
4. Почему ракетный двигатель может работать без атмосферы?
5. В качестве чего могут использоваться ракеты?
6. Сколько типов ракетных двигателей вы знаете?

9. Переведите данные предложения на английский язык.

1. Ракетный двигатель представляет собой трубку, в которой быстро сгорает топливо при высоком давлении.
2. Для сгорания топлива нужен кислород.
3. Кислород хранится в отдельном баке или вместе с топливом.
4. Ракеты находят широкое применение.

5. В 1903 году К.Циолковский описал ракетный летательный аппарат.
6. В настоящее время мечта его осуществилась.

10. Переведите предложения, обращая внимание на перевод слова **“for”**.

Предлог “for” переводят словами: для, ради, за, по, в течение.

Союз “for” переводят: так как, потому что, ибо.

1. All the necessities of life *for* the crew must be considered in the design of a spacecraft. 2. Space engines of definite types should operate *for* periods up to three years. 3. The pilot-static system is very important *for* it drives primary flight instruments. 4. Liquid propellant types of engines are also used *for* this purpose. 5. The controllable flight by air is really possible only by means of heavier-than-air crafts, *for* without engines it is rather difficult to control the flight.

11. Переведите предложения, обращая внимание на перевод слова **“both”**.

1. *Both* types of engines are used on training aircraft. 2. *Both* piston and turbine engines are internal combustion engines. 3. The Moon is the major objective of *both* unmanned and manned astronomical exploration. 4. *Both* compressors have been used in turbojet engines.

12. Переведите предложения, обращая внимание на перевод слова **“after”**.

a) 1. *After* take off, we should attempt to follow the extended centerline of the runway. 2. *After* several hours of manoeuvring in orbit, the two spacecraft docked. 3. The temperature of the gases *after* combustion must not be too high.

b) 1. *After* the spacecraft is placed into orbit the astronauts start carrying out the flight programme. 2. *After* the air enters the intake of the compressor it is heated in passing through compressor and expands into the combustion chamber.

13. Переведите предложения, обращая внимание на слово **“before”**.

Предлог “before” переводят словами: до, перед, прежде чем.

Союз “before” переводят: прежде чем, до того как.

a) 1. *Before* the landing of a spacecraft the landing retro-rockets are switched on. 2. *Before* the invention of radio flying was only a dream of inventors.

b) *Before* we activate the stator we must be absolutely sure that no person is within the range of the propeller. 2. *Before* the designers thoroughly check the project the engine can't be constructed

14. Переведите предложения, обращая внимание на перевод слова **“because”**.

Предлог “because of” переводят словами: из-за, вследствие.

Союз “because” переводится: потому что, так как.

1. The burning of fuel is really a chemical process *because* it changes the fuel into heat, light, gases. 2. The temperature is greatly increased *because of* the burning of the fuel. 3. *Because* all the valves are closed, the air charge cannot escape. 4. *Because of* the many types of turbine engines, it is not possible to list all the major components.

15. Задайте вопросы к подчеркнутым словам.

1. The rocket engine can be used at extremely high altitudes where there is no oxygen. 2. The rocket engine provides a possible means of propulsion for interplanetary vehicles. 3. A rocket engine is essentially a tube in which propellants are burned rapidly at great pressures. 4. In 1903 K. Tsiolkovsky described a rocket driven vehicle for space travel.

