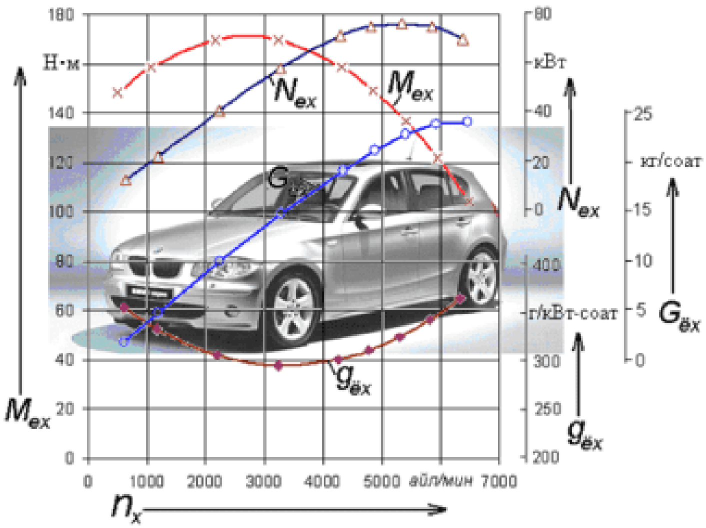
REPUBLIC OF UZBEKISTAN
MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATION

NAMANGANINSTITUTE OF ENGINEERING AND CONSTRUCTION

"VEHICLE ENGINEERING" DEPARTMENT

CONSTRUCTION OF TRANSPORT VEHICLES
by science



POWER-METHODICAL COMPLEX

Field of knowledge	300,000 – Production and technical sector
The field of education	310000-Engineering work
COURSE of Study	60712500 - "Vehicle engineering (motor transport)"

Namangan 2024

REPUBLIC OF UZBEKISTAN

MINISTRY OF HIGHER EDUCATION , SCIENCE AND INNOVATION

NAMANGANINSTITUTE OF ENGINEERING AND CONSTRUCTION

NamMQI
O'quv-uslubiy boshqarma
№ 759
«3» 07 2024y.

"TASDIQLAYMAN"
NamMQI rektori
Sh.Ergashev
3.07 2024 yil

ENGINEERING OF TRANSPORTATION VEHICLES

From the subject "Construction of vehicles".

POWER-METHODICAL COMPLEX

Namangan 2024

This educational methodical set is recommended for the students of the full-time department preparing engineering bachelors to conduct exposure training in the science of " construction of vehicles ". This educational methodical complex creates an opportunity to practically consolidate students' knowledge of the subject of "construction of vehicles", to see and understand, and to create the ability of students to use literature .

Developers : Assoc. A. Khamzayev
PhD A. Abdullajonov

Reviewer: Prof. A. Polvonov

2024 meeting of the "Vehicle Engineering" department (meeting report №1).

It was considered at the "_26_" __06__ 2024 meeting of the scientific-methodological council of the Faculty of Transport (meeting report No. 1_).

03.07.2024 meeting of the NamMQI scientific-methodical council (minutes of the __-s o n meeting) it was considered and recommended for use (list number №759) .

TABLE OF CONTENTS

EDUCATIONAL MATERIALS

I. EDUCATIONAL MATERIALS

1- Subject. Access to science.
Plan.

1. Goals and tasks of science.
2. History of the development of the automobile industry.
3. Importance of road transport in the socio-economic development of the Republic.

Basic phrases: Stages of development of the automobile industry, prospects for the development of the automobile industry in Uzbekistan, the importance of automobile transport in the republic and national economy

1. Goals and tasks of science.

The purpose of teaching the subject is to form the knowledge, skills and competence of the students in accordance with the profile of the field in terms of the classification, structure, working process of vehicles, as well as determining the possibility of working effectively in certain operational conditions and evaluating the extent to which their construction is adapted to the given conditions.

The main tasks of science are as follows:

- development and prospects of automobiles and specialized transport vehicles, development and prospects of transport and specialized vehicles, to know the mutual arrangement of types, parts, nodes, mechanisms, systems of transport and specialized vehicles;
- knowledge of the function, structure and operation of mechanism aggregates;
- to know the technical description and dimensions of the car and ITV, as well as the effect of external conditions on operational characteristics;

This subject consists of lectures, practical and laboratory exercises, and course work. In the process of teaching science, modern new pedagogical technologies, constructions of modern Uzbek cars and foreign cars. The use of EHM, virtual laboratories, animated textbooks and training manuals is envisaged.

2. History of the development of the automobile industry.

Cars have entered our lives so much that it is hard to imagine life without them. Today, in particular, transportation of raw materials and finished products, open pit mining of coal and ore, industrial construction of residential buildings and industrial enterprises, transportation of cargo, fertilizers and various products necessary for agriculture, wide demand Cars are used for timely delivery of goods directly to consumers and for other purposes. In addition to trucks, passenger cars are also very important in the daily life of the people of our country.

Where and when was the first car created, what was the vehicle before cars? When were engines created as a source of motion? What types of engines are there? Let's take a look at the history of the car to find answers to questions like what cars are being made today and so on.

The word "car" is a combination of the Greek words "autos" - self and Latin "mobilis" - moving, meaning "Self-moving". A car is a ground-moving vehicle, equipped with an engine with an independent energy source, and designed for the transportation of goods and people on non-rail roads with great comfort and safety. This description of the car distinguishes it from other vehicles.[1]

The modern automobile has come a long way from a simple mill wheel to a self-propelled wheelchair powered by human muscle. For the first time such a carriage was created 200 years ago. Such a self-propelled cart was created by Leontiy Shamshurenkov, a farmer living in Russia. Later, IPKulibin invented the three-wheeled "samokat". It was propelled by human muscle power.

But moving such carts caused a number of difficulties and inconveniences to people. Therefore, they searched for a long time to move these chariots by means of some force. Eventually, they realized that such energy could be obtained from fuel. In addition to Russian inventor I. Polzunov, Frenchman Denis Papin, German Leupold, Swedish Triveld, Englishmen Newcomen and Watt and others conducted research in this regard. Finally, in the history of mankind, the universal engine of transport - the steam engine - was invented. The steam engine was primarily used as a power source for a self-propelled crew car. The first generations of automobiles were horse-drawn carriages with a steam engine to turn the front wheel.

The car is the result of the inventors' development and improvement of the steam carriage and continuous work on it over many years. Over the years, several self-propelled cars have been created based on the steam engine. The first steam car was created in 1769 by the French military engineer Cunot. This vehicle is designed to transport artillery cargo. He created his second steam engine designed to carry 4-5 tons of cargo. It can be considered the first truck in the world. This car of Kyuno had three wheels, with the front wheel leading and steering. The steam boiler was mounted on the front of the car with a firebox, and the steam was transferred from the boiler directly to the two-cylinder steam engine. The piston of the cylinder is connected to the front wheel, screw mechanisms. The machine could not be developed in terms of practice due to the incompleteness of the steam engine and the great weight and size of the steam engine. Nevertheless, it must be recognized that Kyuno's invention is of great importance. Because he was the first to prove that it is possible to create a car that moves with an engine.

In the first half of the 19th century, several steam-powered cars were built in England. Often they would have the appearance of a bus. Due to their size and weight, steam cars could hardly move on ordinary roads. As a result, the idea of improving roads and creating railways was born. Putting the steam car on the rails became the basis for the creation of the steam locomotive. In this period, cars did not develop well due to many technical and economic shortcomings. For example, the aforementioned disadvantages of the steam engine prevented its full use in the automobile. In 1860, French mechanic Etienne Lenoir created the first gas-powered internal combustion engine. But he was not without some flaws.

---

[1] Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

Many inventors worked on improving the internal combustion engine. During the years 1862-1877, the German NAOtto created an internal combustion engine that made him famous all over the world. Otto developed an internal combustion engine with an efficiency of 0.15 over a period of 15 years. This engine was called a four-stroke internal combustion engine. This newly created four-stroke internal combustion engine became the foundation for the development of automobile industry.

For many years, oxen, followed by horses and other large domestic animals, were the main driving force for land transportation. But people began to think about another type of energy, that is, they began to look for sources of energy that do not get tired, do not get sick and do not know what hunger is. In this regard, nature itself has shown the way to man. They used wind power as a source of energy.

The sails could use the wind to move the boat in any direction, either with or against the wind.

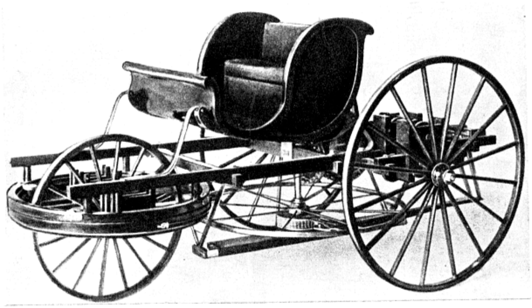
The first sailing chariots appeared in ancient Egypt in the XVII-XVIII centuries BC. Egyptian pharaohs used sail chariots to travel from one city to another across the desert. Later, the sailing carts will be forgotten for a certain period.

In the 16th and 17th centuries AD, the Dutch mathematician Simon Stephen proposed the idea of using sails on land. The natural conditions of the Netherlands - flat sea coasts and constant strong winds - made it possible to test Stephen's idea in practice. In 1600, the inventor created a four-wheeled 2-seater "vetrokhod".
Stephen creates several more such crews and uses them to create a transport service between the cities of Scheveningham and Pitten along the Dutch coast. "Vetrokhod" covered the distance between these cities in 2-3 hours.60 km

In 1791, the mechanic IPKulibin developed the idea of his compatriot Shamshurenkov's "self-propelled stroller" and created a "samokatka" that moves with the help of human muscles.

The flywheel located under the frame ensures smooth movement of the crew (Fig. 1.1). In addition, the "samokatka" had a gearbox and a brake device.

Picture 1.1 Kulibin's "samokatka" 1791.



The maximum speed of the samokat 30 kmwas 100 km/h, two people could fit in the body, and the third person stood behind the "samokat" and moved it with his feet and led the crew. Kulibin's "samokatka" was one of the important inventions in the creation of the automobile.

Later came chain drives and pneumatic tires. Three-wheeled passenger bicycles and two-seater bicycles for sports competitions were invented based on the treadmill. These bicycles were equipped with a differential, invented in 1887 by James Starle and Frenchman Henri Pecker. Differentials ensure smooth turning of the bicycle by rotating its leading wheels at different frequencies when the bicycle turns.

Improvements in bicycles, especially the use of bearings, pneumatic tires and differentials, later became of great importance in the creation of the automobile.

THE AGE OF STEAM. Observing the boiling of water, a person realized that the steam coming out of the vessel is a "handmade wind" that does not depend on the weather. But the low pressure of the steam was insufficient to set any serious machinery in motion. There was a need to invent a means to collect and use the energy source in a large amount.

Finally, in 1657, the Italian Fernando Webrist created a simple model of a steam engine (Fig. 1.2).

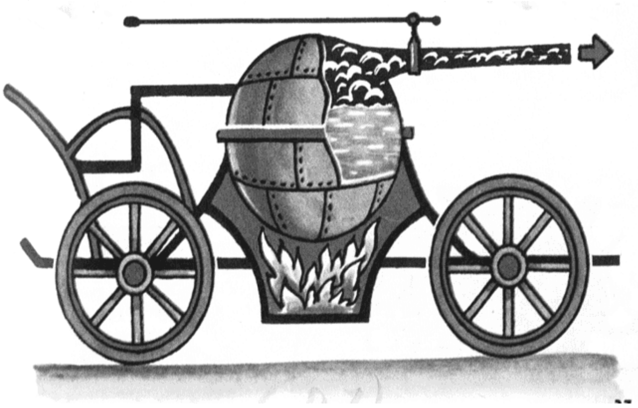


Figure 1.2

The steam coming out of the narrow mouth of the boiler above the hearth drives the wooden wheels.

This model by Fernando Webrist led to the creation of a chain of steam engine inventions by the end of the 17th century. In particular, in 1681, a book dedicated to steam engines by the French emigrant Denis Papin was published in England. Denis Papin was trying to prove that atmospheric pressure could make a piston move inside a cylinder and do useful work. In other words, Papen decided to turn the air pump into an engine.

First, Papen invented the steam boiler, a thick-walled iron vessel equipped with a hermetically sealed lid and a safety valve. In the history of mankind, the so-called "Papin's cauldron" and now known to every housewife is the result of the French scientist's many years of experiments in studying the possibilities of steam. His "engine" worked as follows: water is poured into the bottom of the cylinder, heated by a fire from the bottom, and the steam moves the piston. Then the firebox is removed from the bottom of the cylinder and the engine is cooled by pouring water. The piston is returned to its original position using external atmospheric pressure. This cycle lasted one minute. Unfortunately, Papen did not find other ways to use steam at that time.[2]

[2] Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.

It would be wrong to say that people did not use steam to do any work before Papin, because 2000 years ago, the Greek mathematician and mechanic Archimedes invented the idea of firing a nucleus from the barrel of a copper cannon using steam.

With the increase of steam engines, the evaluation of their technical capabilities became the demand of the time. The solution to these problems is also associated with the name of James Watt. Watt installs one of his steam engines in the brewery. Until then, factory pumps were driven by horses, which were replaced by steam engines. Then Watts had the strange idea of estimating the power of machines in "horsepower" (abbreviated axis). He found that a horse driving a water pump 75 kgraises water in 1 second. 1 mFrom this it can be understood that its power is approximately 75 kgequal to m/s, and this power is taken as 1 horse power (ok). But this criterion was not enough to correctly assess the power, because one strong horse can give 2 horsepower for a certain time.

The uncertainty of the measurements and the lack of a single measurement method would cause an incorrect assessment of the power of the machines.

From 1901 to 1907, the information about the possibility of machines is approximate, for example, from 20 ok to 25 ok.

Several European countries have proposed their own measurement criteria. There was even a concept of "donkey power". It was proposed by English engineer W. Price in 1884 to evaluate small power engines. According to him, the power of 3 donkeys was considered equal to 1 arrow.

Finally, in 1960, all of them were put an end to. At the 11th International Conference on Weights and Measures held this year, the single International System of Units (SI) was adopted. According to this system, power is expressed in watts (W). The unit of measurement of power is written W (Watt), named after James Watt. 1 ok 75 kgis equal to 735 W (. m/s). This means that if the machine lifts 75 kgthe load from the depth to the distance in 1 s, 1 mits power is equal to 1 ok.

By the second half of the 18th century, steam engines began to be used for carts intended for railless roads, railway and water transport. For a certain period of time, it developed in competition with steam cars, steam locomotives and gasoline cars, and at the same time complementing each other.

The first perfectly moving steam car was created in 1769 by the Frenchman Nicole-Joseph Cunot (1715-1804) (Fig. 1.3).
The steam engine was mounted on the front wheel of the cart, and the front wheel was both leading and steered. This arrangement of the steam engine caused difficulties in steering the cart, because when the wheel turned to the right or left, the steam boiler, which had a large volume, turned with it.

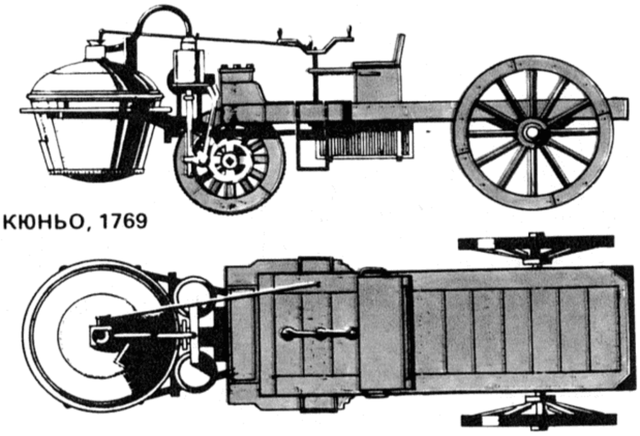


Figure 1.3. Kuno's car

This machine of Kyuno was mainly intended for cargo transportation and was used more for military purposes (transporting artillery weapons and shells). The total weight of the car is 4 tons, its speed is 2-4 km/h with a load of 3 tons. This steam carriage can be called the first freight car. The car was barely able to reach two horsepower. Due to the large size of the boiler, the pressure of the steam would soon drop. To keep the pressure constant, it was necessary to stop and increase the fire every quarter of an hour. This procedure was performed by a "kochegar" and required a lot of time.

Later, Kyuno's steam engine was handed over to the museum.

At the beginning of the 19th century, railways began to develop. But the railways could not penetrate all the streets of the city. Therefore, several types of steam cars were created, especially in England.

The power of steam cars increased 8-10 times, their fuel consumption and dimensions were reduced. They placed the steam engine on the back of the cart. The use of the curve ship mechanism in steam cars became the basis for the creation of internal combustion engines in the future.

Steam cars did not develop as smoothly as railway transport. Road conditions did not allow enough for the movement of steam cars. Only in the 20s and 30s of the 19th century, after the roads were somewhat improved, steam cars began to appear on the city streets.

INTERNAL COMBUSTION ENGINES AND AUTOMOBILE. By the 80s of the 19th century, the widespread introduction of oil production and the establishment of oil refineries in America, Great Britain and other European countries, with gasoline or diesel internal combustion engines (internal combustion engine - in such engines heat energy the process of conversion into mechanical energy is carried out inside the engine) had prepared enough ground for the improvement of equipped cars.

Now scientists are more interested in internal combustion engines, not steam engine, electric engine. Because such engines were compact, economical and highly efficient.

Jacques Etienne Lenoir from France is recognized as the "father" of internal combustion engines. The fact is that, unlike other inventors, he creates not an experimental model of the engine, but a possible technological version for production. 30-year-old Nikolaus Otto from Cologne, Germany improves Lenoir's engine by increasing its power. Otto discovered that the gas must be compressed before ignition, and combustion must be done at the highest position of the piston in the cylinder. This process matches the intake, compression, stroke, and exhaust strokes of today's modern engines. It is not difficult to understand the importance of Otto's invention.

In 1864, under the auspices of the wealthy Eugen Langen, Otto founded the company "Otto and Company" and started the production of gas engines. At the International Exhibition in Paris in 1867, the Otto engine wins with its compactness and economy.

Otto expands the production of stationary engines for the craft industry under the brand name "Otto-Deuts". "Deuts" is the name of the place where the factory was built near the city of Cologne.

To develop production, Otto's patron Langen invites an educated and experienced engineer Gottlieb Daimler from Karlsruhe (Germany). Daimler brings with him his best friend and assistant, Wilhelm Maybach. Thus, fate gathered the most talented technicians and mechanics of their time (Langen, Otto, Daimler, Maybach) in one enterprise. The enterprise produced more than 5,000 gas engines during 10 years of operation.

Like Lenoir and Otto, Diesel was from the lower class and had the opportunity to receive an engineering education. The son of a German craftsman was born and raised in Paris, but at the beginning of the Franco-Prussian war he was forced to flee with his family first to England and then to Germany. Here, Diesel enters the Munich Higher Polytechnic School. The theory of combustion of fuel in heated air was founded by the professor of this school, Beau de Rocha. Diesel creates a new "Diesel" engine based on the knowledge he received at this school. A diesel engine used 10 times less fuel than a steam engine, and could run on any fuel: coal and oil dust, tar and palm oil. The operation of a diesel engine is as follows: fuel is injected into the compressed and heated air inside the cylinder, the fuel mixes with the heated air, ignites and explodes, creating a large pressure, and this pressure rotates the engine shaft with the help of parts and mechanisms.

The city of Mannheim, located on the banks of the Rhine River in Germany, is considered the birthplace of the world's first automobile: in the spring of 1885, Karl Benz created a three-legged self-propelled carriage equipped with an internal combustion engine.

Benz's engines were in high demand and he dreamed of installing his engines in cars. Bents could not find a like-minded person and sponsor to realize this dream. Bents, unable to fulfill his dream in this company, is forced to sell his shares and leave the company.

By that time, Otto had created a lightweight and convenient 4-stroke internal combustion engine for the carriage. This Otto engine did not leave the metal merchant Max Rose indifferent. Since Benz is well acquainted with Max Roze, he begins to improve Otto's engine under his auspices. In 1883, Bents founded the "Bents and Co" factory together with Roze. Benz improved Otto's engine, increasing its power to 3-4 axes and the maximum number of revolutions of the shaft to 450 rpm.

Bents creates his 3-wheeled crew for 2 years (Fig. 1.4). The inventor uses the design of the bicycle to create this crew. Its weight 260 kgwas

This car was not easy to drive. First of all, it's not safe for humans, and secondly, it has not been tested yet.

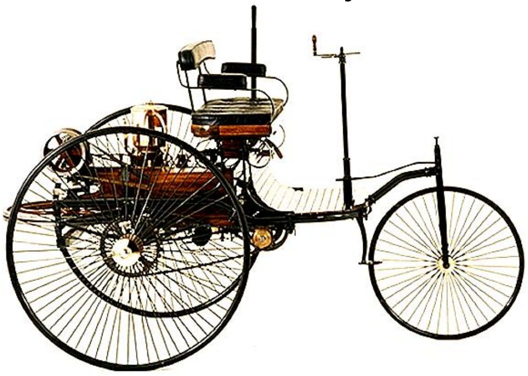


Figure 1.4. Bents-1885.

People who are amazed by the crew of Bents moving with 2-3 passengers call it "creature". Rumors about "Crazy" Bentz and his car will be published in the press and heard all over the country. Later it turned out that this crazy inventor - the creator of the world's first car - Karl Benz.

Benz and Daimler begin their inventive activities without knowing each other and under different circumstances.

Benz was a talented mechanic, that is, a natural practitioner, while his compatriot Daimler was an engineer in the field of mechanical engineering, having received theoretical knowledge in the field of technology, not only in Germany, but also in France and Great Britain.

Daimler developed his own air-cooled gasoline engine independently of Benz and received a patent for it in 1883. Initially, Daimler installed this engine on a special bicycle. Rollers are installed on the sides of the bike to prevent it from falling. At the same time, Daimler created the world's first motorcycle in 1885.

Unlike Benz, Daimler created its own 4-wheeled car in 1886.

In 1889, Daimler created a motorized carriage with a light metal body and mounted on bicycle wheels. Daimler equipped this model with a 2-cylinder V-shaped engine with a frequency of 920 rpm. It was this model that surprised Karl Benz at an international exhibition in Paris. The French company "Panar-Levassor" buys this Daimler engine and applies it to its cars. In 1890, Daimler founded the "Daimler-motoren-Gezelshaft" automobile production joint-stock company in Germany with the help of patrons interested in his work, and started the production of cars under the "Daimler" brand.

The Franco-Prussian war seriously undermines the position of Daimler cars in the French market. To eliminate this, the German brand will have to replace "Daimler" with another name, that is, "Daimler" will be replaced by "Mercedes", the name of the 12-year-old daughter of the company's sales representative. This is how the "Mercedes" car was born.

After many years of competition, in 1926, Daimler and Benz companies merged, the three-pointed "lucky star" was combined with the former competitor's "laurel flange" to form the Daimler-Benz company, which continues to delight the world with its cars. found The company started producing cars under the Mercedes-Benz brand.

Currently, one of the issues that will give the first impetus to the market economy is the establishment of the automobile industry in our republic and the regular development of this sector.

MS During the period of the Russian Empire, why were automobile manufacturing enterprises not built in our Russian republic?

In our country, which gained independence, the government is not taking any significant steps to solve this problem. First of all, as soon as Uzbekistan became an independent state, measures were taken to develop the modern automobile industry in our Republic.

What made **MS to produce cars in our Republic?**

In 1993, when our president Islam Karimov paid an official visit to South Korea, he paid special attention to this issue, as a result, the automobile company " *Asaka-DEU* " began to be established in our republic in cooperation with the Korean state. In cooperation with *DEU Corporation* of South Korea, an agreement was signed on assembly and production of small and medium-sized passenger cars and minibuses in our republic.

By 1996, the " *UzDEU auto* " car factory was fully operational in the city of Asaka, Andijan region. About 200,000 per year, two types of small and medium, small-capacity *Tiko* and *Nexia passenger cars, as well as a small Damas minibus* , which consume very little fuel, have been produced. In the following years, Matiz and Lacetti cars were also produced at this plant. At the same time, workshops for technical maintenance and current repair of these cars were established.

As a result of the official visit of our President Islam Karimov to Turkey in 1996, an agreement was signed with Uzavtosanoat of our Republic and Turkey's Koch Holding organizations to build a SamKochavto car manufacturing plant in the city of Samarkand and start it up quickly. The plant was put into operation in March 1999 and between April and September 294 small ton diesel trucks and 140 diesel buses were produced.

As a result of the official visit of President Islam Karimov to Germany, an agreement was signed with the German company *Mercedes-Benz* , and an assembly workshop and maintenance workshops for the assembly of *Mercedes-Benz cars and trucks and buses were established* in Urganch, Khorezm region. done.

A contract similar to the above has been concluded with the Czechoslovak state, and work is underway to build a Tatra dump truck factory in Angren, Tashkent region. The good works that have been started and are being carried out in this regard will create a solid foundation for Uzbekistan to become one of the countries that produce large automobiles in the future.

As President Islam Karimov noted, road transport is becoming the backbone of Uzbekistan's economy.

3. The importance of automobile transport in the development of the republic's social economy.

The word "car" is a combination of the Greek words "autos" - self and Latin "mobilis" - moving, meaning "Self-moving".

By 1996, the " *UzDEU auto* " car factory was fully operational in the city of Asaka, Andijan region. About 200,000 per year, two types of small and medium, small-capacity *Tiko* and *Nexia passenger cars, as well as a small Damas minibus* , which consume very little fuel, have been produced.


According to the function of the cars, light, cargo, passenger special (fire extinguisher, sanitation, truck crane, gasoline carrier, water sprinkler, construction vehicles, etc.) specialized (tractor, flour, cement, concrete mixer, farm for construction , tractors carrying long pipes and excavators) are divided into cars .

Control questions:

1. What are the stages of development in a car?
2. Explain the prospects of automotive industry in our country?
3. What is the importance of road transport in the republic and national economy?

2 - Subject. General structure of the vehicle.

1. General information. Tariff and duty of the vehicle.
2. Passenger vehicle. Cargo transport vehicle.
3. Trailer vehicle.
4. The history of the development of car construction.
5. General structure of the car. Technical characteristics and designation (marking).

Basic phrases: Classification of automobiles, **the** general structure and main indicators of automobiles . Creating a cluster for the car. Creating a syncway for a car.

1. General information. Tariff and duty of the vehicle.

The word "car" is a combination of the Greek words "autos" - self and Latin "mobilis" - moving, meaning "Self-moving".

By 1996, the " *UzDEU auto* " car factory was fully operational in the city of Asaka, Andijan region. About 200,000 per year, two types of small and medium, small-capacity *Tiko* and *Nexia passenger cars, as well as a small Damas minibus* , which consume very little fuel, have been produced.

According to the function of the cars, light, cargo, passenger special (fire

extinguisher, sanitation, truck crane, gasoline carrier, water sprinkler, construction vehicles, etc.) specialized (tractor, flour, cement, concrete mixer, farm for construction , tractors carrying long pipes and excavators) are divided into vehicles

According to the function of the cars , they are divided into transport, specially specialized racing and passenger cars.

Special cars are equipped with mechanisms, devices and equipment that allow to perform certain tasks.

Racing cars are sports cars designed to participate in car sports racing.

Depending on the purpose of the buses : suburban, intra-city, inter-city, going to certain places and used for general work.

Depending on the length of the buses : 5 mvery small (minibus); 6- 7,5 msmall; 8- 9,5 maverage; It is divided into 10.5 12 mlarge buses.

Depending on the working volume of the engines installed in passenger cars: up to 1.2 l, medium and small; 1,2- 1,8 lsmall; 1.8- 3,5 lmedium and more than 3.5 liters will be large-capacity.

Trucks depending on the load weight: light weight 0.3-1 t; small weight 1-3; medium weight 3-5 t; heavy weight is divided into 5-8 tons and very heavy weight is more than 8 tons.

Various loads are transported in cars *with opening walls (boards) , and such cars are called ordinary cars for general work.*

Spills and spills are transported in dump trucks, liquids in tank trucks, and food in vans.

A car with a universal body is called a cargo-passenger car if cargo and passengers are transported at the same time.

Special cars are equipped with mechanisms, devices and equipment that allow to perform certain tasks.

Racing cars are sports cars, designed to participate in car sports racing.

Cars for driving in different road conditions are ordinary and supercars:

1. A car with one leading axle is called a normal car.

2. A car with two or three leading axles moving on bad and unimproved roads is called a hybrid car.

4. General structure of the car.

The car is made up of three main parts, which are engine, chassis and body cabins.

Figure 2.1. Car body.

An engine is a source of mechanical energy that propels a vehicle.

The chassis of the car is made up of mechanisms designed to transfer the torque on the crankshaft of the engine to the leading wheels for moving and controlling the car.

Figure 2.2. Light vehicle chassis.

Mechanisms consist of clutch, gearbox, cardan transmission, main transmission differential and half-axles. The main transmission differential and half-axles are located in the housing of the next leading bridge. The running part of the car is made up of a frame, front and rear axles, springs and wheels.

Vehicle control mechanisms consist of steering and brake controls, which are necessary for the driver to move the vehicle in a specified direction. The car body serves to place cargo and passengers in an orderly manner. The cabin serves to separate and protect the driver from the external environment, to create a comfortable environment for the driver, to place the car's control levers, pedals, control and measuring devices, and warning lights.[3]

Steering wheel a serves to change the direction of movement of the car.

Brake control serves to slow down the vehicle and stop the vehicle.

The front axle serves to mount the suspension and drive wheels of the vehicle's roll control parts. The rear axle serves for the installation of the main transmission differential half-axles suspensions and leading wheels.

The running part of the car is made up of a carriage that provides the forward movement of the car, and the frame (19) or the body serves as its basis. Front and rear axles, suspension and wheels are installed on the frame.

Technical indicators of vehicles. Brief technical specifications are provided by the manufacturer for each type of vehicle, which includes the following information.

shows the car's carrying capacity or number of passengers, weight with cargo, maximum speed, fuel consumption, engine type, wheel formula and external dimensions of the car.100 km

Brief technical indicators of cars produced in our republic and Russia (table 2.3).

2 . Table 3

Produced in Russia and our Republic
a brief technical index of cars.

Indicators	Car replicas							
	in Russia				In our republic			
	GAZ-53A	ZIL-130	KamAZ-5320	VAZ-2106	UzOtoyol M-50	Tico	Damascus	Nexia

[3] Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

	Cargo avt.	Cargo avt.	Cargo avt.	Light avt	Bus	Light car	Micro bus	Light car
Load capacity kg, number of seats kg/seat	4000	6000	8000	4000/ 5	3020/ 18	275/4 pieces	560/ 7	400/ 5
Weight with load kg, net weight kg	7400 3250	10525 4300	15305 7080	1445 1045	8000 4980	895 620	1895 810	1455 1036
Maximum vehicle speed, km/h	80	90	85	154	98	143	114	163
100 kmfuel consumption, liters	24	29	24	8.5	19.5	4.3	4.1	5.5
Engine type	Carb	Carb	Diesel	Carb	Diesel	Carb	Carb	Forsun Cali
Number of wheels	4x2	4x2	6x4	4x2	4x2	4x2	4x2	4x2
Leading bridge	Back	Back	Back	Back	Back	Before	Back	Before
Vehicle base, meter	3.70	3.80	4.51	2.42	3.60	2.33	1,840	
Widest floor, meter	2.38	2.50	2.50	1.61	2.22	1.40	1.40	1.66
Maximum floor height, meter	2.22	2.40	3.65	1.44	2.93	1.39	1.92	1.39
The distance between the front wheels, meters	1.63	1.80	2.02	1.36	1.60	2.23	1.21	2.52
Car length, meters	6.40	6.68	7.43	4.16	6.93	3.34	3.23	4.48

Control questions:

1. Classify cars?
2. What is the general structure of the car?
3. Briefly describe the function of the main parts of the car?
4. Tell us about the technical indicators of cars?
5. Explain this by commenting on one of the car factories?

3- Subject. Internal combustion engines.

Plan.

1. Car engine classification, general concepts and basic parameters.
2. Principles of operation of various engines, four stroke engines, two stroke engines, rotor piston engines, gas tube engines.
3. Engine designs. Mechanisms and systems of engines.

Basic phrases: Engine function, basic dimensions, general structure of two- and four-stroke piston engines, multi-cylinder engines and their operation, rotor and gas tube engines, environmental impact of internal combustion engines

1. Car engine classification, general concepts and basic parameters .

An engine is a machine that converts the chemical heat generated by the combustion of the working mixture into mechanical energy and uses energy to move the vehicle. According to the structure of the internal combustion engine: there are piston, electric, gas turbine, jet, rotor-piston, flywheel, steam, orbital and stirling engines.

Modern vehicles are mainly equipped with piston internal combustion engines. Piston internal combustion engines installed in cars are divided into the following types:

- depending on the type of fuel used: light liquid fuel - carburetor engines running on gasoline or compressed liquid gas, diesel engines running on heavy liquid fuel.

- depending on the method of formation of the combustible mixture, carburetor engines with mixture formation outside the cylinder and diesel engines with mixture formation inside the cylinder.

- with carburettor engines, which are ignited by an electric spark of the working mixture, and diesel engines, which spontaneously ignite by touching fuel particles sprayed into clean air heated by compression.

Depending on the method of production: four-stroke and two-stroke engines. According to the structural structure: 1,2,3,4,5,6,8,12 pistons and depending on their location (vertical row, horizontal row or V-shaped), according to the location of the gas distribution mechanism - the valves are above or located below and according to the location of the camshaft - the camshaft is located inside the block or on the block cover.

The general structure of the internal combustion engine, functions of mechanisms and systems. Reciprocating internal combustion engines are composed of the following mechanisms and systems: crankshaft-rod mechanism, gas distribution mechanism, and cooling, lubrication, fuel supply, ignition (in a carburetor engine) and propulsion systems.

The crank mechanism receives the pressure of the gas produced by the combustion of the working combustible mixture inside the cylinder, and converts the straight forward and backward movement of the piston inside the cylinder into the rotational movement of the crankshaft. The engine consists of a cylinder and a crankcase covered with a bottom part .[4]

[4] Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.

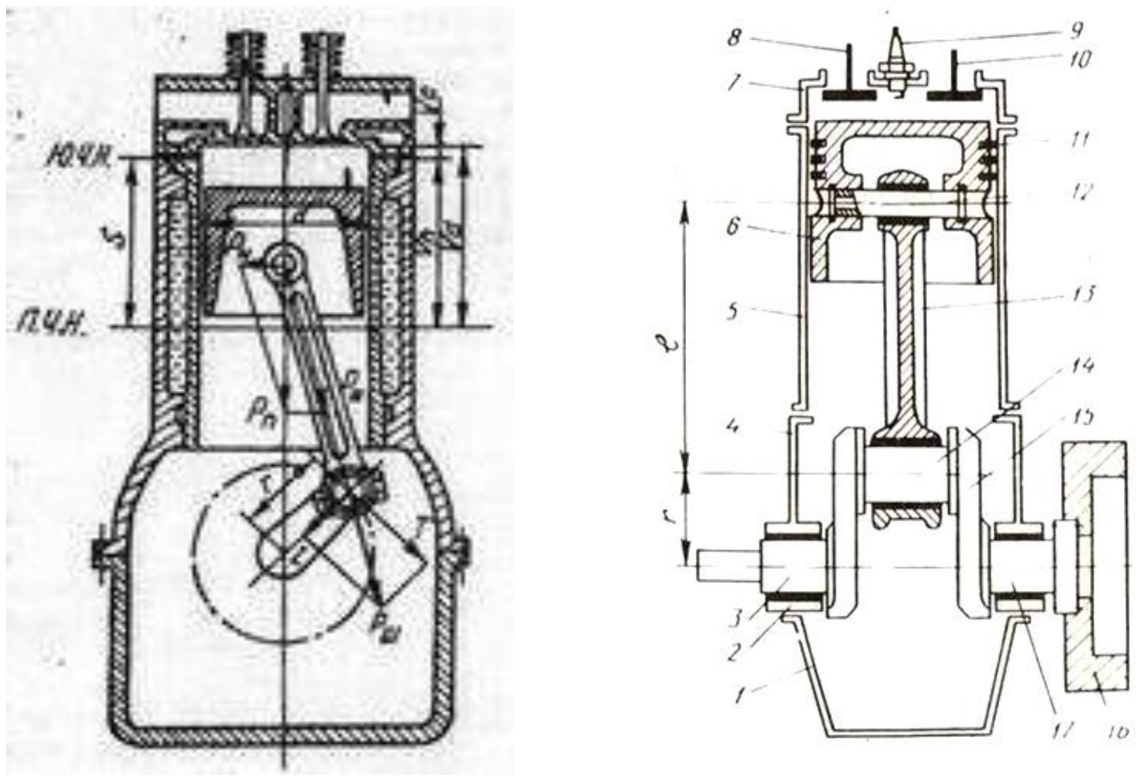


Figure 3.1. Car engine.
3 . Figure 2 . The structure of the piston internal combustion engine.
A- transverse view, B-longitudinal view.

a) Inside the cylinder there are compressor (compressor) piston rings (11), the cup-shaped piston (6) with its top facing up moves. The piston pin (12) is connected to the crank shaft (15), which rotates on the support bearings located in the crankcase. The crankshaft consists of support necks (17), jaws (15) and connecting rod neck (14). The cylinder, piston, connecting rod and crankshaft together make up the crankshaft mechanism.

b) This mechanism converts the advance-return movement of the piston into the rotational movement of the crankshaft.

The cylinder (5) is covered with a cylinder head (7) from the upper side. In this head, intake and exhaust valves (8, 9) are installed, the opening and closing of which corresponds to the movement of the piston and the rotation of the crankshaft.

Gas distribution mechanism . The burner serves to carry out the entry of the working mixture or air into the cylinder and the expulsion of the used gases. This mechanism includes gas distribution shaft, shaft drive gear, pushers, valves, valve springs, rocker arm, rocker arm shaft, rods.

The fuel supply system cleans gasoline and air, prepares a combustible mixture from them, transfers it to the engine cylinders and expels the used gases to the environment.

Cooling system. It distributes the heat released from the hot parts of the engine to the outside environment and ensures its most comfortable thermal operation. The engine is liquid or air cooled.

The lubrication system injects oil at high pressure between the engine's rubbing parts, reduces their wear, partially cools the surfaces of the rubbing parts, washes dirt and wear particles from the rubbing surfaces, and cleans the oil.

The ignition system creates an electric spark and sends it to the cylinders in order to ignite the carbureted engine.

The drive system serves to drive the engine.

2. Principles of operation of various engines, four stroke engines, two stroke engines, rotor piston engines, gas tube engines.

The main rates and indicators of the internal combustion engine. The position (point) inside the cylinder where the piston rod is farthest from the crankshaft axis is called the upper end point (U.CH.N). The lowest position (point) inside the cylinder closest to the crankshaft axis of the piston top is called the lower end point (P.CH.N). The distance traveled by the piston from one end point to the other end point is called the stroke of the piston (*S)*.

r) between the support neck of the crankshaft and the axis of the connecting rod is called the radius of curvature.

is equal to twice the radius of curvature $S = 2R$.

The volume created when the piston moves from the upper end point to the lower end point ($V_{шч}$) is called the working volume of the cylinder. With a sheepish expression
is determined.

$$V_{shch} = pD^2 S/4 \text{ , m}^3$$

where: D is the cylinder diameter, m

S - piston path, m

When the piston is at the upper end point, the volume created above it (V_s) is called the volume of the compression or combustion compartment.

V_a) formed on it is called the full volume of the cylinder.

The working volume of the cylinder and the volume of the combustion compartment are added together to represent the full volume (V_a) of the cylinder.

$$V_a = V_c + V_{shch}$$

The ratio of the volume of the cylinder to the volume of the combustion chamber is called the compression ratio. It is defined by the following expression.

$$\varepsilon = \frac{V_a}{V_c} = \frac{V_h + V_c}{V_c} = \frac{V_h}{V_c} + 1$$

Compression level value:

Carburetor engines up to 6.5-10;

It is equal to 14-21 in diesel engines.

Compression ratio piston P.CH.N. from Yu.Ch.N. shows how many times the volume of the working mixture inside the cylinder decreases due to compression.

In multi-cylinder engines, the sum of the working volumes of the cylinders is called engine displacement (V_l) *:*

$$V_l = V_{shch} \cdot i \; 1000, \text{ l}$$

where: *i* - number of cylinders; The coefficient that converts 1000-m ^{3} to liters.

3 . Table 3

Technical indicators of the car engine

Indicators	Car replicas							
	GAZ-53A	Zil-130	KamAZ-5320	VAZ-2106	UzOtayol M-50	Tico	Damascus	Nexia
Engine	SM3-53 V-shaped	Zil-130 V-shaped	Kamaz 740 V-shaped	VAZ-2106	IVECO 8040.25	F8C	F8CB	SON C
Cylinder diameter, mm	92	100	120	79	104	68.5	68.5	
Number of cylinders	8	8	8	4	4	3	3	4
Piston rod, mm	80	95	120	80	115	72	72	
Working volume of the cylinder, liter	4.25	6.0	10.85	1.57	3.90	0.89	0.89	1.49
Compression level	6.7	6.5	17	8.5	17	9.3	9.3	8.6
Operation procedure of cylinders	15426-378	15426-378	15426-378	1342	1342	132	132	1342
Maximum capacity, kW	84.6	110.6	154.4	58.8	85	30,14	27.9	66.1
Number of revolutions, rpm	3200	3200	2600	5400	2700	5500	5000	5400
Maximum torque , kW	284.4	402	637.4	121.6	353	60	64	123
Number of revolutions, rpm	2000-2200	1800-2000	1400-1700	3000	1400	2500	3000	3400

The disc-shaped flywheel (16) maintains the continuous movement of the piston at the extreme points.

The sum of the input, compression, expansion and output processes is called the duty cycle.

A part of the work cycle is called a tact.