16. Следующие слова помогут вам понять текст В.

to drive	[draɪv]	получать, извлекать
pulse jet	[ˈpʌls dʒet]	пульсирующий воздушно-реактивный двигатель (ПуВРД)
in view of	[vju:]	ввиду того, что; в связи; из-за
to overcome	[ˌoʊvəˈkʌm]	преодолевать
sufficient	[səˈfɪʃənt]	достаточный
divergent inlet duct	[daɪˈvɜːdʒənt]	расходящийся входной канал
to some extent	[tʊ sʌm ɪkˈstent]	до некоторой степени
residual	[rɪˈzɪdʒuəl]	остаточный
whereby	[weəˈbaɪ]	посредством чего
expansion	[ɪksˈpænsən]	расширение
exit velocity	[ˈeksɪt]	скорость на выходе

17. Просмотрите текст В. Найдите предложения, в которых говорится следующее:

1. Как называется авиационная сила в реактивном и турбовинтовом двигателях. 2. Куда направлен воздух в реактивном двигателе. 3. Какую проблему преодолело введение турбореактивного двигателя.

Text B

The Turbo-Prop Engine

Jet engines with which most modern high-speed aircraft are equipped develop thrust on the same principle as the propellers of conventional aero-engines. In both, the propulsive force is derived from the reaction produced by a stream of air driven rearwards at high velocity. However in jet-propulsion the air is directed rearwards in a jet from the engine itself. The earliest forms of jet-propulsion such as pulse jet utilized in the Flying Bomb, were incapable of functioning at rest, in view of the absence of any means of air-compression. But the introduction of the turbo-jet overcame this problem, since then the turbine developed sufficient power to drive a compressor.

Air enters the engine through a divergent inlet duct in which its pressure is raised to some extent. It then passes to a compressor, where it is compressed, and from which it is delivered to the combustion chambers. A proportion of the power developed by these gases is utilized by the turbine to drive the air compressor, and the residual energy provides the thrust whereby the aircraft is propelled. Due to the expansion of the exhaust gases in the jet pipe behind the turbine, their exit velocity is very high.

18. Ответьте на вопросы.

1. On what principle do jet engines develop their thrust?
2. What does this principle consist in?
3. Where is the air directed in jet propulsion?
4. Why were the earliest forms of jet propulsion incapable of functioning at rest?
5. How does air enter the engine?
6. How are the combustion chambers arranged?
7. Why is the exit velocity very high?

19. Переведите текст С с помощью словаря.

Text C

Characteristics of Liquid-Cooled Engines

Liquid-cooled engines offer many decided advantages over the air-cooled type. They have been developed extensively through the Allison division of the General Motors Corporation and are being used with great success as a leading engine among fast pursuit and fighter group of aircraft.

The use of liquid-cooled engines of the Allison type permits a great reduction in frontal area and a resultant reduction in drag, which in turn permits a considerable increase in speed without necessarily increasing the power output.

By using liquid-cooled engines, in addition to the reduction in drag as indicated, the visibility of the pilot is considerably improved and a much more compact arrangement of the fuselage is possible.

The use of a liquid cooling system permits a more uniform cooling of the cylinders and makes possible the use of higher compression ratios.

The use of liquid to cool an engine also permits the use of smaller tolerances in the cylinder and piston assemblies and reduces considerably the tendency of an engine to foul the spark plugs at lower operating and idling speeds through over-oiling. Use of this type of engine also permits smoother operation.

A few disadvantages of this engine as compared to air-cooled are minor when compared to the over-all advantages gained.

SUPPLEMENTARY READING

Types of Jet Engines

Before World War II, all existing aircraft were powered with a conventional piston or reciprocating type of engine. This engine, after years of engineering and refinement¹ has attained a developmental stage whereby it is capable of rotating a shaft with a considerable amount of torque. A propeller is mounted on this shaft to absorb the torque. When the rotating propeller attains its rated speed, huge masses of air are hurled rearward at a fairly slow velocity, thereby creating thrust and pulling the airplane forward. Essentially, "jet engines" do the same thing. Air is taken inboard, heated and expanded, released rearward at a relatively high velocity, thereby creating thrust. However, in this new form of propulsion, all the inherent

disadvantages associated with propellers at high forward speeds and high altitudes are done away with² by eliminating the propeller.

The term “jet engine” in itself means very little. Many different types of jet engines are being developed and produced. In order to avoid confusion, the following classification of the different types is presented:

1. Aviation Gas Turbine (turbo jets):
 - a) Centrifugal-flow, b) Axial-flow, c) Turbo-prop (generally an axial-flow type Equipped with a propeller) d) Turbo-fan.
2. Athodyds (Aero-Thermo-Dynamic-Ducts):
 - a) Pulse Jet, b) Ram Jet.
3. Rockets:
 - a) Solid fuel, b) Liquid fuel.

¹ after years of engineering and refinement – после ряда лет технических усовершенствований.

² disadvantages – are done away with – с недостатками покончено.

How a Jet Engine Works

The principle of jet propulsion was demonstrated by Hero of Alexandria as long ago as the first century AD in the earliest “steam engine” on record.

However, the jet engine did not become a practical possibility until 1930 when Sir Frank Whittle patented the design of his first reaction motor suitable for aircraft propulsion.

The early jet engines were rather crude by today’s standards, but development was rapid, and, though the gas turbine is traditionally associated with aircraft propulsion, it now has an ever-widening sphere of application, including ships, boats, trains, hovercraft, road vehicles, power stations and pumping equipment – all benefiting from the gas turbine’s inherent qualities of high power, small size and low weight.

The gas turbine engine, commonly referred to as the “jet” engine, is an internal combustion engine which produces power by the controlled burning of fuel.

In both the gas turbine and the motor car engine air is compressed, fuel is mixed with it and the mixture is burnt. The heat which results produces a rapid expansion of the gas and this is used to do work.

In the car engine the burning is intermittent and the expanding gas moves a piston and crank to produce rotary or shaft power which drives the car wheels.

However, in the jet engine the burning is continuous and the expanding gas is simply forced out through a pipe or nozzle at the back of the engine – and confusion often arises, not so much regarding *how* the jet engine works, but *why* it works. It is often thought that it works by “pushing” the exhaust gas against the atmosphere – but in that case how would a rocket engine work in the vacuum of space?

The answer is that the jet engine, like the rocket, works by *reaction*, on the principle expounded by the 17-th century scientist Sir Isaac Newton – to every action there is an equal and opposite reaction.

Reaction can be demonstrated very simply by blowing up a balloon and releasing it. The “power” which drives the balloon forward is the reaction to the compressed air being forced out of the neck of the balloon. When the balloon is inflated and the neck is closed, the balloon is in a state of equilibrium – the air inside is pressing equally all round the inside of the balloon; when the neck is released, the air inside, under the pressure produced by the tension of the rubber envelope, is forced out. The air flowing through the neck of the balloon is now in action, producing a reaction on the front inner surface of the balloon which drives it forward.

The “hot end” of the jet engine can be regarded as the balloon. The reaction to the expanded gas being forced out of the nozzle acts on those parts of the engine opposite the nozzle, mainly the “nose” of the combustion chamber and on the tail cone. The reaction – the “power” of the engine – is transmitted from the engine casing to the airframe through the engine mountings, and is usually measured in pounds force (lbf), kilogrammes force (kgf) or the international unit, the Newton (N).

The jet engine is basically a machine for generating a large volume of gas which is forced out of the rear of the engine to produce a reaction in the form of forward thrust. The engine is therefore designed to collect a large volume of air, compress it, mix fuel with it and burn the mixture to produce the expansion which forces the gas out of the nozzle.

The engine has three main components – a compressor, a combustion chamber and a turbine.

The compressor

The compressor, situated at the front of the engine, performs two functions – it draws air into the engine and it compresses it before delivering it into the combustion chamber. Jet engine combustion will, in fact, work at atmospheric pressure, but efficiency and fuel consumption improve considerably when the pressure of the air is increased.

Compressors may be centrifugal and/or axial, the latter consisting of a number of stages of alternate rotating and stationary aerofoil-section blades which force the air through a convergent annular duct.