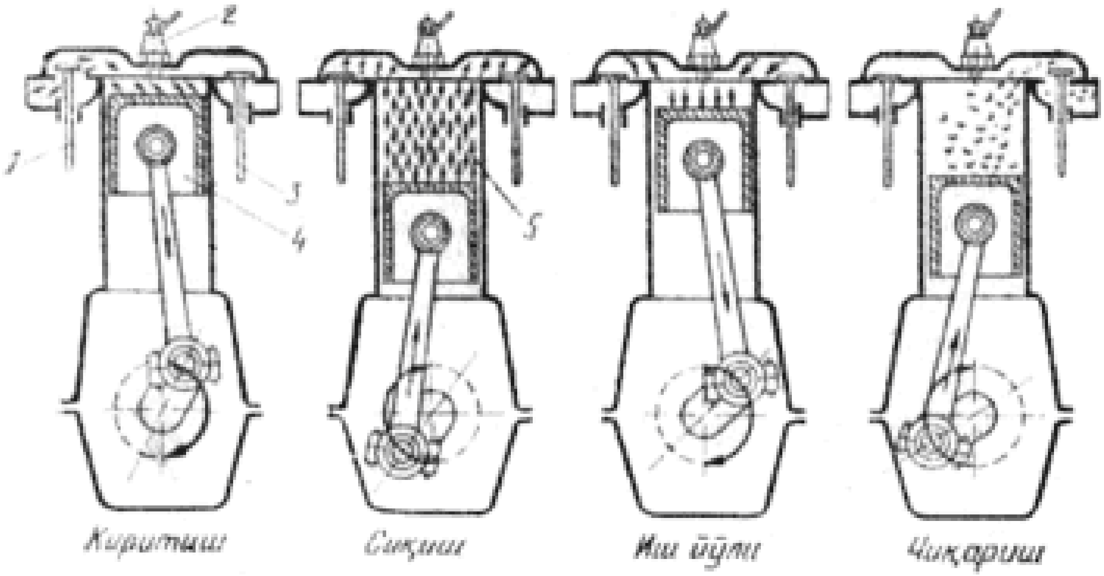
If the working cycle of the engine occurs in four strokes of the piston, such an engine is called a four-stroke engine, if it occurs in two strokes of the piston, the engine is called a two-stroke engine.

The general structure of four and two-stroke piston engines .

2.1 Operating cycles of four-stroke engines.

The duty cycle of a four-stroke carbureted engine. The working cycle of the engine consists of four strokes (Fig . 3.3).

The first beat is input. This stroke is necessary to fill the cylinder with a combustible mixture. When the piston moves from YUCHN to PCHN, a rarefaction (aeration) occurs in the cylinder up to 0.07-0.08 MPa, under its influence, the combustible mixture enters the cylinder through the opened inlet valve. The combustible mixture in the cylinder is mixed with the used gas from the working cycle to form a working combustible mixture. When the piston reaches from YUCHN to PCHN, the cylinder is filled with the fuel mixture, the intake valve is closed. At the end of the stroke, a working mixture with a pressure of 0.7-0.9 kg/cm ^{2} and a temperature of 70-110 ^{0} C is formed.



3 . Figure 3 . The duty cycle of a single-cylinder carbureted engine.
1-intake valve, 2-spark plug (spark plug), 3-exhaust valve,
4th piston, 5th connecting rod, 6th crankshaft

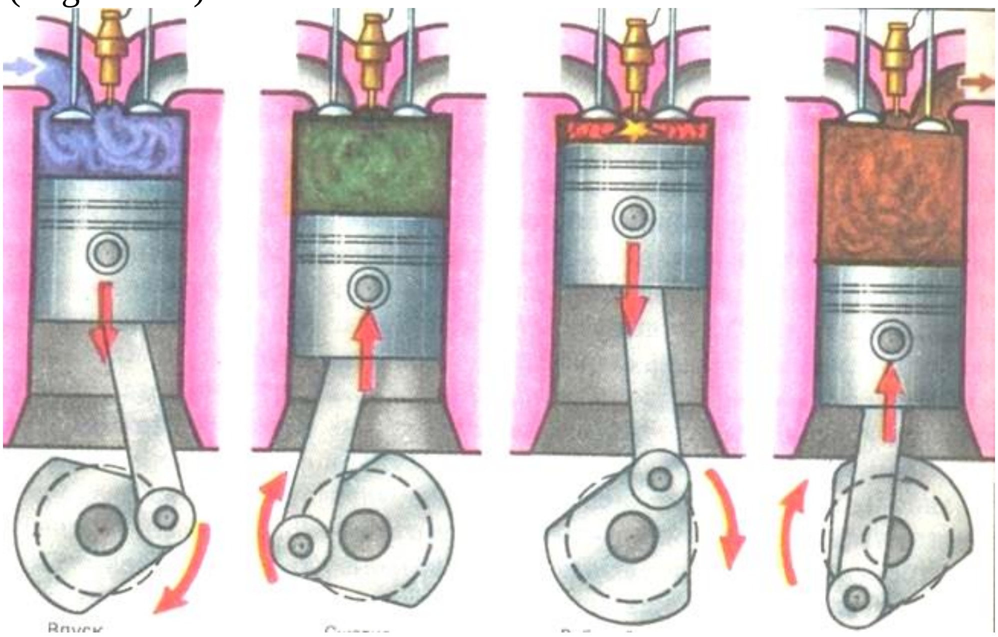
The second beat is compression . As a result of reducing the volume of the tact working mixture, it increases its internal energy and prepares it for combustion. When the piston moves from PCHN to YUCHN, the working mixture is compressed. At this time, the inlet and outlet valves are closed. At the end of the compression stroke, the pressure of the working mixture will be 12-17 kg/cm ^{2} and the temperature will be 300-400 ^{0} C.

At the end of the compression cycle, an electric spark with a high voltage appears between the electrodes of the spark plug, which ignites the working mixture compressed in the cylinder.

The third tact is the way of work . Or the combustion and expansion tact. In this cycle, the thermal energy generated by the combustion of the working mixture is converted into useful mechanical energy. In this case, the inlet and outlet valves are closed. At the beginning of the stroke, the mixture burns and releases a lot of heat. At this time, the pressure of the burned gases rises to 35-50 kg/cm ^{2} and the temperature rises to 2000-2400 ^{0C} . Under the influence of this pressure, the piston moves from YUCHN to PCHN, in which the stroke of the working path is performed.

The fourth beat is release . In this tact, the cylinder is cleaned of used gases. When the exhaust valve is opened, the piston moves from PCHN to YUCHN, pushing the burned gases out of the cylinder and out into the environment. At the end of this stroke, the pressure of the gases remaining in the cylinder is 1.1-1.2 kg/cm ^{2} and the temperature is around 500-830 ^{0} cm.

The duty cycle of a four-stroke diesel engine. In a diesel engine, clean air is injected into the cylinder and fuel is injected into the compressed air using an injector. (Figure 3.4)



3 . 4 - picture. The duty cycle of a four-stroke diesel engine
1-intake valve, 2-injector, 3-exhaust valve, 4-piston,
5-high pressure fuel pump (YuBYoN)

The first measure is introduction. When the piston moves from YUCHN to PCHN, fresh air cleaned of dust is sucked into the cylinder by the inlet valve, at the end of the stroke, the pressure of the air in the cylinder is 0.8-0.9 kg/cm ^{2} and the temperature is 50-70 ^{0} C.

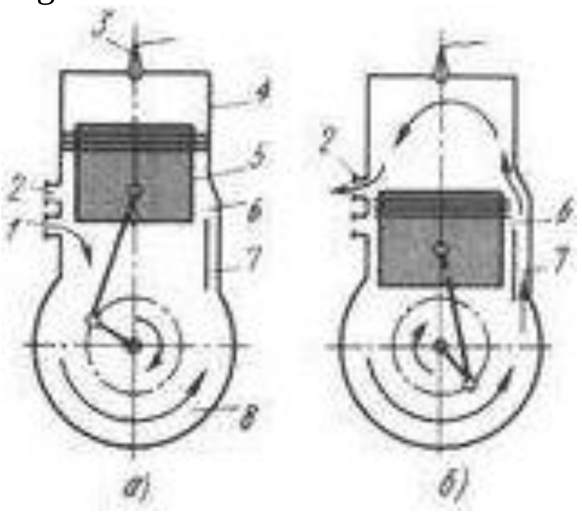
The second beat is compression. Both valves are closed. As the piston moves from PCHN to YUCHN, the air in the cylinder is compressed. At the end of the compression stroke, the air pressure rises to 30-40 kg/cm ^{2} and the temperature rises to 500-730 ^{0C} . At this time, fuel is injected into the cylinder through the nozzle under the pressure of 200 kg/second with the help of a high-pressure fuel pump. The sprayed fuel mixes with superheated air and ignites spontaneously.

The third beat is expansion. Both valves are closed. At the end of the compression stroke, the ignition of the ignited fuel takes a little longer. At this time, the pressure in the cylinder is 50-80 kg/cm ^{2}, the temperature is around 1630-1930 ^{0C}. Under the influence of high pressure, the piston moves from YUCHN to PCHN, turning the crankshaft through the connecting rod at an angle of 180 ^{0} C. When the piston approaches the PCHN, as a result of gas expansion, their pressure in the cylinder decreases by 30-40 kg/cm ^{2}, and their temperature decreases by 630-930 ^{0} C.

The fourth beat is release. In this stroke, the exhaust valve is in the open position. The piston moves from PCHN to YuCHN and expels the used gases to the outside through the exhaust valve.[5]

At the end of this stroke, the pressure of gases remaining in the cylinder is 1.1-1.2 kg/cm ^{2} and the temperature is 430-630 ^{0} C.

2.2. The duty cycle of a two-stroke engine. The duty cycle of a two-stroke engine occurs as a result of two strokes of the piston or one rotation of the crankshaft. (Fig . 3. 5). In such engines, the working mixture is prepared outside or inside the cylinder. Based on this, engines can be carbureted or diesel. These engines use a fuel mixture or air flow to expel spent gases and clean the cylinders.



3.5 . The duty cycle of a two-stroke engine. Cylinder head 1: Cylinder 2: 3-cylinder inlet: 4-compressed combustible mixture or air injection pump: 5- crankcase: 6-crankshaft: 7-exhaust hole (window): 8-rod: 9-piston: 10-cylinder head will have an ignition or nozzle.

When the piston moves inside the cylinder, it uses its walls to open or close the inlet or outlet ports.

In the first stroke, when the piston moves from PCHN to YuCHN, the intake and exhaust ports are open. With the help of a pump, a fuel mixture or air is introduced into the cylinder through the intake port, which expels the gases remaining in the cylinder and fills the space above the piston: the upward moving piston closes the ports. From this time, the combustible mixture or air begins to compress. When the piston reaches TOP, the "burning" mixture in the engine (carburetor) or air (diesel) is supplied to the compression chamber by means of an electric spark or injector, resulting in the mixture being ignited. When the piston moves from PCHN to YuCHN, the cylinder is purged of the remaining gases and filled with a new charge, and the valves close and the compression process begins.

In the second stroke, the piston moves from YUCHN to PCHN. At the end of the compression process, the combustion of the combustible mixture creates

[5]A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

high pressure and high temperature. Under the influence of gas pressure, the piston moves towards PCHN. Then the expansion process takes place and heat energy turns into mechanical energy. At this moment, as soon as the piston opens the exhaust window with its walls, the used gases with a large pressure begin to flow out. Then the inlet ports are opened and a combustible mixture or air is pumped into the cylinder with the help of a pump. They mix with the used gases and push them out through the exhaust ports. Engines of this type are mainly installed on motorcycles.

Multi-cylinder engines and their operation . *V* -shaped eight-cylinder engine. One of the cylinders of KamAZ-5320 car engines is located at an angle of *90* ^{0} *relative to the other* (Fig. 2.5). The strokes of the same name in such engine cylinders are repeated at every 720 ^{0} :8 =90 ^{0} angle of the crankshaft . That is why the curve of the crankshaft is in the form of a "crest" and they are located at an angle of 90 ^{0} to each other . The connecting rods of the first and fifth cylinders are attached to the first elbow, the connecting rods of the second and sixth cylinders are attached to the second, the connecting rods of the third and seventh cylinders are attached to the third, and the connecting rods of the fourth and eighth cylinders are attached to the fourth. In an eight-cylinder four-stroke engine, eight working paths occur in two revolutions of the crankshaft. When the crankshaft is turned to 90 ^{0} , the working path is in two cylinders, which ensures its smooth rotation at one rate. The order of operation of eight-cylinder engines is chosen as 1-5-4-2-6-3-7-8 3 . Table 7).

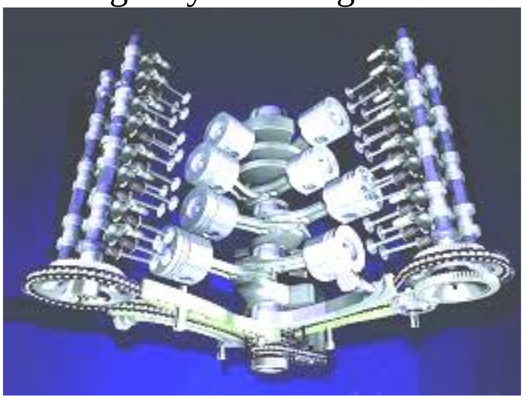


Figure 3.6. Diagram of a four-stroke eight-cylinder *V* -shaped engine with a crankshaft mechanism.

3 . Table 7

four-stroke *V* -shaped eight-cylinder engine with a working order of 1-5-4-2-6-3-7-8

<table>
<tr><td rowspan="2">Crankshaft rotation</td><td rowspan="2">Crankshaft turning angle</td><td colspan="8">TS cylinders</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td rowspan="4">First circle</td><td>0-90 ^{0}</td><td rowspan="2">Job the way</td><td>Enter.</td><td>EXIT</td><td rowspan="2">Compression</td><td>Sq.oxr</td><td rowspan="2">Input</td><td rowspan="2">Release</td><td>Ish.y.ox</td></tr>
<tr><td>90-180 ^{0}</td><td rowspan="2">Compression</td><td rowspan="2">Input</td><td rowspan="2">Job the way</td><td rowspan="2">Release</td></tr>
<tr><td>180-270 ^{0}</td><td rowspan="2">Release</td><td rowspan="2">Job the way</td><td rowspan="2">Compression</td><td rowspan="2">Input</td></tr>
<tr><td>270-360 ^{0}</td><td rowspan="2">Job the way</td><td rowspan="2">Compression</td><td rowspan="2">Release</td><td rowspan="2">Input</td></tr>
<tr><td rowspan="2">Second circle</td><td>360-450 ^{0}</td><td rowspan="2">Input</td><td rowspan="2">Release</td><td rowspan="2">Job the way</td><td rowspan="2">Compression</td></tr>
<tr><td>450-540 ^{0}</td><td>Releas</td><td>Job</td><td>Input</td><td>Compr</td></tr>
</table>

	540-630 ^{0}	Compr ession	e	the way	Input		Releas e	Job the way	ession

Rotor and gas tube engines.

Operation process of rotor-piston engines.

Currently, rotor-piston engines are used in some cars. The inner space of the stator 9 has a complex geometric shape. Shaft 8 is placed on the stator using bearings. Eccentric 7 is immovably fixed to shaft 8. A three-sided rotor-piston 4 is freely placed on the eccentric. The gear flange of the rotor 3 is attached to the stationary gear fixed to the stator. The gear ratio is such that the rotor-piston rotates three times when the rotor-piston rotates once. The rotor and the shaft rotate in the same direction. The stator has a jacket for liquid cooling, inlet 6 and outlet 5 channels and a spark plug. The three-sided rotor-piston divides the inside of the stator into three spaces. As the rotor rotates, the volume of the cavities changes. In each cavity, as in a four-stroke piston engine, a work cycle process occurs. When the piston is in the position shown in Fig. 2.7, a, the working path is completed in the volume limited by the edge II-III, that is, the expansion of gases occurs. The reception of the gas pressure of the rotor-piston causes it to rotate together with the shaft. At this time, the used gases from volume A, limited by edge III-1, are compressed into the atmosphere through channel 5, and compression of the working mixture begins in volume B (edge I-II of the piston). In the next turn of the rotor-piston, the expansion in volume Ye continues. Then, new combustible mixture is pushed from the carburetor through channel 6 into the increasing volume G, and compression continues in the decreasing volume D.

v - the picture shows the state of the discharge channel 5 being fully opened, and the used gases are released from the volume K, while the combustible mixture continues to be injected into the volume J. At this time, the working mixture compressed in volume I is ignited by the spark of the spark plug. 2.8, g – in the volume limited by the edge I-II of the piston, as a result of the ignition of the working mixture, the expansion of gases begins, that is, the working path begins.

Figure 3.8. Scheme of operation of a rotor-piston engine:

1-burning candle; 2nd idler gear; Geared flange of the 3rd rotor; 4-rotor-piston; 5 and 6 inlet and outlet channels for coolant; 7-eccentric; 8th shaft; 9-stator internal cavity.

Thus, in each of the three spaces, sequential insertion (spaces A, G, J, L), compression (spaces B, D, I), combustion and expansion (spaces M,V,E) processes take place. These processes are fast, and in rotor-piston engines, the frequency of rotations of the shaft is in the range of n =6000...8000 min $^{-1}$. Increasing the power of such engines is achieved by installing several rotor-pistons on the shaft.

Operation process of gas tube engines.

The use of gas turbines as a car engine is a new stage in automotive technology. This type of automotive engine has several advantages over a piston internal combustion engine. In this case, the vehicle structure is simplified and the weight of the engine is reduced. A gas turbine engine is more efficient because it has no reciprocating parts. In it, the lubrication system will be simple due to the absence of friction parts, except for the friction in the shaft bearings. Such engines do not need a gearbox and a clutch, as in a piston engine. Figure 2.6 shows a diagram of a two-shaft gas turbine engine. In this case, the disk 4 and blade 1 of the compressor turbine 10 are mounted on the first shaft 11, and the disk 6 of the power turbine 9 is mounted on the second shaft 7. The compressor turbine and power turbine shafts 11 and 7 are called *a two-shaft engine because they are not kinematically connected to each other* . The semi-axle 14 of the car is connected with the shaft 7 of the power turbine through the differential, the main gear 13 and the reducer 8.

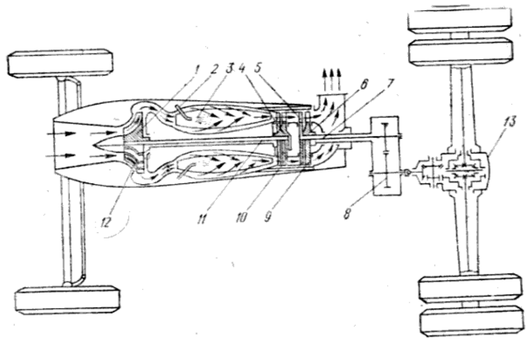


Figure 3.9 . A simple diagram of a car with a gas turbine engine:
1-compressor turbine blade; 2nd nozzle; 3-combustion chamber; 4-disc of the compressor turbine; 5-turbine blades; 6th power turbine disk; 7-second (turbine) shaft; 8th reducer; 9th power turbine; 10-compressor turbine; 11-first (compressor) shaft; 12-centrifugal compressor; 13th main pass: 14th half axis.

The first shaft of the gas turbine engine is driven by 11 starters. Centrifugal compressor 12 begins to transmit compressed air to combustion chamber 3 only when the frequency of revolutions of the first shaft is 25...30%. At this time, the fuel is sprayed into the combustion chamber through the nozzle 2, resulting in the formation of a combustible mixture. A combustible mixture with high pressure and temperature is ignited using an electric spark plug. After the formation of a uniform combustion zone, the candle is extinguished, and then the combustible mixture burns from the resulting flame. Combustion gases through the chamber 3 hit the compressor and power turbine blades 5 and set it in motion. The resulting mechanical energy moves the car with the help of auxiliary mechanisms. The independence of the work of the power turbine compared to the compressor turbine allows to change the frequency of its revolutions in a wide range. Due to the high frequency of revolutions, a large power is taken from the engine. So, without a gearbox and clutch, the torque of the gas turbine with a high frequency of revolutions (25000...40000 min $^{-1}$) is increased from the shaft of the gas turbine with a constant number of transmissions. This torque is increased by the main transmission 13 located on the rear bridge, differential and half axles 14 are transmitted to the wheels.

Although there is no need for a gearbox in gas turbines, it is desirable to use a two-, three-stage gearbox to save fuel and change the traction power on a large scale. One of the main disadvantages of gas tube car engines is the complexity and cost of production, as well as poor fuel economy. It will be more profitable to use such engines primarily in heavy-duty quarry vehicles with high power.[6]

Environmental impact of internal combustion engines.

The number of cars is increasing year by year, different types of cars are coming from abroad. Those cars have a huge negative impact on the environment and human health. For example, a car engine moves about 5,000 liters of fuel mixture through its cylinders in 60 seconds, during which time 100 people can breathe enough air. One car in one year to the outside environment800 kg SO , 220 kg, SO_2 and40 kg NO gas also emits several other toxic gases. At the same time, the noise created by the operation of the car engine has a negative effect on people's health. In order to slightly reduce the harmful effects of the car on the environment and the human body, there are ways to accurately choose the engine's operating mode, adjust the fuel supply devices in time, periodically flush the lubrication system, and use the engine in a liquid mixture. it is possible to reduce the amount of toxic gases coming out of it. In order to reduce the toxic substances contained in the used gases, it is necessary to clean them before releasing them to the outside environment. For this, instead of silencers, special purifiers (neutralizers) are installed. Noise is produced when the car engine is running and the car is moving. In order to reduce the noise, it is necessary to install improved copies of silencers and to improve the running parts of the car. It is necessary to clean the waste water coming out of the cars.

Control questions

1. What is the function of an engine in a car?
2. What does duty cycle tact mean?
3. What mechanisms and systems does the engine consist of?
4. Which volume of the cylinder is called the working volume and which is the full volume?
5. What cavity of the cylinder is called the volume of the combustion chamber?
6. What are the engine displacement and compression ratio?
7. What is the sequence of strokes in a four-stroke diesel engine?
8. For some reason, the rotation of the crankshaft in a single-cylinder engine is not smooth compared to a multi-cylinder engine.
9. What are the advantages of a diesel engine over a gasoline engine?

[6] Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.

10.What does the liter capacity of the engine indicate?
11.What is the duty cycle of an engine?

4- Subject. Crankshaft mechanism (KShM).
Plan.

1. KShM tariff and duty.
2. The structure of KShM construction and the principle of their operation.
3. Cylinder block head, piston, piston rings, piston pin, connecting rod, crankshaft, flywheel.

Basic words and phrases: The function, types, operation and function of the connecting rod mechanism (KSHM), construction of KSHM details, moving and fixed parts of KSHM, materials used, fastening of the engine to the frame.

1. Function, types of connecting rod mechanism (KSHM), operation and function of parts.

The crank mechanism receives the gas pressure generated by the combustion of the working mixture in the cylinders through the piston, and converts the advance-return movement of the piston into the rotational movement of the crankshaft.

Krivoship is one- or two-row depending on the location of the connecting rod mechanisms. (Figure 4.1)

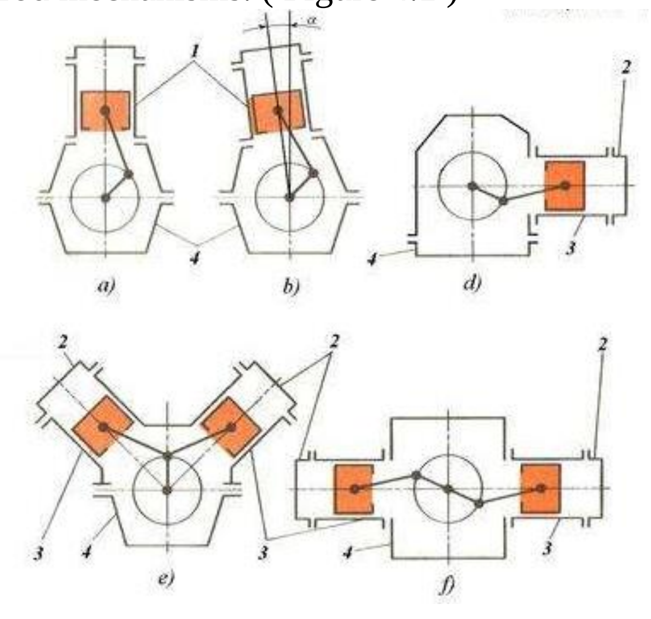


Figure 4.1 . Diagram of the location of the engine cylinders
a - single-row and vertical, *b* - single-row at an angle, *d* - horizontal, y-V-shaped, *f* - cylinders lying on opposite sides (horizontally).
1-cylinders, 2-cylinder head (head), 3-block-carter, 4-oil tank.

The cylinders of most engines are located in a single row or vertical (*a*) GAZ-24 "Volga", VAZ-2106, 21011, 2107, Tiko, Damas, Nexia, Lasetti). (Fig. 3.1, *a*).

In some engines, the cylinders can be at an angle of 20-45 ^{0} from the vertical position (Fig. 3.1, *b*) Moskvich 412 or the Ikarus bus with a horizontal position (Fig. 3.1, *d*). As a result of placing the cylinders in a horizontal position, the height dimension of the engine is reduced.

the angle between the cylinders of engines with two rows of cylinders is less than 180 $^{0 (90\ 0}$), then they are V-shaped engines (ZIL-130, KamAZ-740, GAZ-53, YaMZ-236, BelAZ, "UzOtoyo" l», KrAZ cars) are called (Fig. 3.1, e). (Fig. 3.1) and if equal to 180 ^{0} , two-line engines are called (Fig. 3.1, *f*). The size and weight of such engines are much smaller than those of single-line engines.

2. Construction of details of KSHM .

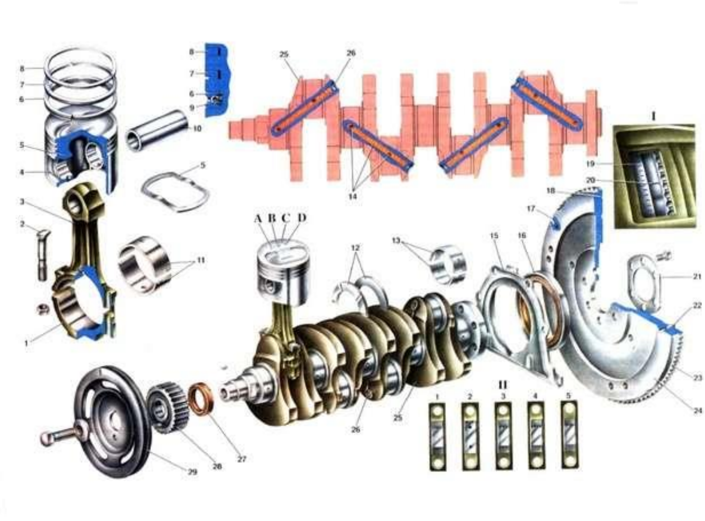
The structure of the crank mechanism **.** KSHM consists of moving and non-moving parts.

Moving parts include: piston, piston rings, pin, connecting rod, crankshaft, insert and flywheel. Includes cylinder block, crankcase, crankcase and cylinder head.

The moving parts are piston, piston rings, finger, connecting rod and crankshaft, function and structural features.

Piston. It receives the gas pressure generated by the combustion of the internal mixture in the cylinder and serves to transfer it to the crankshaft through its finger and connecting rod. In the upper part of the piston, the head has two babishkas and a guide part (sheath). (Figure 4.2).

The upper part of the piston is called the bottom. Carburetor engine pistons have flat bottoms and diesel engine pistons have concave bottoms. The piston head heats up and expands strongly against the casing. Therefore, the diameter of the head is slightly smaller.



4.2 . Parts of the piston connecting rod group:
1- piston, 2- crankshaft core bearing inserts, 3- flywheel,
4- crankshaft core neck, 5- crankshaft bearing cover , 6 - plug,
7- posangi, 8- shcheka, 9 - middle core bearing cover, 10- front neck of crankshaft, 11 - front core bearing cover , 12- sprocket, 13 - crankshaft nozzle, 14 - pulley, 15 - screw, 16 - support washer, 17 - bimetallic washers, 18 - connecting rod necks of crankshaft. 19 - connecting rod bearing inserts, 20 - stopper ring, 21 - piston pin, 22 - bushing of the upper head of the connecting rod. 23 - connecting rod, 24 - connecting rod cover , 25- oil seal, 26- oil drive channel, 27- oil discharge comb, 28- drainage channel.

This mechanism consists of fixed (cylinders, cylinder block, cylinder head, crankcase, crankcase base) and movable (pistons, piston rings, connecting rods, crankshaft with bearings, flywheel) parts (3.2- picture).

The outer side of the piston head consists of circular grooves for mounting the rings. The piston is made by casting an aluminum alloy.

Piston rings. Compression rings serve to reduce the leakage of gases from the cylinder to the crankcase, as well as to squeeze excess oil from the cylinder walls (oil suction rings). The rings are made of gray cast iron or steel and are locked from the inside of the cylinder with the help of cutouts.

Two or three compression rings and one or two oil suction rings are installed on the pistons.

The piston pin serves to allow the piston to freely move to the connecting rod and to attach it to it. It is made of steel with an inner hole, its surface is polished with a high-frequency current, and it is fastened to the piston heads with the help of two stopper rings. This locking method allows the piston pin to join together.[7]

serves to transfer gas pressure from the piston to the crankshaft during the working stroke (expansion process), and from the crankshaft to the piston during auxiliary strokes (introduction, compression and exhaust). The connecting rod is made of steel and consists of a cross-section rod, the upper head is integral and the lower head is detachable. A bronze bushing is pressed into the upper head, and connecting rods are installed in the lower one. In V-shaped engines, two connecting rods are installed on one connecting rod neck of the crankshaft. In this case, in the cylinders on the right side, the number on the connecting rod is "backward" to the chain, and in the cylinders on the left side, the number on the connecting rod is directed forward, that is, it is aligned with the inscription "vperiod" on the piston.

The crankshaft receives the gas pressure force from the pistons through the connecting rods and converts it into torque through the crankshaft.

The crankshaft has support joints and connecting rod joints and connecting rod joints, elbows (crankshafts), flanges for fastening the flywheel and an internal threaded end for screwing in the cotter pin. The crankshaft is made of steel or cast iron.

Bearings serve to protect the support bearings from the harmful effects of centrifugal forces. Oil channels are made to bring the oil from the support joints to the connecting rod joints. The support parts of the crankshaft are installed together with the insert on the pads in the crankcase and they are fastened with the help of studs with the pad caps. The connecting rods of in-line engine crankshafts are placed in pairs at an angle of 180 ^{0} , and one connecting rod is installed on the connecting rods. On the crankshafts of 8-cylinder V-shaped engines, two connecting rods are installed on each of the four connecting rods located at an

[7]A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.

angle of 90^0: one on the left, the other on the right. Their numbers are shown in the diagram (Figure 4.3).

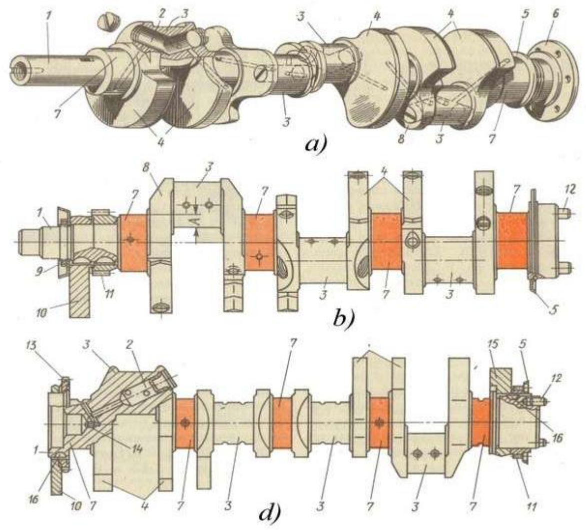
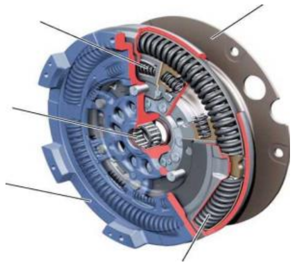


Figure 4.3 . Crankshafts.
a , *b* , *d* - those of eight-cylinder V-shaped engines,
1st and 3rd base and connecting rod joints; 2nd amendments; 4th stitch; 5-sediment handle; A flywheel with teeth on the 6th flange.

Inserts of connecting rod joints and support joints on the crankshaft are made of plastic tape, and its inner (work) surface is covered with a thin layer of antifriction compound. The working surface of the inserts in medium- and light-duty car engines consists of aluminum alloy. In heavy-duty vehicles, connecting rod bearings are made of three layers, and the working layer is cast from lead bronze.

3. Movable and fixed parts of KSHM, used materials.

The function and structure of mahovik. The flywheel is cast from cast iron. The flywheel takes part of the thermal energy in the engine and serves to drive the pistons from the extreme points (PCHN and YuCHN), perform auxiliary strokes (intake, compression and exhaust) and start the engine with the help of the starter. For this purpose, a straight toothed ring is pressed into the flywheel flange. In addition, the flywheel also acts as the leading disc of the working clutch.



Non-moving parts. Functions and structural features of the cylinder block, block cover and crankcase.

Cylinder block. It is the main part of the engine, and it is made integrally with the crankcase. In the upper part of the block there are holes for installing cylinders. The block of cylinders can have one row in a vertical position or two rows of cylinders in a V-shape at an angle of 90^0. The cylinder block is made of gray cast iron for heavy trucks, and aluminum alloy for light and medium-duty vehicles. (Figure 4.4).

Cylinder liners are liquid-cooled and made of cast iron. It has an acid-resistant cast iron top to reduce corrosion. The lower part of the sleeves is sealed with two rubber or copper rings, and the upper part is sealed with a gasket (gasket) of the cylinder head (head).

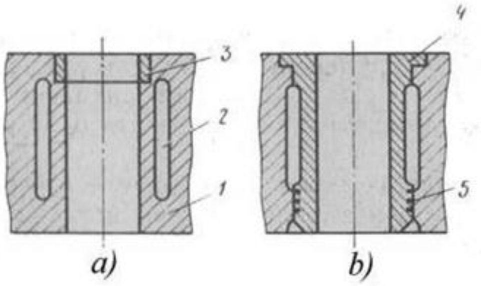


Figure 4.4 . Engine cylinders.
a - dry without sleeve, *b* - with wet sleeve.
1-cylinder block, 2-water jackets, 3-casting, 4-cylinder sleeve, 5-sealing ring (copper or rubber)

The lower part of the cylinder block is called the crankcase, in which there are pads for installing crankshaft support necks and holes for installing the distribution shaft.

Cylinder block cover. Cast from alloyed gray cast iron or aluminum alloy. The block cover is fastened to the cylinder block using bolts and studs (Fig. 4.5).

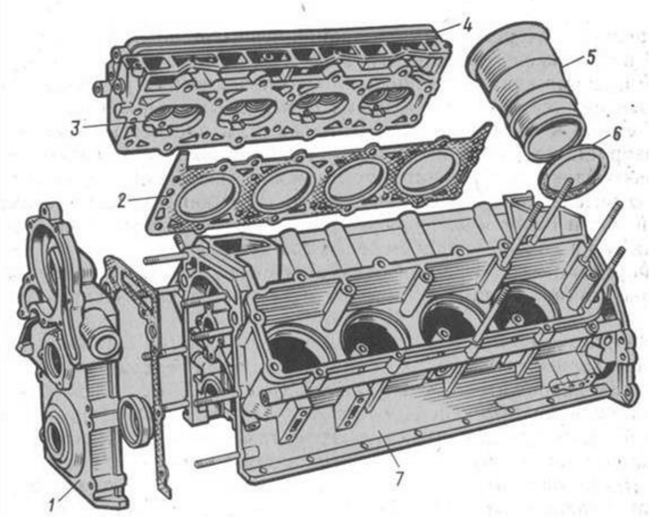


Figure 4.5 . V-shaped engine block crankcase and cylinder block cover.
1- gear distribution block cover, 2- block cover gasket,
3-combustion chamber, 4-cylinder block cover, 5-cylinder sleeve,
6-sealing ring, 7-block-carter .

In order to seal between the cylinder block and the block cover, a steel asbestos gasket is placed between them. There are holes in the cylinder block and the cover for the passage of coolant, and special holes are made for the entry of the combustible mixture and the discharge of burnt products. Engines with cylinders in a row have one cylinder cover, and V-shaped engines have two, and one cover is installed on each row of cylinders (ZIL-130). In the KAMAZ-740 engine, each cylinder has its own cover.[8]

4. Fastening of the engine to the frame.

Fastening of the engine to the frame is carried out with the help of claws or brackets made in the engine and flywheel housings. The fastening supports are elastic, they are provided with rubber pads and springs. Such elastic fastening reduces vibrations caused by uneven operation of the engine and insufficient balancing of rotating masses, as well as impulse shocks from the frame to the

[8] Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b .

engine during the movement of the car (Fig. 4.6).

Engines are attached to the frame or semi-frame in three (all light and MAZ-500 car engines), four and five (KamAZ-5320 car engines) places.

The engine of the KamAZ-5320 car is fixed to the frame in the following five places (Fig. 3.6), supports located on both sides of the front part of the cylinder block 1, supports on both sides of the flywheel housing 13 and one auxiliary support located on the gearbox housing 22.

The front support consists of a bracket 4 fixed to the cylinder block 1, a rubber pad 7, a puller 6 used to attach it to the bracket 8, and a column 9 used to fasten the bracket 8 to the frame 10.

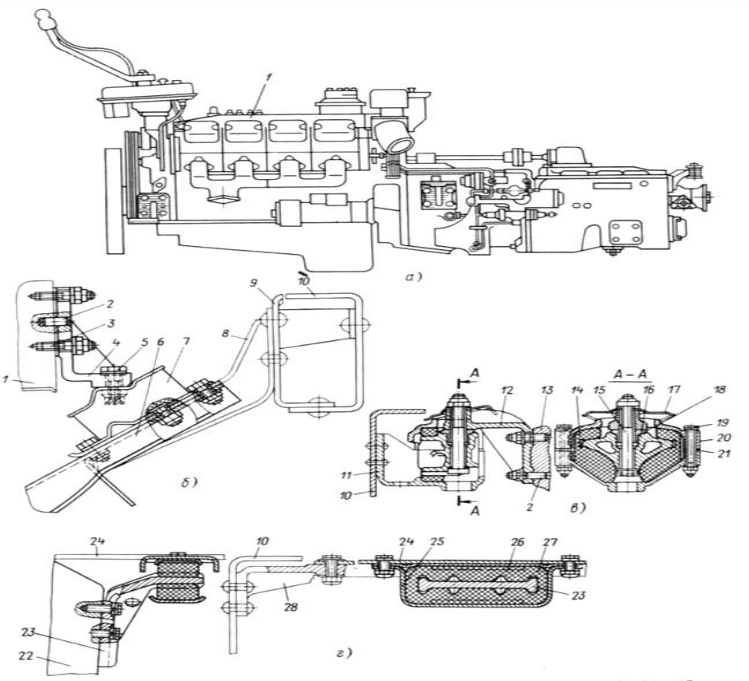


Figure 4.6 . The configuration of the KamAZ-5320 car engine: a-engine; b-front support; v-back support; g-holding support; 1-block of cylinders; 2nd pin; 3-pin; 4,8,23 and 28 brackets; 5,15 and 19-bolts; 6th puller; 7,14 and 27 rubber pads; column 9; 10-frame spar; 11-back support bracket; 12-engine bracket: 13-flywheel crankcase; 16th finger; 17th protective cap; 18th bushing; cover 20; 24-alignment gasket; 22-gearbox crankcase; 24th transverse list; 25th pad size; 26-pad carrier.

The rear support consists of an engine bracket 12 fastened to a flywheel housing 13, a rear support bracket 11 attached to a frame strut 10, with a cover 20, a finger 16, etc. The finger 16 is placed on a rubber pad 14. Between the cover 20 and the bracket 11, adjusting gaskets 21 are placed.

A steel bushing 18 is pressed into the aluminum alloy finger 16 from crushing.

The auxiliary support is composed of a bracket 23 attached to the transmission case 22, a block 25, a rubber pad 27, a transverse sheet 24, a bracket 28, etc. Rubber pad mounts reduce engine shocks when the car is moving and keep the engine from rolling.

Control questions:

1. Tell the function of the crank mechanism and its component parts and their names?
2. What are the types of piston rings and their functions?
3. Why should the mass of the piston be as small as possible?
4. Why is the outer surface of the piston coated with thin tin?
5. Why is the lengthwise cone of the piston, and the section of the skirt

oval?

6. What is meant by its design so that the piston does not get stuck in the cylinder in a hot engine?

7. How is the shape of the section of the connecting rod core and what is the reason?

8. What are the methods of piston pin installation?

9. What are the elements of the crankshaft and what are their functions?

10. What is the function of crankshaft bearings?

11. At what angle can the connecting rod necks of the crankshaft (depending on the number of cylinders) be located?

12. What are the functions of a mahovik?

13. What causes torsional vibrations?

14. What is the principle of vibration dampers?

5-Topic. Gas distribution mechanism (GTM) .

Plan.

1. GTM tariff, function and classification.
2. The structure of the GTM construction and the principle of their operation: valves: guide bushing: pusher: rod: koromislo: distribution shaft: distribution shaft guide: hydraulic compensator.
3. Description and diagram of gas distribution phase.

Key words and phrases: Gas distribution mechanism (GTM) function, operation process, GTM types, operation and function of parts, construction and materials used, GTM phase diagram, hydro compensator.

1. The function of the gas distribution mechanism (GTM), operation process.

The gas distribution mechanism includes the timely introduction of a combustible mixture (in carburetor and gas engines) or purified air (in diesel engines) into the cylinder during the compression and work (expansion) processes, and the restriction of the cylinder from the external environment and exhaust gases in a timely manner. serves to expel from the cylinders to the outside environment.

Car engines are mainly equipped with valve gas distribution mechanism. The technical and economical indicators of the engine depend on the volume of the combustible mixture or air entering the cylinder, timely opening and closing of the valves, tightness of the valves, and quality cleaning of the cylinder.

The following types of gas distribution mechanism are used in car engines:

- the valves and distribution shaft are located below or in the block (GAZ-52, ZIL-164), the valves are located above in the cylinder head and the distribution is located below in the block (GAZ-24, Volga, ZMZ-53; ZIL-130, KamAZ-740);

-valves and distribution shaft are located above the cylinder head (VAZ, Moskvich, Tiko, Damas, Nexia, Matiz, Lasetti and UzOtoyol engines).

Engines have one intake and one exhaust valve per cylinder. The number of punches on the camshaft is equal to the number of these valves. Each valve opens once when the crankshaft rotates twice.

Structure and operation of GTM. The structure and operation of the gas distribution mechanism with the valves above and the distribution shaft below. The valves are located on the cylinder head, the combustion chamber is compact, the compression ratio and the cylinder filling coefficient are large. These factors increase the power and economy of the engine.[9]

This gas distribution mechanism consists of the following parts: the distribution shaft with its gear, its axis with the cams, valves, springs, fasteners, adjusting screw guide bushing, pusher and rod. This mechanism works as follows (Fig. 5.1) when the distribution shaft 18 rotates, its fist is attached to the pusher 17 and raises it together with the rod 15.