Many modern engines have more than one compressor because a high degree of compression requires a large number of compressor rows or stages. Each stage has an optimum speed for best efficiency – the smaller the blades the higher the speed. If all the stages are on the same shaft, only a few of them will be operating at their optimum speed – the majority will be running either too fast or too slow. This problem is overcome by dividing the compressor into two or three parts, each driven by its own turbine and each rotating at its optimum speed. By this means, compression ratios up to 30:1 can be achieved, resulting in extremely high efficiency and very low specific fuel consumption.

The combustion chamber

The air from the compressor section, at anything up to 450 lb/sq in, passes into the combustion chamber. This is an annular steel “flame tube” or ring of tubes

designed to achieve the most efficient combustion of the fuel/air mixture so that the maximum possible heat energy is extracted from the fuel in order to give the greatest rise in temperature and hence expansion of the gas.

The combustion chamber has a number of burners to vaporise the fuel before mixing it with the compressed air. Igniters are provided to initiate combustion. Unlike the motor car engine, combustion is continuous.

The turbine

As a result of the burning of the air/fuel mixture, the velocity and the temperature in the combustion chamber increase rapidly and the gas is forced out of the rear of the engine, through the turbine. The turbine consists of one or more stages of alternate stationary and rotating aerofoil-section blades. It is attached by a shaft to the compressor, and its function is to absorb enough energy from the gas stream to keep the compressor rotating at its optimum speed.

The complete rotating assembly – compressor, shaft and turbine – is carried on bearings and is known as a “spool”. In a multi-spool engine, each compressor is driven by one or more turbine stages.

In the turbojet and turbofan, the turbine is designed to extract just sufficient energy from the gas stream to drive the compressors, leaving the remainder to provide the thrust. The turboprop and turboshaft, however, have an additional turbine which is designed to absorb as much energy as possible from the gas stream in order to drive the propeller or power output shaft.

The main types of gas turbines

There are four main types of gas turbine engine – the first two, the turbojet and turbofan, are “reaction” engines, deriving their power from the reaction to the jet. The second two, the turboprop and turboshaft, operate on a different principle, where the energy in the gas is used to drive a separate turbine which is connected to a propeller or power output shaft.

The turbojet, the simplest and earliest form of gas turbine, is used principally in high-speed aircraft where its relatively low frontal area and high jet velocity are advantages.

The turbofan is probably the most common derivative of the gas turbine for aircraft propulsion. It is a “bypass” engine, where part of the air is compressed fully and passes into the combustion chamber, while the remainder is compressed to a lesser extent and ducted around the hot section. This bypass flow either rejoins the hot flow downstream of the turbine, or is exhausted to atmosphere through an annulus surrounding the hot exhaust. In both cases the result is reduced overall jet velocity, giving better propulsive efficiency at lower aircraft speeds, lower noise levels and improved specific fuel consumption, features which make the turbofan ideal for both civil and military aircraft.

The turboprop is a turbojet with an extra turbine which is designed to absorb most of the energy remaining in the gas stream after sufficient has been removed to drive the compressor; in practice there is always a small amount of “residual” thrust in the exhaust gases. The power-turbine drives the propeller through a reduction gear, usually at the front of the engine.

The turboprop is a very efficient power unit for relatively low-speed, low-altitude aircraft (eg 400 mph/30000 ft) though recent strides in propeller technology, in the pursuit of quietness and economy, have demonstrated the feasibility of a new generation of high-speed propeller-driven shaft. The power of this type of engine is measured in total equivalent horsepower (tehp) or kilowatts (kW) – the shaft horsepower (shp) plus the residual thrust.

The turboshaft is virtually a turboprop without a propeller, the power turbine being coupled to a reduction gearbox or directly to an output shaft. As with the turboprop, the power turbine absorbs as much of the remaining gas energy as possible and the residual thrust is very low. The power of this type of engine is normally measured in shaft horsepower (shp) or kilowatts (kW).