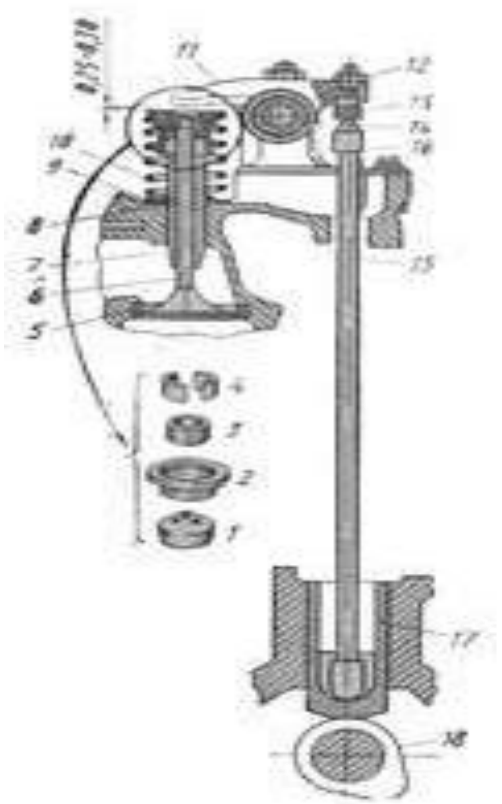


Figure 5.1. Gas distribution mechanism with valves located above

The movement is transmitted through the rod to the screw 13, which is screwed to the end of the rocker arm 11, and the rocker arm turns around its axis and its front end presses down the valve stem, overcoming the spring force, as a result of which the valve opens and the intake port opens, and the combustible mixture or air enters the cylinder through the hole. starts, or used gases start to escape from the cylinder.

As the distribution shaft turns, the pusher 17 deviates from the right part of the shaft fist and moves together with the lever. The valve moves up under the force of the spring 10, and the valve stem is strongly pressed against the front end of the crank arm, as a result, the crank arm rotates around its axis 14, and the valve spring closes the inlet hole in the cylinder head.

2. Types of GTM, function and function of parts, structure and materials used.

The structure and operation of the gas distribution mechanism with valves and distribution shaft above. In the gas distribution mechanism located above the valves and the distribution shaft, there will be no pusher and lever, therefore it will be reduced. The inertial force of the valve mechanism is reduced. It reduces the noise in the engine and allows to increase the number of revolutions of the crankshaft (Fig. 5.2). This type of gas distribution mechanism is divided into three types: (Fig. 5.2, a), with two rows of valves (Fig. 5.2, b), and cup-shaped, pusher (Fig. 5.2, c).

Mechanism of the first type. Installed on VAZ-2105, 2107 "Zhiguli"

[9] Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.

engines, the distribution shaft is installed on the block cover.

The motion is transmitted to the rocker arm through the camshaft sleeve. One end of the rocker rests on the valve stem, and the other end rests on the ball end with 5 grooves . The rocker is held in place by a pin spring.

The second type of mechanism is installed on "Moskvich" type engines (Fig. 5.2, b). In this mechanism, there are two rows of valves, which are opened and closed under the influence of camshafts and camshaft pistons.

The thermal slots of the valves are mounted on a spherical support 8, adjusted using an adjusting screw 5, a lock nut 6

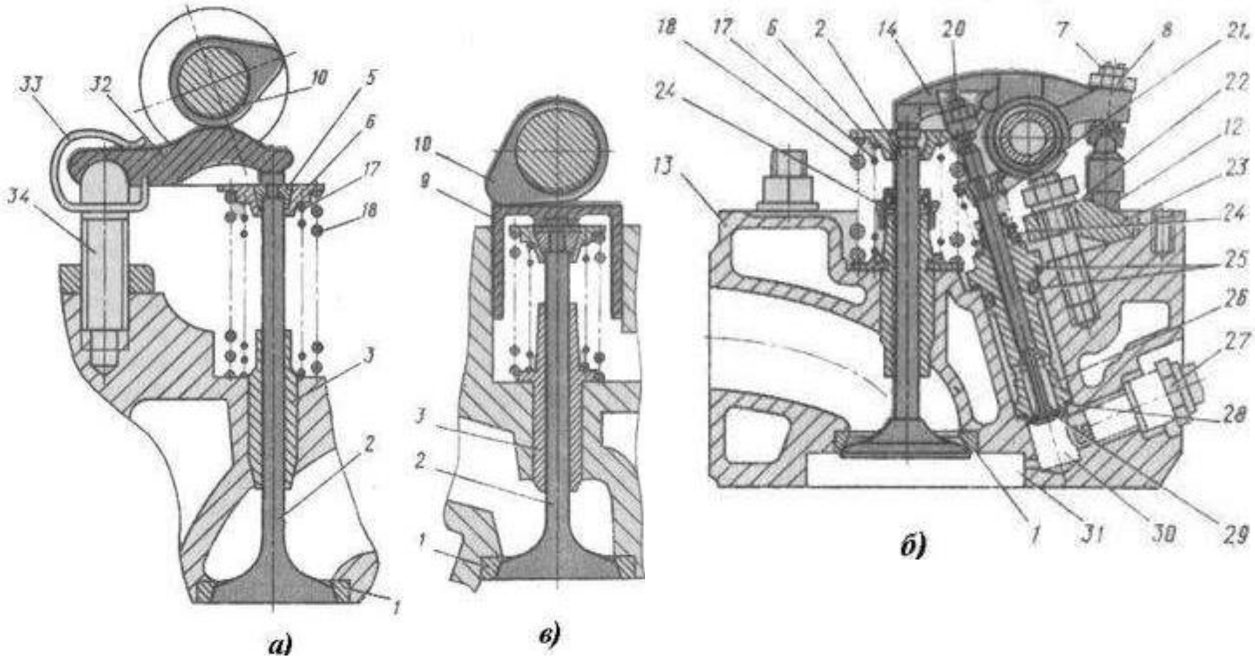


Figure 5.2. Types of gas distribution mechanism with valve distribution shaft above:
a- with a lever (rocker), b- valves are located in two rows,
v- cup-shaped pusher.

The third type of mechanism is installed on VAZ-2108 "Sputnik", VAZ-2109 car engines (Fig. 5.2, c). In this mechanism, the distribution shaft is installed in a separate housing (case) 10, which is installed on the cylinder head. The guide bushing 13 of the valve 1 is pressed into the cylinder head and its upper part is glued with a metal rubber cap 12

Valves 1 are opened or closed under the influence of camshaft pistons and cylinder pushers 15 without levers or cams. On top of the cylinder pusher there is a slot in which the washer 11 is placed to adjust the valve clearance.

The cylinders are in-line and V-shaped, and the valves are located above and the distribution shaft is located below the crankshaft. The drives in this tkr are installed on truck engines.

Moskvich and VAZ passenger car engines get the gas distribution shaft from the crankshaft through a two-row chain drive with a single roller.

In VAZ-2108 "Sputnik", VAZ-2109, Tiko, Damas, Nexia passenger car engines, the distribution shaft is moved through a gear-belt drive.

Structure of parts of the gas distribution mechanism. The gas distribution mechanism consists of the following parts: valve, guide bushing, valve springs, rods, rocker arm, holder, distribution shaft and distribution shaft guides.

Valves. Valves open and close the inlet and outlet ports of the cylinder. Kalapan is composed of head, stern, face and stern ditch. Valves are divided into input and output types. The diameter of the inlet valve head is larger than that of the outlet valve. The angle of the working chamfers of the intake and exhaust valves is 45 ^{0} . Exhaust valves are fire-resistant and operate at a temperature of 600-800 ^{0} C. Guide bushing. Ensures correct movement of the valve stem. It is made of cast iron. Valve springs. When the valves are closed, they are held closed by gypsum pressing against the seat. Barbells. When the valves are in the upper position, the movement is transmitted from the pusher to the valve through the valve stem. Koromislo. It serves to transfer the movement of the rod to the valve stem. It is double shouldered and made of carbon steel. The valve stem rests on the rod end via the cam adjustment screw on the front triple valve stem. Koromislo is mounted on a fixed axle. Holder. It transmits the movement from the cams of the camshaft directly to the valves or the rod. Handles are cylindrical or coiled. The heat gap between the valve and the coromislo tip 0,30 mmis set to 0.25 by the adjusting screw. Distribution shaft. It opens and closes the valves in a certain order with the help of pistons and moves the parts entering the engine systems. The distribution shaft is composed of supports, bushings, pinion, eccentric and screw pinion.

Design features of GTM. Design features include the location of the camshaft on the valve. Modern truck engines mainly use gas distribution mechanisms with rocker arms, pushrods, pushers, toothed gears, with the valves above and the distribution shaft below. The "Mokvich" passenger car engine is equipped with a gas distribution mechanism with two rows of chain drives with valves located in two rows above, a camshaft located above, and a bushing-roller.

VAZ passenger car engines are equipped with a gas distribution mechanism with a rocker and a cup-shaped pusher and a toothed-belt drive. The Nexia later replaced the SONC engine with a gas distribution mechanism with four valves per cylinder, two intake and two exhaust valves, and two camshafts. DONS type dvegatkli is being installed. The diameter of the inlet valve is larger than the diameter of the outlet valve.

3. GTM phase diagram

In order to get the most power from the engine, it is necessary to fill the cylinders more with a combustible mixture or air and clean the cylinders better from the used gases, but the intake and exhaust processes take place in a small time of 0.05-0.0087 s. As a result, the cylinders were not properly filled with the combustible mixture or air, and the cylinders were not completely purged of spent gases during the exhaust process. To improve the performance of these processes, it should be opened at one point or angle a before reaching the curve and closed at a second point or angle after passing PCHN . δ The exhaust valve should open at 3 points or angle before the piston reaches PCHN χ and close at 4 points or angle b when the piston passes YUCHN. The opening and closing times of the valves, expressed in degrees of the angle of the crankshaft edge relative to the YUCHN and PCHN points, are called the working cycles of the gas distribution mechanism. (Figure 5.3) .

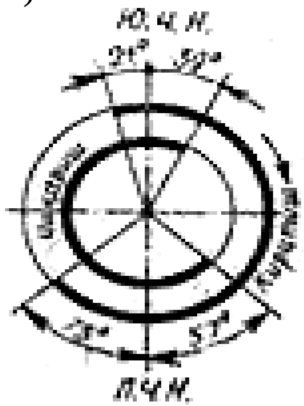


Figure 5.3 . Circular diagram of car engine gas distribution phases.
a- total cycles of gas distribution of a four-stroke engine;
b- general cycles of gas distribution of the ZIL-130 engine;
v- general cycles of gas distribution of the KamAZ-740 engine;

Opening and closing times of the valves, expressed in turning angles relative to the end points of the crankshaft, are given in (Table 5. 4).

5 . Table 4

Car engine	Inlet valve		Exhaust valve	
	Opens against the UCHN	Closes against PCHN	opens against PCHN	It closes against YUCHN
Tico	12^{0}	38 0	460	100
GAZ-24	12^{0}	600	540	180
ZMZ-53	24^{0}	640	500	220
YaMZ-240	200	560	560	200
ZIL-130	310	830	670	470
KamAZ-740	100	460	660	100

From the diagrams of the gas distribution circuits, it can be seen that the gas distribution circuit of the ZIL-130 engine is 294^{0} for the intake valve, 294^{0} for the exhaust valve, 236 0 for the intake valve on the Kamaz-740 engine , 256^{0} for the exhaust valve, and 230^{0} for the intake valve on the Tiko engine. and 236 0 for exhaust valves .

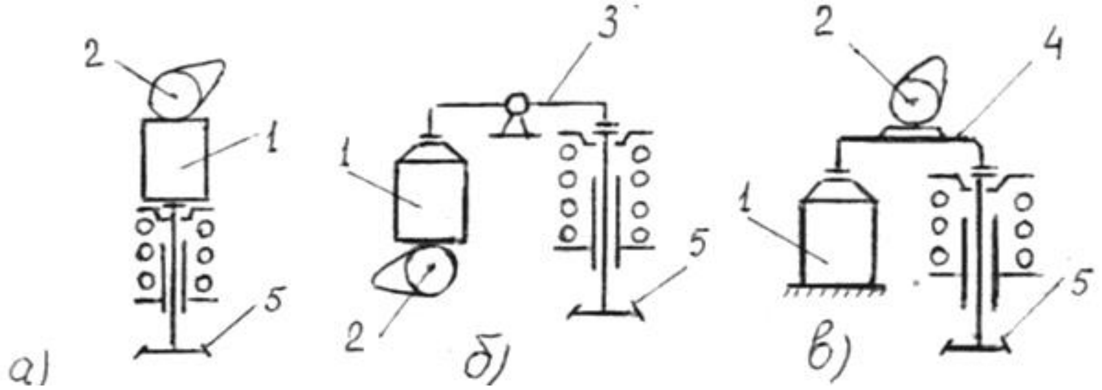
Operation of engine cylinders. In order for a multi-cylinder engine to work at the same time, the strokes of the same name must be repeated one after the other after the crankshaft turns at an equal angle in different cylinders. This repetition is called the working order of the engine cylinders.

The order of operation of the cylinders of the Gaz-24 engine is 1-2-4-3; From ZMZ-53, ZIL-130 and KamAZ-740 V-shaped eight-cylinder engines, the working order of cylinders is 1-5-4-2-6-3-7-8;

The VAZ-2106 engine has a cylinder arrangement of 1-3-4-2, and the YaMZ-236 V-six cylinder arrangement has a cylinder arrangement of 1-4-2-5-3-6. After turning 90^{0}, the crankshaft with the same name stroke is equalized.

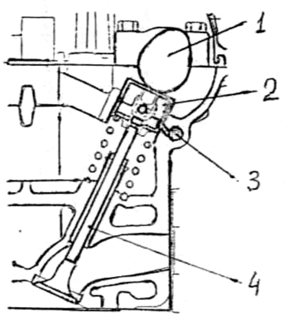
4. Hydraulic compensator

The operation of the hydraulic compensator: when the valve is closed, the pusher 5 (Fig. 5.4) under the influence of the spring 11 of the plunger is pressed against the fist of the distribution shaft, and the sleeve 7 is pressed against the valve stem 3. Then the pressure of the oil in the spaces A and B is the same, the reverse valve 8 is pushed to its seat by the spring 9.



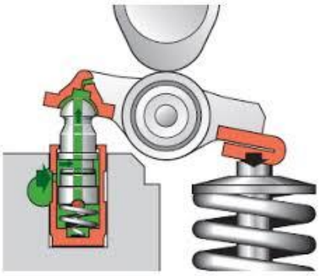
5 . Figure 5 . Schemes of hydrocompensator placement methods:
α-hydraulic compensator is located between the valve stem and the valve stem; b- the hydraulic compensator is located between the distributor shaft and the koromislo; v- the hydraulic compensator is located between the head of the cylinder block and the valve arm;
1-hydraulic compensator; 2nd distribution shaft; 3rd koromyslo; 4-valve lever; 5th valve.

When the valve opens, the fist of the distribution shaft pushes the pusher 5 down and acts on the plunger 6. As a result of the push down of the plunger in the sleeve, the pressure of the oil in the cavity B increases. Then, under the influence of pressure, a small amount of oil leaks from the radial slot between the sleeve and the plunger into the pusher cavity. Due to the fact that the time of impact of the punch on the valve during operation is very short, the partial leakage of oil into the V space actually affects the operation of the pusher and sleeve as a whole, that is, the timely opening of the valve does not show. So, when the valve heats up, the stem lengthens due to the leakage of oil from the B cavity to the V cavity. In the closed phase of the valve, the pressure in space B decreases compared to that in space A. Then the difference in pressure created in the gaps is lost due to the oil coming from the system. That is, the oil flows from space A to space B through the reverse valve 8, which is opened due to the pressure difference, and the amount of oil there is filled. As a result, there is always a crack-free condition in the valve guide.



5.6 . Diagram of placement of the hydraulic compensator in the gas distribution mechanism of the S2 engine of the Nexia car:

1st camshaft punch;
2-hydraulic compensator; 3rd oil channel;
4 valve.



5 . Figure 7 . Operation scheme of hydrocompensator:

gas distribution mechanism:

1st camshaft punch;
2-hydraulic compensator; 3rd oil channel;
4 valve.

Control questions

1. Explain the functions of the gas distribution mechanism and its components?
2. What are the types of gas distribution mechanism according to the location of the valve and what are their characteristics?
3. What methods are used to move the distribution shaft in engines?
4. What should be the gear ratio of the camshaft in four-stroke engines and why?
5. Why is the intake valve head larger than the exhaust?
6. Why are the exhaust valves of some engines equipped with a structure that allows them to rotate around their axis during operation?
7. What is the function of the thermal crack in the valve?
8. What is the function of a knock "hydraulic compensator" used in some engines?
9. What do the phases of the gas distribution mechanism mean?
10. Why does the opening of the intake valve (relative to the extreme points of the piston) advance, and its closing is delayed?
11. Why is the opening of the exhaust valve (relative to the extreme points of the piston) advanced and its closing delayed?

6-Topic. Cooling system .
Plan.

1. Tariff, function and classification of the cooling system.
2. Coolant.
3. The structure of the construction of the cooling system and the principle of their operation: radiator: shutter: liquid pump: fan: hydrocoupling: thermostat.

Key words and phrases: Function, types, structure, operation process, construction of parts, thermostat and its types. open and closed cooling system, radiator cover, radiator and its types, water pump

1. Function, types, structure and operation of the cooling system.

When the combustible mixture burns in the engine cylinders, the engine parts heat up and expand, as a result, the parts in the joints can quickly corrode and seize, the engine block heats up, the gasket pads, rubber seals, insulation of the electric wires that touch it can melt, and the oil in the base can thin out and reduce its lubricating properties.

Types of cooling system. There are thermosyphon, mixed and forced systems according to the method of fluid movement.

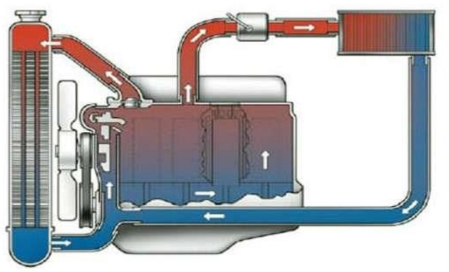
In the thermosiphon method, the movement of liquid occurs naturally due to the difference in density of hot and cold liquids.

In the mixed method, the cooled liquid in the radiator is sent to the upper part of the cylinders with the help of a pump, and the liquid flows to the lower part with its natural flow.

In the forced method, the liquid in the system moves continuously with the help of a pump.

Modern car engines use mixed or forced (in V-shaped engines) cooling systems. In terms of the cooling system structure, there are liquid cooling and air cooling methods according to the engine cooling method.

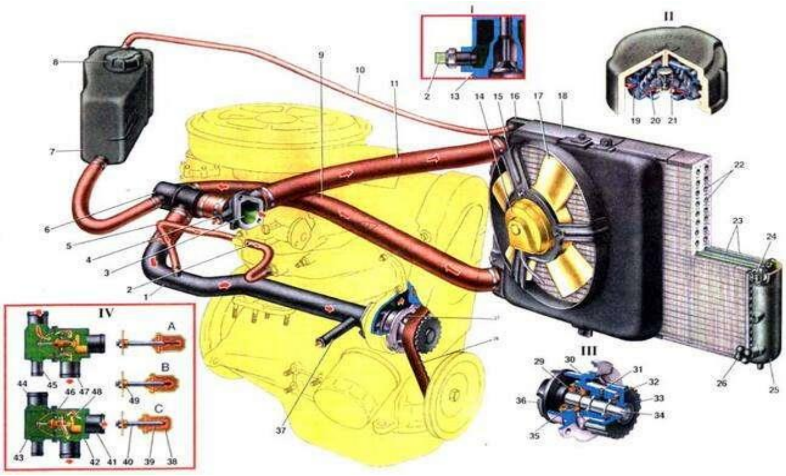
General structure and operation of the liquid cooling system. The liquid cooling system consists of a cooling jacket, radiator, shutter, pump, thermostat, connecting hose and short spacer tubes.



6.1 - picture. Illustration of the operation of the liquid cooling network.

1-radiator cover; 2- the upper tank of the radiator; 3,4-liquid pipes; 5-pump inlet pipe; 6-liquid outlet; 7-thermostat; Liquid inlets in block 8; liquid exits in block 9; 10th liquid path; Block 11; 12-liquid drain tap; 13-liquid pump; 14,15,16-bottom liquid pipes; 17-the tap under the radiator; 18-lower tank of the radiator; 19th fan; 20th radiator; 21st steam pipe.

The structure of the parts of the cooling system. Pure water is mainly used as a coolant because it absorbs and dissipates heat quickly, is cheap and available in sufficient quantity. But water forms sediment, reduces the thermal conductivity of the block, and the walls of the casing are corroded as a result of rusting. Water can freeze in winter and crack or crack block walls. Antifreeze TOSOL A40 and A65 are widely used as coolants to avoid these shortcomings.



The radiator serves to disperse the heat of the heated coolant in the engine block to the outside environment under the influence of air flow and reduce the temperature. The radiator consists of lower tanks, pipes, grills, throttle valve and drain valves. In addition, in order to reduce the ventilation of the radiator and the engine with air flow, a barrier (blind) is installed, which is made of hinged vertical plates.

The liquid pump performs the forced movement of the liquid. It is a centrifugal type and is installed on the front wall of the cylinder block. The pump blade is located on one shaft with the fan. Seals are installed on the pump shafts and bearings to prevent liquid from escaping.

The fan serves to increase the flow of air passing through the radiator. It has two, four and six spades. To reduce noise, the blades are placed in X-shaped pairs at 70 °and 110 °angles. Shovels are made of steel sheet or plastic. The fan and fluid pump are driven by a belt from the crankshaft pulley.