The most obvious application of the turboshaft is the helicopter, where the engine drives both the main and tail rotor, though turboshafts are widely used in industrial and marine applications, including power and pumping stations, hovercraft and ships.

Vectored thrust

Thrust-vectoring is a means of changing the direction of the jet and hence the reaction or thrust in order to meet the requirements of V/STOL (vertical or short take-off and landing) aircraft. An example is the PEGASUS turbofan, which powers the Harrier, where the engine has four linked swivelling nozzles which direct the jet vertically downward for VTOL, through an arc to horizontally rearward for forward flight. In the Pegasus the fan or bypass air is discharged through the front two nozzles and the hot exhaust gas through the rear two.

Liftjets are very compact turbojets which are installed vertically in an aircraft to provide purely vertical thrust for take-off, hovering and landing. Liftjets are shut down during forward flight.

A ramjet is a virtually a turbojet from which the compressor and turbine have been removed. Compression is achieved by the “ram” pressure in the intake and for this reason the engine can operate efficiently above about Mach 1 – the speed of sound. The ramjet has no moving parts and is the simplest of all air-breathing engines.

Reheat

Afterburning or reheat provides a means of increasing thrust without increasing the engine’s frontal area. Unlike a piston engine, the fuel in a jet engine is burned in an excess of air, so there is still a certain amount of oxygen present in the exhaust. These gases will therefore support combustion and it is possible to burn additional fuel in the jet pipe to increase the exhaust velocity and consequently increase the thrust of the engine. In a turbofan, where the bypass air provides even more oxygen, thrust increases up to 100% are possible by this method; it is normally applied to military engines for short-duration boost, eg for take-off or combat.

Reverse thrust

Thrust reversal is simply a method of altering the direction of the jet reaction, like thrust-vectoring, to meet an aircraft’s operational requirement, in this case slowing the aircraft after landing. The jet deflection is achieved by three main methods; one uses clamshell-type deflector doors to reverse the exhaust gas stream;

the second uses a retractable ejector to do the same thing; the third, used on high bypass ratio turbofans, uses blocker doors to reverse the cold stream airflow, which provides the majority of the thrust.

Some Fuel Problems

The new era of fast high-flying jets brought with it many problems. The high fuel consumption is problem number one.

The jets suffer from high fuel consumption. A 10,000-pound thrust engine consumes a lot of fuel. For example, the largest jets have fuel tanks in the wings capable of storing in excess of 21,000 gallons of fuel. Twenty-one thousand gallons is the equivalent capacity of five or six of the refueling trucks one sees normally around an airport.

There were experts who said that jet airliners could never come into general use because it was uneconomical.

But note the fuel consumption was exceptionally high only relative to duration in the air, not to distance covered. High fuel consumption is a relative matter; it can be low relative to kilometers covered; yet high relative to time in the air. They cover long distances in short period of time.

Still, fuel makes up a big part of the total gross weight of the airplane. Whole power-to-weight ratio or specific weight has always been a critical factor in prime movers for aircraft.

Besides there exists a problem of the fuel choice. Power for aerial propulsion is known to be produced by using the oxygen of atmospheric air as a chemical reactant in combustion with some fuel, e.g. a hydrocarbon such as gasoline or kerosene. Regular jet engines can definitely be used for speeds up to two or three times that of sound. But at two thousand mph hydrocarbon fuel will begin to boil. Also at altitudes of 100,000 feet or more, there is very "little" air for the jet to "swallow".

There is a great future in nuclear energy. However, there appear many problems of utilizing atomic energy. It is well-known fact that the radiation from atomic pile is dangerous, and the power plant must be properly shielded. The shielding for the plane will weigh about the same as the engine, fuel load and tanks of our present big planes. Eventually the research performed in this field will give satisfactory solution.