The thermostat accelerates the warm-up of a cold engine and serves to automatically adjust the temperature of the liquid in the cooling jacket and maintain it at the specified temperature. There are two types of thermostats: liquid or solid filled thermostats.

2. Thermostat and its types

***The thermostat* is** an automatic valve that helps to maintain the optimal temperature in the cooling system by adjusting the amount of liquid passing through the radiator while allowing the cold engine to warm up quickly.[10]

Such a thermostat has a thick-walled cylinder filled with copper powder mixed with ceresin (petroleum wax) with a large expansion volume. A thick-walled cylinder is closed with a rubber diaphragm. The stem is fixed to the valve by means of a guide bushing mounted on the diaphragm through a rubber buffer. Coromislo is hingedly connected to the thermostatic valve. When the engine is cold, the mixture in the cylinder is solid and the thermostat valve is closed by the return spring. Fig. 6.2.

[10]A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

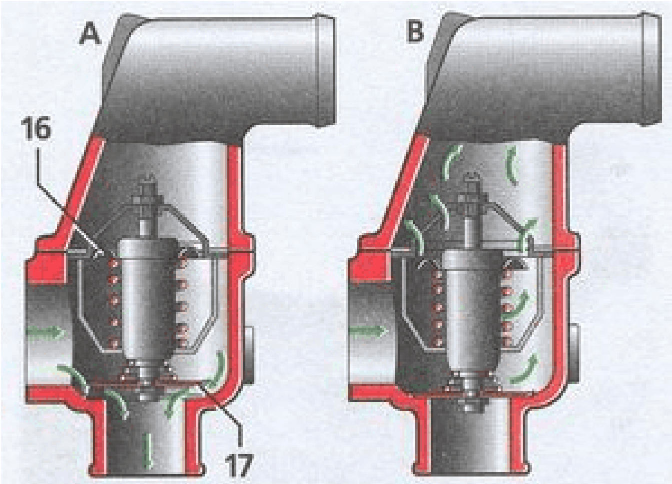


Figure 6.2. Schemes of thermostats: a-liquid thermostat; b-solid filler thermostat; Thermostats I and IV are open; II and III - thermostats are closed; 1-water pump housing; 2- liquid cylinder; stocks 3 and 13; 4th gasket; valves of the 5th and 15th thermostats; 6 and 16 hot liquid discharge nozzles; Housings of thermostats 7 and 18; 8th bracket; 9-thermostat cylinder; 10-solid mixture; 11th diaphragm; 12-guide bushing; 14- return spring; 17-valve valve stem; buffer 19; 20-input conductor.

3. Open and closed cooling system.

In order for the engine to work at the specified temperature, the temperature of the moving liquid in the liquid casing °should be 80-95 C. In this mode (regularity), the engine works normally, the cylinders are well filled with the combustible mixture, the rotation of the crankshaft is normal, the burnt gases have time to fully leave the cylinder, the oil in the crankcase does not lose its lubricating properties, the seals between the engine parts , the insulation of coils and electric wires does not melt, the engine works smoothly, thermal energy leads to an increase in engine power, fuel economy increases, no particles are formed, the liquid does not boil, the level remains the same, friction and corrosion between parts appear won't be. The operation of the engine in constant heat mode is maintained only with the help of a thermostat.

Radiator and its types

The radiator serves to distribute the heat of the liquid heated in the block to the outside environment . It consists of upper and lower tanks, radiator core, and radiator cap. Liquid is poured into the radiator from the throat of the upper tank. The throat is tightly closed with a lid. Types of radiator cores can be tube-plate or tube-tape. In the case of tube-plate, the tubes are passed between a series of thin plates placed horizontally, and the ends are welded to the upper and lower tanks. In the case of tube-tape, corrugated tapes are placed between the tubes in order to increase the cooling surface. The tubes used in both types of radiator cores are mostly of flat oval cross-section. Tubes can be installed vertically or horizontally in the radiator core. In most cars, they are installed vertically, while in some cars (Nexia) the tubes are placed horizontally.

Figure 6.3. Radiator and blinds:
1 and 9 connecting hoses; 2nd faucet; 3 and 6 - lower and upper tanks; 7-radiator cover; 8-radiator throat; 10-radiator core;
11th referral cojux.

Figure 6.4. Radiator cap:
a – steam valve is open, air valve is closed; b-air valve is open, steam valve is closed; 1-air valve spring; 2nd air valve; 3-steam valve gasket; 4- steam valve spring; 5-radiator throat.

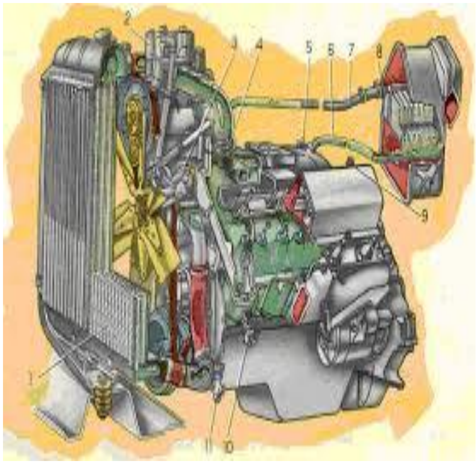


Figure 6.5. Details of the car radiator:
1-radiator core; 2-fastening nuts; 3rd outlet tank;
4-transmission oil cooler distributor (in the case of a hydromechanical transmission); 5th input tank; 6-drain faucet

5. Water pump.

Liquid pump. *The forced movement of liquid in the cooling system is carried out with the help of a pump.* A low-pressure (40...100 kPa) centrifugal liquid pump is usually used.

The fan *accelerates the flow of air passing through the radiator core and accelerates the spread of heat from it to the outside environment.*

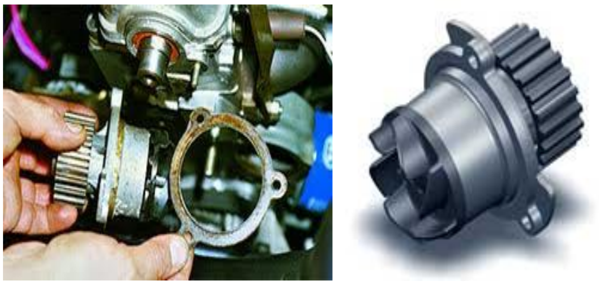


Figure 6.6. Fluid pump and fan:
1-fan pulley spigot; 2nd fan; 3rd pulley; 4-pump housing; 5-parrack body; 6th paragraph; 7-squeezing bag.

automatic mode - the fan starts automatically when the temperature of the coolant in the engine rises to 85...90 ^{0} C;

fan-on mode - in which the fan rotates at a low frequency under the influence of the frictional force created by the rotation of the bearings and cuffs, as well as under the influence of the counter-air flow created by the movement of the car;

the fan is always connected mode - in which the frequency of rotations of the fan is always rotating, regardless of the temperature of the coolant in the engine, approximately equal to the frequency of rotations of the crankshaft.

Running the cooling system is preheating. When the outside temperature °is below -20 C, it becomes difficult to start any internal combustion engine. Therefore, the cooling system is heated before starting the engine.

When the combustible mixture burns steadily in the boiler, the candle is disconnected. Hot air is sent to the cooling system and the liquid is heated.

Advantages and disadvantages of liquid and air cooling systems. A liquid cooling system has the following advantages over air cooling:

a) °since the boiling temperature of the used liquid is 100-110 C, the parts of the engine do not overheat;

b) the liquid partially absorbs the sound of the engine;

c) the engine heats up faster when driving;

g) the structure of the cooling system is smooth and compact.

The advantages of the air cooling system are as follows:

a) it is simple and light because there is no liquid pump, radiator, water pipe, thermostat in the system; 9

b) because the engine does not have a liquid jacket, it does not freeze;

c) the engine can be used even in places without water.

The main disadvantage of the liquid cooling system is that water °freezes at 0 C, forming cracks in the block and block head. Deposits form in the water jackets of the block, the radiator tubes can be filled with deposits.

The main disadvantage of air cooling is that:

a) when the ambient air °exceeds 30 C, the engine heats up;

b) cylinder ribs are contaminated with dust;

c) the fan bearing quickly fails.

Control questions.

1. Why is engine cooling necessary?

2. What is the radiator for and how is it constructed?
3. What is the purpose of the liquid pump and how is it constructed?
4. What is the fan for and how does it move?
5. What is a thermostat for and how is it constructed?
6. How does the displacement heater work and where is it located?

Topic 7: Lubrication system .
Plan.

1. Tariff function and classification of the lubrication system.
2. Lubrication methods.
3. Lubrication system construction structure and working principle: Oil pump. Oil elephants. Oil pan (paddon). Oil radiator. Valves.
4. Crankcase ventilation.

Key words and phrases: Lubrication system. Operation of the lubrication system. Oil cleaners and their properties. Oil types and their properties. Chester oil pump. Engine ventilation methods.

1. Tariff function and classification of lubrication system .

The friction between the parts of the engine connected to each other at high loads causes them to wear and heat up. Therefore, it is necessary to continuously apply oil to the surfaces of the parts to reduce the friction between the parts, to cool their surfaces, to remove the metal particles formed as a result of corrosion, and to protect the parts from rusting. This task is performed by the engine lubrication system.

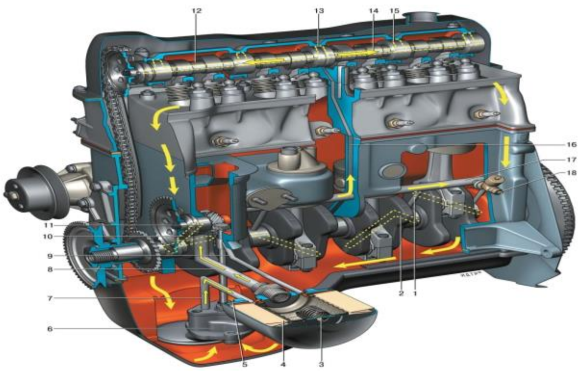


Figure 7.1. Lubrication system
1- oil filter, 2- oil temperature gauge thermometer, 3- oil cooling radiator; 4-return valve; 5th collection; 6-oil receiver; 7-oil pump; 8- pump return valve; 9- coarse oil cleaner return valve; 10- rough oil cleaner; 11- pressure gauge in the lubrication system - monometer; 12 oil inlet groove located in the crankcase; 13-crankshaft support neck; 14-distribution shaft support neck; 15th koromyslo axis; 16-oil gauge; 17th oil filler neck.

2. Lubrication methods.

Operation of the lubrication system. When the oil pump is working, due to the deaeration created in its case, the oil in the base goes through the oil receiver to the pump, from it to the coarse cleaner, and from there, under pressure, to the oil channel in the crankcase. It lubricates the camshaft support necks and camshafts and piston pin with pressure. The remaining parts are lubricated by splashing and draining. The oil cleaned in the soft cleaner is returned to the oil pan. If the oil temperature rises above the specified level, the tap 5 is opened and the oil is sent to the oil radiator for cooling through the return valve 4, the oil cooled in the radiator is returned to the oil pan. The oil pump gets its drive from the crankshaft or camshaft. In order not to increase the pressure in the system, check valves are installed in front of the nozzles and oil cleaners. The oil level in the oil pan is determined with an oil dipstick. Oil pressure in the system is determined by manometer 11 and oil temperature by thermometer 2. An oil drain tap is installed in the crankcase to drain the oil from the crankcase. The pressure of the oil in the system is 3-.5 kg/cm $^{2\text{ in a carburettor engine}}$ and 5-7 kg/cm $^{2\text{ in diesels}}$.

3. Lubrication system operation scheme and construction of parts.

Oil cleaners clean the oil from metal particles and other contaminants produced by the corrosion of engine parts.

Rough cleaner; Located between the oil pump and the main oil line. The cleaning parts of the cleaner include perforated plates made of steel. A star-shaped plate spacer is installed between the plates. The oil is filtered through them. Contaminated particles of oil are trapped between the plates. And the big ones fall to the bottom of the cooler.[11]

Gentle cleanser; Modern engines are equipped with centrifugal wipers. This cleaner is completely cleaned of mechanical cleaners down to 0.001mm that have passed through the coarse cleaner and trap oil deposits. their rotors rotate under the influence.

Oil types and their characteristics. The oils used to lubricate the parts are obtained by recirculation of fuel oil. Oils form a thin film of surfaces on the rubbing surfaces, which prevents the films from touching each other and causing rapid wear of parts. These curtains retain their viscosity and lubricating properties even at 100 $^{0\text{ C heat.}}$

Oil absorbs heat from rubbing surfaces and has the property of cooling them. 3-14% complex additive with various composition is added to the oil to increase its viscosity, oxidation resistance, anti-rust and washing properties, and to make it non-washable at high temperature , anti-foaming and anti-scratch of surfaces.

4. Oil filters, oil pump, crankcase ventilation and ecology.

Oil filters clean oil from metal particles formed as a result of corrosion of engine parts, as well as dust and various oxide substances and other polluting elements formed in it as a result of oil wear. Oil contaminated with organic and inorganic particles causes rapid corrosion of the parts' rubbing surfaces and causes the oil channels to become clogged with tar and oil sludge that pollutes the oil.

[11] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

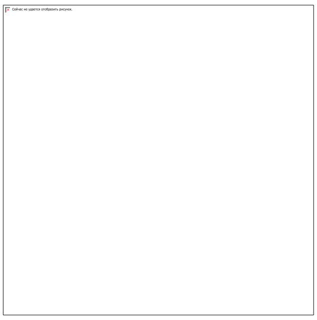


Figure 7.2. Oil filters

In full-flow series-connected plate-slotted coarse filters, the oil cleaning elements are composed of steel plate assemblies.

Full-flow plate-slot coarse filters are connected in series to the system and are located between the oil pump and the main oil channel. The oil cleaning elements of such coarse filters consist of a set of steel plates and are placed in a cast iron body. Plates are made in two different forms. One of them, 0,35 mmprocessed in thickness, is considered a cleaning element. The second, which is used as a gasket, is made in a star shape 0,08 mmand is thick. Star-shaped plates are inserted between each cleaning element. As a result, gaps equal to the thickness of the gasket plates are formed between the cleaning elements. When the oil passes through the slits, it is cleaned of particles with a size of 0.08 mm and larger and sent to the main oil channel.

Soft cleaning filters. In modern car engines, slotted or centrifugal cleaning filters are used as fine filters. Such filters completely clean the oil from mechanical particles up to 1-2 microns. Also, it retains tar and oil stains. As a replaceable cleaning element in slotted filters, tape-paper, special cardboard or a set of cardboard discs and other materials are used. The oil driven by pressure from the pump passes through the micro pores (slits) of the filter elements and goes to the main oil channel.

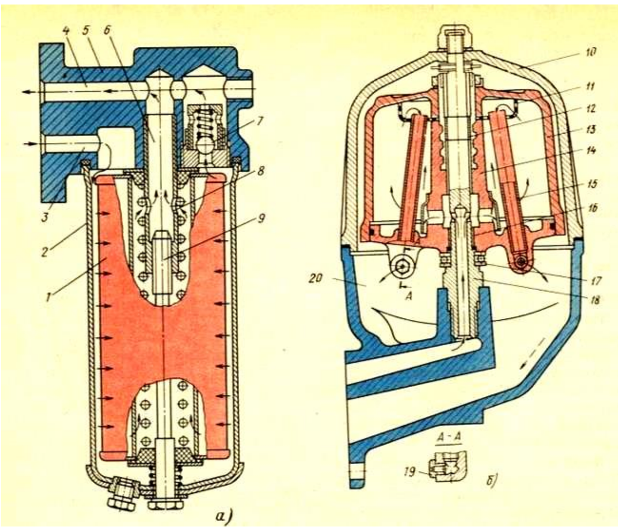


Figure 7.3. Oil filters:
α-slotted; b - centrifugal (centrifuge); 1-filtering element; 2nd corps; 3 and 4 input and output channels; 5th cover; 6th flute; 7-transfer valve; 8-purified oil transfer holes; 9-bolt; 10th cover; 11th wire mesh; 12 and 16 - bushings; 13-rotor cap; 14th rotor; 15 flutes; 17th bearing; 18-hole bullet; 19th graders; Space 20.

Centrifuge. Centrifugal oil filters (centrifuges) are widely used mainly in trucks. Such filters have a reactive behavior and move in a circular motion under the influence of the oil flow coming out under pressure in the opposite direction.

An oil radiator is necessary to maintain the temperature of the heated oil as a result of the operation of the engine. Oil radiators are mainly used in trucks, because they often work in difficult road conditions. Radiators are also used in some passenger cars with high permeability and relatively powerful engines.

S h esternal oil pump structure and operation. The oil pump generates pressure and sends the oil to the lubrication system and ensures the circulation of the oil in the system.

Gear oil pumps are usually used for car engines. The main elements of the pump are interconnected and gear .

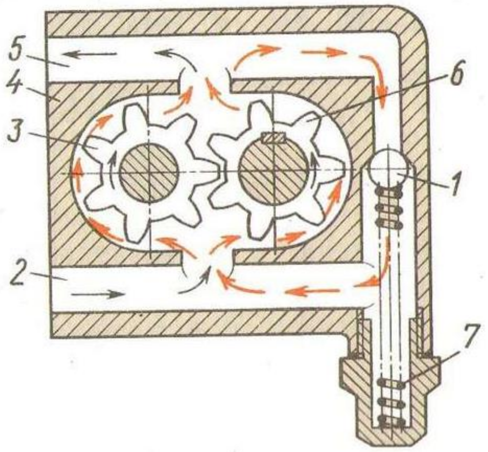


Figure 7.4. Oil pump performance picture: 1st case; 2-drive gap; 3rd oil channel; 4-ball valve; 5th spring; 6-adjustment screw; 7th drive pinion axle; 8-leading gear; 9th suction cavity; 10-leading gear; 11th val.

Crankcase ventilation and ecology. When the engine is running, the high-pressure gases formed on the pistons of the cylinders pass from the vibration between the piston rings to the crankcase. This gas is a combustible mixture consisting of complete and partially burned products. These gases include fuel and water vapor, carbon dioxide, sulfur, nitrogen, and partially carbon-hydrogen compounds. Fuel vapor turns into droplets and dilutes the oil. Water vapor oxidizes the oil and destroys its quality. In addition, gas pressure increases in the crankcase, as a result of which oil leaks from the oil seal and gaskets. In addition, if this gas enters the cabin or the body, it seriously poisons the driver and passengers. For this purpose, it is necessary to expel the gases from the crankcase cavity and to ventilate the crankcase all the time.

Control questions.

1. What is the reason for the use of the lubrication system in the engine?
2. How are the bearings of crankshafts and distribution shafts lubricated and where is the oil supplied?
3. How is the surface of the piston moving cylinder lubricated and where is the oil sent from?
4. What types of oil pumps are used in the lubrication system?
5. How is oil cleaned in the "Tcentrifuge"?
6. What is the reason for use of reducer, diverter and check valve in lubrication system
7. Why is it necessary to ventilate the engine crankcase?

8-Topic. Supply system of gasoline engines .

Plan.

1. The function, scheme, general structure and operation of the carburetor engine supply system.
2. Features of fuel pump, filters, fuel mixture
3. The composition of the combustible mixture, its effect on engine operation.
4. Simple carburetor operation method.
5. The system and devices installed on the carburetor, their operation.
6. The function, structure and operation of the supply system of the gas cylinder car engine.
7. Basic properties of compressed and liquefied gases.
8. The main equipment used in the supply of compressed and liquefied gases, their location scheme.
9. Modern injection system of injector engines.

Key words and phrases: Function, diagram, general structure and operation of the supply system of a carbureted engine, fuel pump, filters, properties of the fuel mixture, composition of the fuel mixture, its effect on engine performance, the method of operation of a simple carburetor . the system and devices installed in the carburetor, their operation, the function, structure and operation of the supply system of the gas cylinder car engine, the main characteristics of compressed and liquefied gases. the main equipment used in the supply of compressed and liquefied gases, their location scheme. modern injection system of injection engines.

1. The function, scheme, general structure and operation of the carburetor engine supply system.

The fuel supply system serves to store a certain amount of fuel, clean the air with fuel, prepare a combustible mixture in them with the required composition, introduce the mixture into the cylinder and expel the used gases.

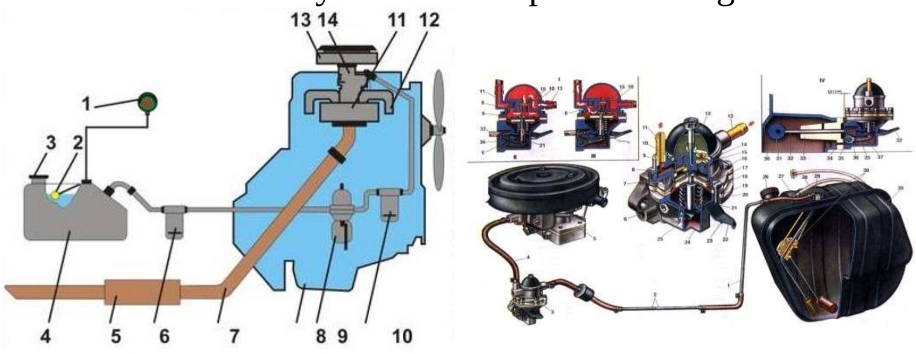


Figure 8.1. Carburetor engine fuel supply system device location diagram.