There exists one more problem. This is the problem of fueling and refueling the jet planes. Jet airplanes have been designed so that they are capable of being fueled at the rate of one to two thousand gallons per minute from four hoses through underwing pressure-fueling points. At some airports there are installed large underground hydrant-type fueling systems. With such an installation fuel is pumped underground from a remotely located fuel-tank system to the airplane location and from there directly into the airplane fuel tanks. The problem of refueling the plane is solved by plane-to-plane or in-the-air refueling.

There is still a lot to be done in the field of jets and rockets with improved fuels and less complex engines. Scientists seem to be able to handle such problem.

Frozen Propellant

With few exceptions, propellant containers have been the most weight and bulky elements of large rocket vehicles. Propellant tanks have often been referred to as "dead weight" and correctly so because of the penalties they impose on payload. If the tanks were made for reuse, these penalties would be compounded by the additional weight requirements for their recovery, and the entire vehicle design would be centered around the bulky tanks.

The ideal solution would be to eliminate the tanks entirely. But how the propellants be contained and supported?

Freeze them!

Most substances can be frozen, and propellants are no exception. We know that oxygen freezes at liquid-hydrogen temperatures and hydrocarbon fuels can be frozen with liquid nitrogen. The densities of frozen cryogenic propellants run 10 to 25% greater than at boiling point, and the lower enthalpy state would increase their storability. They could also be transported more easily and safely frozen. Even airbreathing vehicles might utilize frozen fuel to reinforce structure.

Why not, then, use frozen propellants as structural members, supporting themselves? So used they might greatly reduce tankage requirements and thus increase payload or performance markedly.

Ram Jet

The fastest flights within the atmosphere have been made by a rocket craft that carried fuel for only a few short minutes of powered flight (полет с работающим двигателем). For short experimental flights, for longer trips and higher payloads within the atmosphere, other forms of propulsion, such as the ramjet, are necessary.

The ramjet lies somewhere between the jet and the rocket and is technically known as the "Aero-Thermo-Dynamic-Duct" (athodyd). It is probably the simplest airstream jet propulsion device built since it has no moving parts. In appearance, the ram jet looks like a tube which is opened at both ends. The forward part of the main chamber is the diffuser section; the mid-portion is the combustion section; and the aft portion is the nozzle section. Fuel is fed through a distributing ring in the diffuser section to a series of small nozzles. To start combustion, a conventional type spark plug (запальная свеча) is located within the combustion chamber. When started, the combustion process is continuous and self-supporting.

Operation. This engine is dependent upon the forward speed of the unit to introduce sufficient mass flow of air for operation. Thus, to start this engine, it is

necessary to provide a launching mechanism capable of accelerating the unit to at least 300 m.p.h.

The air from the atmosphere enters the diffuser section by ram action (скоростной напор). After passing through the diffuser, the cross-sectional area of the tube increases and the velocity of flow of the air decreases. This causes the pressure of the air to increase somewhat. Fuel, injected into the airstream at the diffuser, mixes with the air and the combustion process is started by an electric spark. This causes the air to increase in temperature and pressure. After the unit is in operation, combustion takes place at approximately constant pressure. The heat added to the air causes the air to be ejected from the nozzle at a velocity which is greater than the velocity at the entrance to the diffuser. The reaction to this accelerating force is the thrust force. It acts against the forward internal walls of the diffuser section. There can be no thrust unless the velocity of the jet is greater than the entering air velocity.

With constant combustion chamber pressure, the exhaust velocity (скорость истечения) of the jet increases with temperature. The greater the difference between the velocity of the jet, the greater the thrust. The thrust of a ram jet also varies considerably with flight speed. The efficiency with which the fuel energy is converted into jet energy depends upon the compression ratio which, in turn, depends upon the flight speed. Finally, the thrust depends on the increase in momentum which is proportional to the difference between jet velocity and the flight velocity. However, its overall efficiency is low as a result of poor conversion of the fuel energy, particularly at low speeds.

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