Fuels used in a carburetor engine and their properties. Gasoline is mainly used as fuel in carburetor engines. The quality of gasoline is determined by its ability to give heat, specific gravity, volatility and tendency to immediate explosion (detonation). The specific gravity of gasoline is 700-760 kg/m ^{3} , the freezing temperature is 250 ^{0}C.

1 kgThe amount of heat produced when gasoline is fully burned is 44,000-46,000 kJ, which is called the heat transfer capacity. Gasoline changes from a liquid state to a vapor state determines its temperature. The lower this temperature, the higher the quality and volatility of gasoline. The tendency of gasoline to detonation is the burning of the fuel mixture at a speed of 25-35 m/s without complete detonation. A part of the fuel mixture is called explosive (detonation) combustion, which generates a shock wave at a speed of 1500-2000 m/s. The explosion resistance of gasoline is determined by the octane number. The higher the octane number of gasoline, the more resistant it is to detonation. Car gasoline has an octane number of 66-96. To increase the resistance of gasoline to detonation, an anti-detonator is added to reduce detonation. The anti-detector substance includes ethyl liquid, 1.0 cm ^{3} of ethyl liquid is added to one liter of gasoline. This type of gasoline is called ethylated gasoline. Since ethyl alcohol is highly toxic, ethylated gasoline is also toxic. To make it easier to distinguish ethylated gasoline from regular gasoline, the color is changed by adding a little reddish-yellow or blue-green dye.[12]

According to GOST, the following brands of gasoline are produced for automobile engines: A-72, A-76, AI-93, AI-98.

The letter A on the gasoline labels indicates that it is automotive gasoline, and the numbers indicate the octane rating.

2. Features of fuel pump, filters, fuel mixture

Structure and operation of a gasoline suction pump. Carburetor engines use a diaphragm type fuel pump.

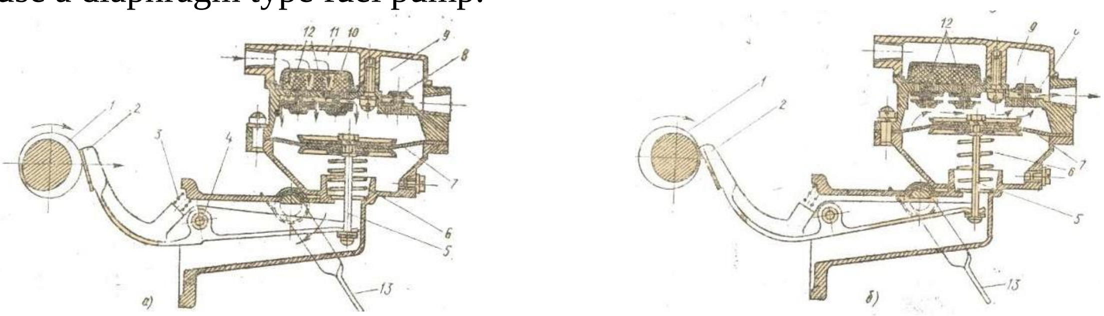


Figure 8.2. Diaphragm type fuel pump.

A diaphragm fuel pump serves to transfer fuel from the tank to the valve compartment of the carburetor. The diaphragm type fuel pump is the most common.

A diaphragm is installed between the pump cover and the casing, the middle part of which is attached to the stern. The lower end of the stem is fastened to the end of the operating rod.

Air and fuel cleaners

[12] Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

As a result of color in the air entering the carburetor entering the cylinders, engine parts are quickly eaten away. Therefore, an air cleaner is installed in the supply system. It serves to decolorize the air entering the engine cylinders. The air cleaner is mounted on the top of the carburetor. Energy-oil air cleaners are widely used in car engines.

Coarse cleaners Its cleaning part 0,05 mmconsists of plates made by stamping in thickness. The fuel is filtered through the slit between the plates.

Gentle cleanser. The case cleaner consists of a cup, a plunger, a compacted ring, and inside the cup there is a ceramic cleaner or a coil of fine mesh wire. When this cleaning composition of the fuel passes through the parts, it captures its highly mechanical particles, as a result of which the fuel is cleaned well and of high quality. Some mild cleaners include a magnet to trap metal particles in the fuel.

3. The composition of the combustible mixture, its effect on engine operation.

The composition of the fuel mixture and its properties. In order for gasoline to burn fully in the engine cylinders during the combustion process, it must be well and evenly mixed with air. This process occurs when the crankshaft rotates at 2500-4000 rpm, and each stroke lasts approximately 0.01s.

Requirements for the combustible mixture according to the engine operating mode.

The internal combustion engine operates in 5 different modes depending on the operating conditions:

Cold engine running, engine idle, medium load, peak load and acceleration rates.

A cold engine requires a thick mixture for running, because in this case, the speed of the air flow is small due to the small number of revolutions of the crankshaft, and there is enough fuel vapor in the mixture for the mixture to ignite.

When the engine is idle and the crankshaft rotates slowly, the amount of mixture entering the cylinders is very low and the quality is low. Therefore, this ritual requires a thickened combustible mixture.

When the engine works with average load, it does not require full power, therefore, a liquid mixture is used, which ensures full combustion of the mixture and saves fuel consumption.

For the heaviest loads, a thicker mixture is needed, as this requires full power from the engine.

During acceleration, the number of revolutions of the crankshaft must increase quickly, for this the mixture is thickened for a short time, otherwise the engine will shut down. All these works are done by the carburetor.

4. Simple carburetor operation method.

A simple carburetor and preparation of a combustible mixture in it.

Carburetors are mainly used in automobiles, where the air flow is directed from top to bottom.

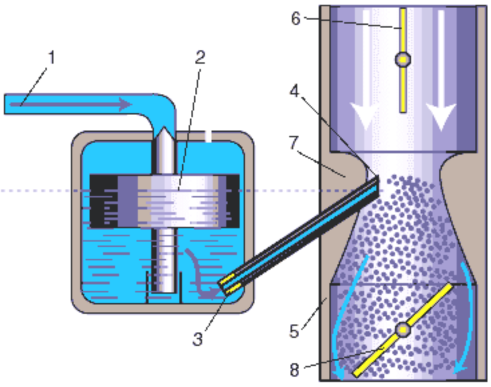


Figure 8.3. Drawing of a simple carburetor: 1. Main injector, 2. Throttle valve, 3. Needle valve, 4. Injector, 5. Air cleaner, 6. Air damper (damper), 7. Diffuser, 8. Throttle damper (flammable mixture damper) , 9-input tube, 10-input valve, 11-piston, 12-space.

The carburetor is a device that prepares the combustible mixture, which is installed in the intake pipe of the engine.

5. The system and devices installed on the carburetor, their operation.

The structure and operation of a modern carburetor. In order to prepare a satisfactory combustion mixture at different operating conditions of the engine, several additional systems and devices are installed in the modern carburetor design. The structure of the transfer of coal is the structure of the direct operation, the structure of keeping the composition of the mixture the same (compensation), the structure of the enricher and the accelerator.

Engine start-up structure. When starting the engine, the number of revolutions of the crankshaft is very small, so the dilution in the mixture preparation section is not enough for fuel to flow from the nozzle of the regulator. It is necessary to thicken the mixture when starting and warming up a cold engine . the air valve is closed to form a thick combustible mixture , which increases the dilution in the mixing compartment. To prevent the mixture from over-thickening, there is a valve which is opened by air pressure to prevent the mixture from over-thickening in the mixing compartment. The driver closes or opens the shutter using a lever attached to the cable and shutter shaft. At the same time as the air valve closes, the throttle valve opens slightly. In order to open the shutter under the influence of the air pressure difference on both sides of the shutter, the axis of the air shutter is eccentrically fixed to the input nozzle.

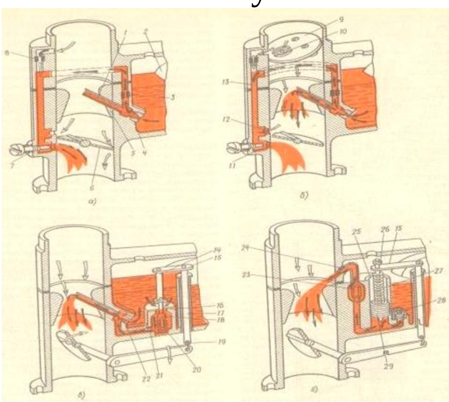


Figure 8.4. Structures of the carburetor:
A-mix compensation structure;
B-salt performance structure;
V-accelerator structure;
D-expulsion structure.

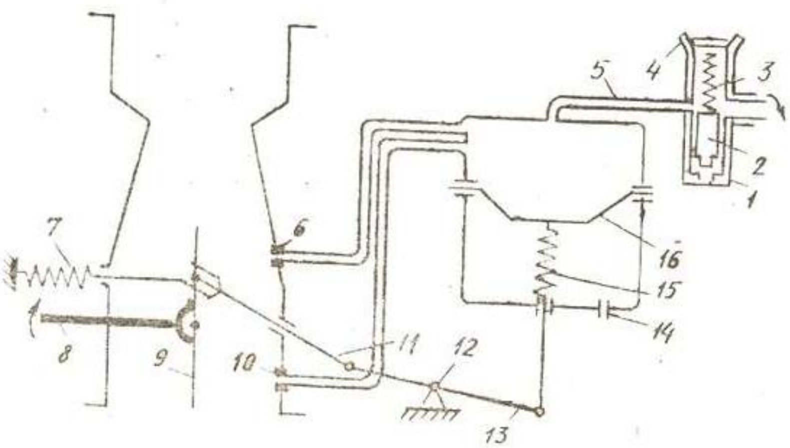
Salt working structure . Salt operation structure is designed to prepare a combustible mixture when the engine is under no load and the crankshaft is operating at a low number of revolutions. In this situation, a large amount of spent gas remains in the engine cylinders, the combustion rate of the working mixture slows down, so a thick burning mixture is needed for the engine to work.

Acceleration pump. When the car climbs a slope or overtakes the car in front, the engine has to increase the number of revolutions of the crankshaft or the load rapidly. In this case, the combustible mixture may liquefy, as a result of which the engine may shut down. Acceleration pump performs the task of thickening the mixture in a short time by providing an additional amount of fuel so that the combustible mixture does not become too liquid when the throttle valve is opened quickly.

Adjusting the frequency of rotation of the crankshaft with air.

In trucks, the maximum power of the engine or the frequency of revolutions of the crankshaft is adjusted using a special air limiter, that is, it is limited. In order to limit the frequency of engine revolutions , a restrictor device with air handling is installed on the carburetor (Fig . 8.5)

This type of limiter consists of a centrifugal sensor and a diaphragm mechanism. The centrifugal sensor is fastened to the cover of the distribution gear. Sensor rotor 8 moves from the engine camshaft. For this purpose, the drive shaft is fastened to the front part of the distribution shaft, the end of which enters the housing 9 of the rotor shaft. The diaphragm mechanism acts on the throttle valves 16 of the carburetor. The mechanism is attached to the carburetor. The sensor is attached to the diaphragm mechanism by means of pipes 5 and 6 and to the inlet pipe 4 of the carburetor.



8 . Figure 5 . A drawing of the limiter of the maximum frequency of revolutions of the shaft of the ZIL-130 engine.

When the rotation frequency of the engine crankshaft reaches 3100-3200 rpm, the valve 7 moves and closes the hole of the saddle 12 as a result of the increase in centrifugal force, so the air intake from the tube 6 to the space B stops. Since space B is connected to the mixing section of the carburetor through tubes and nozzles 17, a large rarefaction occurs in it. At this time, cavity A connects to carburetor inlet pipe 4 through pipe 15. The pressure in space A is higher than in space B. Diaphragm 3 overcomes the extension of piston 2 and moves up due to pressure difference. Along with the diaphragm 3, the stem 1 also moves up, while the stem 1 turns the axis of the throttle flaps through the lever 18 and the throttle flaps are closed. When the throttle valves are closed, the intake of the combustible mixture into the engine cylinders is reduced, as a result, the frequency of rotation of the crankshaft does not exceed the specified value.

Modern injection system of injection engines.

Fuel injection system.

Gasoline injection systems are rapidly displacing traditional carburetor systems. The advantages of a gasoline injection system over a carburetor system include:

- separate rationing of fuel and air, different supply of fuel according to the supplied air;
- correction of the main calibration program by many factors (depending on the regime of loads and speeds, temperature of air and coolant, atmospheric pressure, etc.);
- exact adjustment of the mixture as required for neutralization of used gases - probe systems;λ
- improve engine efficiency, power percentage indicators by 5-15%, diagnosis, self-diagnosis;

of the injection system are the cost, construction and maintenance complexity of the carburetor system .

Electronically controlled systems, which are adjusted by changing the duration of cyclic (periodic) spraying of gasoline, are used more often.

Depending on the number of electromagnetic nozzles used, these systems are classified as follows:

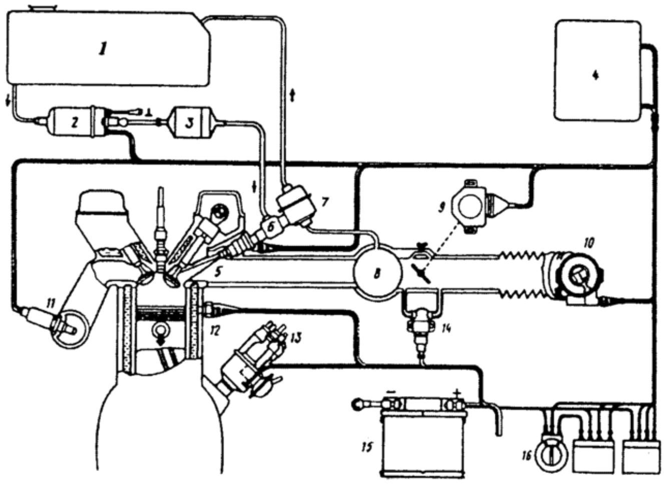
- each cylinder has a separate nozzle, (distributed spraying);
- there will be one injector (central injection) for all cylinders;

In four-stroke engines, injection systems with electromagnetic injectors with gasoline under a pressure of 0.15-0.4 MPa in the input stroke are common.

Direct injection of gasoline into the cylinders of automobile engines is also used in practice. The main reason for this is the poor working conditions of the injector, the difficulty of placing it in the combustion chamber and the high spray pressure (3.5-10.0 MPa).

8 . Figure 6 shows a distributed gasoline injection system.

The central injection system will have a similar picture with a single injector that sends fuel to all cylinders. The nozzle inlet is installed at the inlet of the pipeline.



8 . Figure 6 . Distributed sprinkler system.
1st fuel tank; 2-electric pump; 3-oil filter; 4-electronic control unit; 5-electromagnetic nozzle; 6th driving highway; 7-reduction valve; 8th Inlet Pipeline Road; 9-throttle valve position sensor; 10-air consumption connector; 11- λ-probe; 12th temperature sensor; 13-fire distributor;
14-additional air adjuster; 15th battery; 16-fire lock.

Fuel is drawn from the tank (1) by an electric fuel pump (2). Then the oil is pumped through the filter (3) to the trunk (6). A pressure difference is always maintained in the trunk by means of a reduction valve (7) when the fuel enters and exits the injector (5). Excess fuel returns to the tank through the reduction valve (7).

Fuel is sent from the drive main to separate electromagnetic injectors (5) that spray the area of the fuel intake valves. Air enters the cylinders through the flow meter (10) and the inlet pipe (3). The amount of air is adjusted through the throttle valve. The electronic fuel control system is supplied with power from the battery (15) and is connected to the circuit when the ignition lock (16) is engaged.

The air consumption meter (10) and the ignition distributor meter (shaft rotation frequency signal) are studied in the electronic control unit (4) and pulses are issued in accordance with the program included in it. These pulses control the opening of the injector valves and have a duration suitable for each operating mode of the engine. Since the reducing valve (1) maintains a constant overpressure of the fuel relative to the pressure of the air in the inlet pipe ±with an accuracy of 2 KPa, the periodic supply of fuel with the injector (5) depends only on the time of the injector valve being open.

The spray duration is corrected (corrected) by the control unit depending on the temperature of the coolant (sensor 12), the effect of the economizer in the acceleration mode and the thickening of the mixture, provided on the basis of the signals of the sensor (9) mechanically combined with the axis of the throttle valve.

The sensor also provides a pair of signaling contacts to stop the supply of fuel in forced idle mode.

Stopping the fuel supply, when the frequency of revolutions in the closed position of the throttle valves drops below about 1500 min $^{-1}$, the fuel supply is connected again. The fuel cut-off time is adjusted according to the temperature regime of the engine.

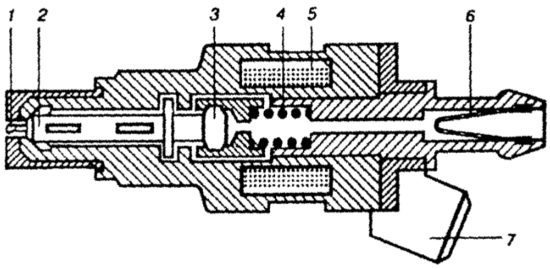
Automatic adjustment of the amount of air entering the engine, depending on the temperature of the cooling liquid, is provided to ensure that the engine operates at the same speed as the engine during normal operation. When the engine is not yet warmed up, the throttle valves are closed, so air enters through the upper and lower check valve channels.

Depending on the temperature of the engine, starting from a liquid temperature of 50-70 °C, the air adjuster (14) stops supplying additional air. After that, the air begins to enter only through the upper safety valve, the cross-section of which can be changed by means of a screw that adjusts the frequency of revolutions during the operation.

High-quality fuel filtration is important for the reduction valve and injectors to work without damage for a long time.

Measurement of air consumption is carried out with high accuracy by thermoanemometer and allows to keep the composition of the mixture constant even when the atmospheric pressure changes. A sensitive element made of a thin platinum wire with a thickness of 70 μm is placed along the cross section of the input pipeline and connected to the resistor bridge circuit. A thin wire is heated to a constant temperature of 150 °C. The higher the air consumption, the stronger the removal of heat from the thin wire, therefore, the temperature and resistance of the wire will decrease. and the heating current increases. The current, which is proportional to the air consumption, is continuously measured through a bridge of accumulated electrical resistances and determines the amount of air consumption. After the engine stops, the thin wire of the thermoanemometer heats up to a high temperature for a short time at the command of the control unit and is cleaned of dirt that can spoil the air consumption signal.[13]

The accuracy of regulation and uniformity of fuel delivery to the cylinders largely depends on the quality of the injector. Principle diagram of electromagnetic nozzles 8 . shown in Fig. 7 .



8 . Figure 7 . Electromagnetic nozzle

1st feeder; 2nd valve; 4th spring; 5-electromagnet; 6th filter; 7th electrical contact.

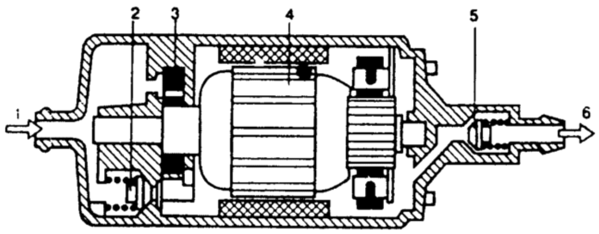
Fuel is sent to the injector body through the filter (6) by means of a hose. A valve (2) with a regulator (1) at one end and a fast-acting electromagnet (5) are placed inside the injector body, and the end of the electromagnet is insulated (protected) from the body by contacts (7). released through When the solenoid is de-energized, the valve is held in place by the spring (4). When a control electrical pulse is sent to the injector contacts, the valve 0,1 mmopens approx. The difference

[13] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

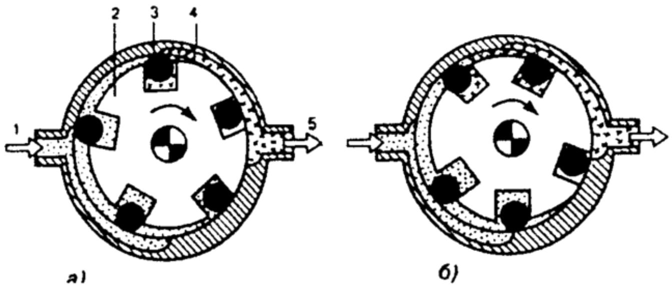
in cyclic (periodic) fuel transfer in one set of injectors ±can be from 4% in low gear to 1.5% in high gear .±

This provides significantly improved mixture composition uniformity across cylinders compared to carburetion or central injection.

The gasoline pump (Fig. 8.8) has an electric drive, which can be connected (turning the key in the ignition lock) before the stater rotates the crankshaft while the engine is running. As a result, the necessary pressure for fuel injection is achieved in the drive line before the engine starts. Sometimes, for better cooling of the electric motor, the electric pump is operated in a hermetic manner and lowered into the fuel in the tank.



8 . Figure 8 . Electric petrol pump
1-gasoline input; 2-storage valve; 3rd pump; 4th anchor; 5-reverse valve; 6-gasoline output;



8 . Figure 9 . Operating cycle (period) of the pump.
absorption of α-gasoline; b-driving; 1-gasoline input; 2nd pump rotor; 3-rollers; 4 the base surface of the rollers; Output of 5-gasoline.

The pump rotor (2) (Fig . 8.9 a) is located eccentrically in relation to the body (4) and rotates together with the electromotor armature. The rollers move in the grooves of the rotor, pressed against the base surface of the stator .

The principle of operation of the pump (principle)

As the rotor rotates, the volume of the sickle-shaped space bounded by the two rollers, the stator surface (4) and the rotor (2) above and below the inlet opening (1) increases.

At this time, the aforementioned space is filled with gasoline. When the rotor and the rollers with it occupy the position shown in Fig. 4 b, the size of the sickle-shaped gap between the rollers is reduced, as a result of which the transfer of gasoline to the drive line is ensured.

Reduction valve (2) (see figure 3). A check valve (5) prevents the system from over-pressurizing and prevents fuel from flowing into the tank after the pump stops.

Control questions

1. Explain the function of the fuel supply system of a carbureted engine?.
2. What are fuels and their properties?
3. What is a normal carburetor made of?
4. Tell the composition of the mixture and their properties.

5. What do you mean by engine performance?
6. How is the structure and operation of a modern carburetor?
7. Tell the structure of air and fuel cleaners?
8. How is the gasoline suction pump constructed?
9. How to manually adjust the frequency of rotations of the crankshaft?
10. Give information about liquefied and compressed gases?
11. Tell the equipment structure of the gas cylinder supply system?
12. How are the effects of combustion residues on the environment and their elimination measures implemented?
13. Explain injector supply system?

Topic 9: Engine supply system of gas cylinder cars.

Plan.

1. The general scheme and principle of operation of the gas cylinder supply system.
2. Basic properties of gases.
3. Functions and structure of the equipment used in the supply system of gas engines.

Basic words and phrases: the main properties of compressed and liquefied gases. the main equipment used in the supply of compressed and liquefied gases, their location scheme.

Creating a cluster on a topic

Creating a syncway to the topic

1. The general scheme and principle of operation of the gas cylinder supply system.

Gas engines are widely used in modern city vehicles. It uses compressed or liquefied natural, industrial and synthetic gases. Compressed and liquefied gases are stored in special cylinders, which is why vehicles are called gas cylinders.

As a rule, it is created on the basis (on the basis) of gas-powered engines that run on liquid fuel in series (massively). When converting a mass-produced engine to work with gaseous fuel, its main parts and components remain unchanged. The main difference between the gas-powered modification is the fuel delivery system, the ignition of the combustible mixture and regulation (correction). (regulirovaniya)

Conversion of carburetor engines to gaseous fuel is carried out in two ways. The first method is to create a gas modification of a standard carburetor engine by equipping it with gas cylinder devices. In this case, the possibility of running the engine on both gasoline and gas remains. At the same time, in gasoline, the engine reaches full power, and in gas, the power decreases slightly. In the second method, a special gas engine is created from a carburetor engine that achieves full power on gaseous fuel. Due to the fact that such engines have increased compression and the installation of a gas mixer, efficiency indicators are significantly improved.[14]

[14] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

Conversion of diesel engines to gaseous fuel is also done in two ways. The first method is to retrofit (convert) a diesel to a spark-ignition gas engine. For this, the compression level in the cylinders is reduced to 8-9, and the ignition system and gas cylinder devices are installed.

2. Main properties of gases .

Gaseous fuels used in gas cylinder cars are natural or liquefied combustible gases, which are liquefied petroleum gas (LNG), compressed and liquefied natural gas (LNG). Car engines running on STG are common. CNGs are stored in cylinders, these types of gases are of three types, i.e. propane, butane and their mixtures. Since STG has no smell, a gaseous substance with a pungent odor is added to it. A car that worked on STG has advantages over the one that worked on STG: the number of cylinders is less, the car's carrying capacity is higher. The gas pressure in the cylinder with STG is not high, that is, 16 kg/cm2. Therefore, their transportation is not dangerous, they have a high heat transfer capacity, and therefore the power of the engine is high. This gas is safe. But there is a risk of explosion if liquid gases accumulate in one place. GHGs are transported in special trucks, these gases mainly consist of methane. Compressed gas (CNG) fuels are transported in special cylinders. The gas pressure in the cylinder is around 200 kg/cm ^{2} . Their ability to provide heat is 8500 kcal /m ^{3} . The disadvantage of a car running on compressed gas is that its power is reduced by 10-20% due to the low coefficient of cylinder filling . 6-8 cylinders weighing 65-70 kg are installed on the car. Because of this, the car's carrying capacity decreases. Cylinders are filled at special gas filling stations. A cylinder 10 m^{3}is filled with gas. Compressed gases mainly consist of propane or butane.

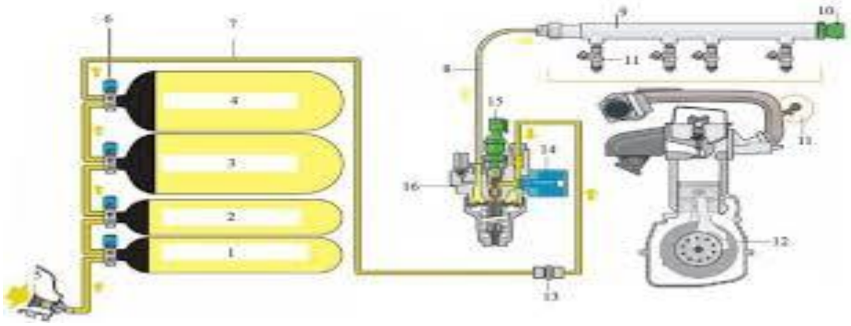
3. Functions and structure of the equipment used in the supply system of gas engines.

Nexia cars, trucks and bus engines run on liquefied gas.

Figure 9.1. Of a car running on liquefied gas gas supply system.

1-carburetor-mixer, 2-gasoline filter electromagnetic valve, 3-gasoline tank, 4-gas reducer, 5-liquefied gas burner, 6-hot water supply nozzle, 7-hot water outlet nozzle, 8-water drain , 9-electromagnetic valve with gas filter, 10-reductor manometer. 11-engine, 12-steam valve, 13-storage valve, 14-liquefied gas cylinder, 15-control valve, 16-filling valve, 17-liquefied gas level indicator, 18-drain plug (plug), 19-fluid valve.

A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.



Gas supply system of a car engine running on compressed gas.
1-gasoline pump, 2-gasoline filter solenoid valve, 3-carburetor-mixer, 4-inlet pipe, 5-gas transfer hose to the carburetor-mixer, 6-gasoline filter-muffler, 7-pipe from the cylinder to the heater, 8-spend valve, 9. Filling valve, 10. High pressure gauge, 11. Pipeline for connecting cylinders, 12. Pipeline for connecting sections, 13. Rear section of cylinders, 14. Front section of cylinders, 15. Gasoline tank, 16. Solenoid valve with gas filter, 17. - high-pressure reducer, 18-passage pipe from filter to low-pressure reducer, 19-low-pressure manometer, 20-low-pressure reducer, 21-tube barrier with vacuum, 22-salt walking pipe, 23-motor.

Control questions

1. Give information about liquefied and compressed gases?
2. Tell the equipment structure of the gas cylinder supply system?
3. How are the effects of combustion residues on the environment and their elimination measures implemented?

Topic 10: Supply system of diesel engines .

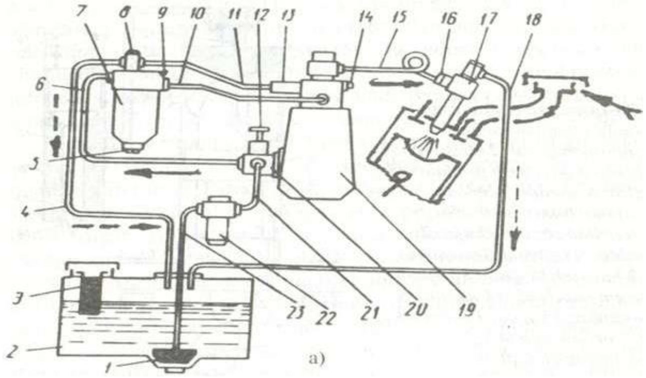
Plan.

1. The function, structure and operation of the supply system of a diesel engine.
2. Fuel pump, cleaner filters.
3. High pressure pump, nozzle design and operation processes.
4. Adjuster of the number of revolutions of the crankshaft.
5. Fuel injection advance automatic clutch.

Key words and phrases: Diesel engine fuel supply system, diesel fuel and its properties, fuel suction and drive pump, fuel coarse and fine cleaners, high pressure fuel i pump, low and high pressure fuel pipes and their location, injector and air cleaner, combustion compartments, formation of a combustible mixture in diesel, adjustment of the frequency of crankshaft revolutions with all-speed adjuster.

1. The function, structure and operation of the supply system of a diesel engine.

The fuel supply system of a diesel engine stores a certain amount of fuel, refines it coarsely and finely, creates high pressure in the high-pressure fuel pump, and compresses and heats it inside the cylinder with the help of an injector. serves to spray into the air in the form of mist. In a diesel engine, a combustible mixture is formed inside the cylinder. In diesels, fuel injection consists of a high-pressure pump and an injector mounted closed to each cylinder. The supply system consists of two main branches: lower and upper branches. The low pressure manifold transfers fuel from the tank to the high pressure pump. A high-pressure manifold delivers a certain amount of fuel to the engine's cylinders at a certain time under pressure. A generalized diagram of the YaMZ diesel engine fuel supply system is presented in Figure 10.1 .



10. Figure 1 . YaMZ diesel fuel supply system.

The fuel from the tank 2 is sent to the coarse cleaner 22 under the influence of dilution created by the drive pump 20. Fuel from the Bk cleaner is sent to the Fine cleaner 7, from it through the fuel tube 10 to the fuel injection nozzle 17 under a pressure of about 150 kg/cm ^{2} using a high pressure pump. When the pressure of excess fuel accumulated in the high- pressure pump 19 is equal to 150 kg/cm ^{2} , the bypass valve 13 opens and flows into the fuel tank 2 through the return pipes 4 and 11. The fuel dripping from the injector 17 slots returns through the tube 18.[15]

The process of filling the system with fuel during the initial driving of the diesel engine is carried out using a manual pump 12 in the casing of the driving pump 20. There are holes drilled in plugs 9 and 14 to expel air that has entered with fuel. In the system, the main cleaner 7 and the coarse cleaner 22 and the mesh wire cleaner at the neck of the tank, on the cover of the fuel receiver 1 and on the nozzle 16 of the nozzle 17 there are wire cleaners.

In addition, the high-pressure pump has a two-stage adjuster that changes the number of revolutions of the crankshaft. The engine adjuster stabilizes the minimum speed of 600 rpm and limits the maximum speed of 2800 rpm by itself.

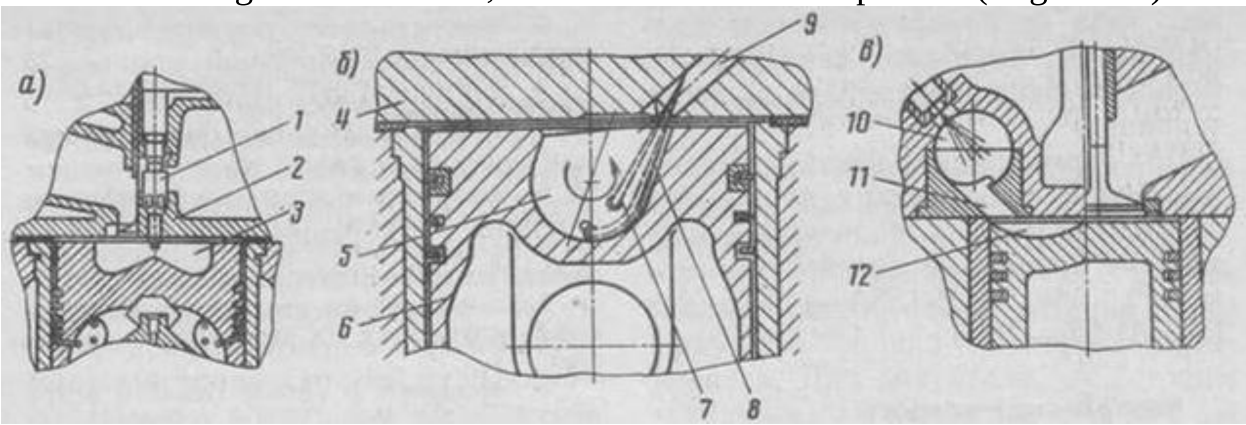
Low and high pressure fuel pipes and their location. Low-pressure fuel tubes serve to deliver fuel with low pressure. They are made of copper, between the fuel tank and the coarse cleaner, between the coarse cleaner and the fuel suction pump, between the high pressure pump and the fine cleaner, between the fine cleaner and the fuel tank. iga and between the injector and the fuel tank. High-

[15] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

pressure tubes are made of steel and serve to send the filling at high pressure. These tubes are located between the fuel intake and drive pump and the scavenger gap, between the scavenger and the high pressure pump.

Formation of a combustible mixture in a diesel engine In a diesel engine, a combustible mixture is prepared in the combustion chamber in the cylinder. The quality of the mixture depends on the fuel injection pressure, the structure of the injector, the quality of the fuel and the structure of the combustion chamber.

According to the structure, combustion units are separated (Fig . 10.2)



10. Figure 2 . Types of combustion units:
a-fuel direct injection non-separated combustion unit;
b-combustion chamber with separate front compartment;
v-unseparated lump combustion unit;

The main part of the undivided combustion compartment is located in the depression 3 in the middle part of the bottom of the pot 1 (Fig. 10.2 , a). Fuel is injected directly into the combustion chamber, which accelerates its vaporization and good mixing of compressed and heated air. During the expansion process, the rate of increase of gas pressure and temperature is greater, and the economy of the engine increases. This combustion compartment is common in automotive diesels.

Combustion compartment with a separate front compartment (Fig. 10.2 , b). It consists of two parts, the main part is located at the bottom of the piston 7, and the smaller part is located in front of the compartment inside the cylinder cover at 4. At the end of the compression process, part of the air spreads from the bottom of the piston to the front compartment 9. As a result of fuel injection into the front compartment, part of the fuel burns, the pressure in the compartment increases. As a result, the expanded gas, together with the combustion products, spreads to the main combustion compartment at high speed. Due to the high speed of air in the combustion chamber, the air mixes well with the fuel. But in this combustion unit, the combustion speed is weak, the FIK is small and the fuel consumption is high. In cold conditions, it becomes difficult to start the engine.

It is located on the cover of the combustion chamber with a stacking compartment, and (Fig. 10.2, v) moves in a stacking in the air compartment as a result of compression. At the end of the compression process, the fuel exchanged with the air, vaporized, and partially burned. As a result, the pressure rises in the combustion chamber, unburnt combustion products move at a high speed through the tunnel 11 to the main combustion chamber 12, and the heated air burns very quickly. This makes the engine run easily through the compartment. Diesels with separate and lumped combustion units are installed on more tractors.

Features of diesel fuel.

Diesel fuel is a product obtained by direct driving by adding catalytic cranking components to oil. In diesel fuel, carbon-S is composed of hydrogen-N and oxygen-O_{2} elements. The ignition temperature of diesel fuel is 35-40 ^{o}C, the freezing temperature is -10 ^{o}C in summer, 35 ^{o}C in winter, the specific weight of fuel is 800-850 kg/t and 1 kgthe heat capacity of fuel is 42500 kJ /kg, cetane number 45.

Autotractor diesel fuel is produced in three varieties: summer, winter, arctic and special.

The letters on the diesel fuel brand indicate the following: L- summer fuel, used when the air temperature is above 0 $^{o\ C;}$ 3- it is used when the winter air temperature is -20 ^{o}C and above.

In diesel engines, the fuel is compressed with air directly in the cylinder to a pressure of 30-50 kg/cm ^{2} and a portion of fuel is sprayed through a nozzle working under high pressure into the air heated up to 600-800 ^{o}C due to compression.

Fuel mixes with hot air in the cylinder. A mixture is formed in a short time , then the fuel evaporates, hydrocarbons are chemically oxidized, reactions occur, as a result of which the fuel spontaneously ignites and burns.

In order for the engines to work reliably and economically, it is necessary to choose the right fuel and the angle of advancing the fuel injection should be optimal, otherwise the gases will turn black, the power will decrease, and the fuel consumption will increase.

In order for the fuel to be full and of good quality, the high-pressure pump and the injector must work well, there should be no rust in the valves, pistons and rings, there should be no water in the fuel, and the fuel should not be rusted, the viscosity of the fuel should be normal. should be, its decrease and increase will have a bad effect on the operation of the engine. If the viscosity is low, the fuel will leak through the compounds. If the viscosity increases, the fuel will not wear well, the quality of the mixture will decrease and it will burn prematurely. When the weather is cold, the viscosity of fuel increases.

The tendency of diesel fuel to self-ignition and engine roughness is evaluated by cetane (TSS). Diesel fuel is a mixture of cetane and alpha-methylnaphthalene. When the TSS is high, the start of combustion is smooth, the engine runs smoothly, without knocking and noise. TSS increases the amount of excess smoke. Therefore, TSS for diesel fuel is accepted to be in the range of 40-60. TSS is the percentage of cetane ($S_{16}N_{34}$) in the mixture.

In the operation of diesel engines, fuel burns better when the fuel injection advance angle grid is set.

The engine can be run normally and run smoothly when using fuel with a TSS of about 45 units in summer and 50 units in winter.

Fuel decomposes in the absence of air at a high temperature (800-900 ^{o}C) and forms a worm. It corrodes rings and valves. The amount should not exceed 0.03 percent. When fuel is burned in air at a temperature of 800-850 ^{o} C, ash is formed and accelerates the corrosion of parts, the amount should not exceed 0.02 percent.

The fuel must not contain water, as it makes it difficult to start the engine in cold weather, rusts parts and freezes in the wiper holes, preventing fuel from flowing. There should be no mechanical impurities in the fuel, because they contain corrosive particles that cause fuel devices and injectors to be eaten. Therefore, diesel fuel is stored in tanks for 17-20 days.

If the elementary rules of reception, distribution and storage of oil products are followed, engine parts can be prevented from premature failure.

2. Fuel pump, cleaner filters.

The tasks and structure of the equipment and devices in the supply system. With the help of the equipment and devices in the supply system, the fuel in the fuel tank is sucked up, it is cleaned in coarse and fine cleaners, and it is sent under pressure to the high pressure pump, high pressure by extracting a certain amount of fuel at the pump and sending it to the injector with high pressure, spraying the fuel at the injector into the cylinder and reducing or increasing the amount of fuel delivered depending on the engine's operating status (mode).

The supply system consists of low-pressure fuel and high-pressure fuel branches.

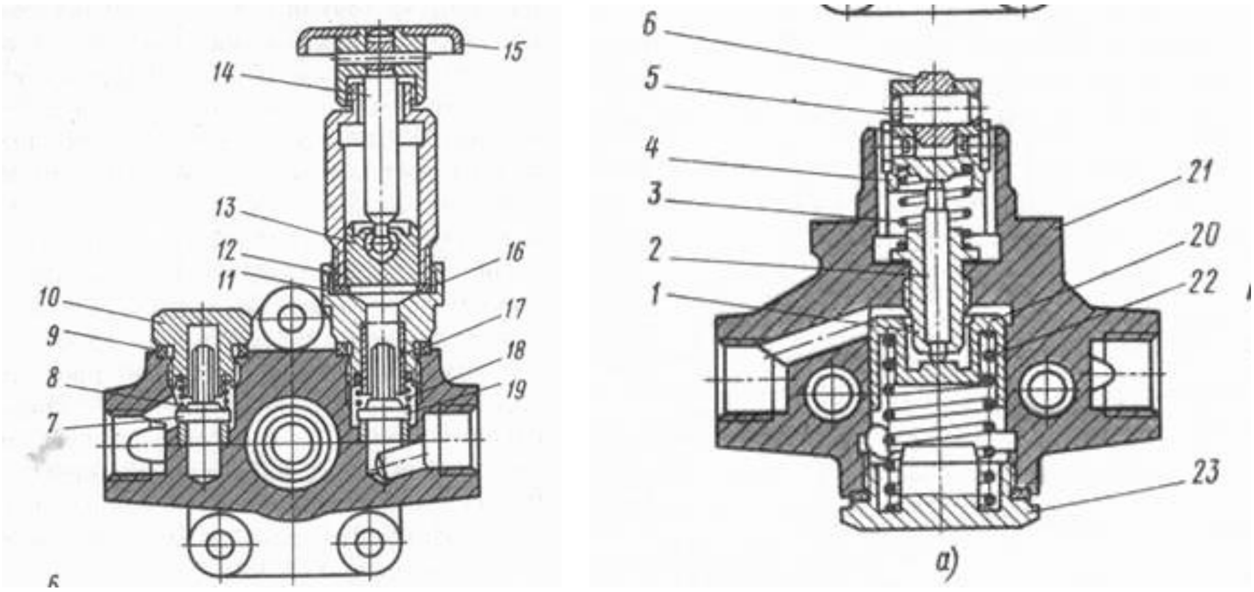
The low pressure fuel rail includes coarse and fine cleaners, fuel suction, drive pump and tubes.

Rough cleaner. The wiper casing is made of wire mesh and is fitted with a mesh-braided wiper. The fuel is cleaned by passing through the tissue. At the bottom of the case there is a ripple hole to drain the sediment.

Gentle cleanser. Cleans the fuel better. In the center of the squeegee is a steel mesh squeegee with mesh ribs mounted on the rudder. The ribbed netting is placed in a mesh with holes wrapped in fabric, and several layers of gauze are wrapped on top of it. A nozzle is installed in the cleaner cover to remove excess fuel and air from the system. Sediment and sediment are expelled through the plug.

Fuel intake and drive pump . This pump is mounted in the housing of the high pressure pump and draws fuel from the tank through the coarse cleaner and then drives it through the fine cleaners to the high pressure pump. The pump gets its movement from the eccentric of the distribution shaft of the high pressure pump. When the engine is running, the pump is manually operated to supply fuel to the system. (Figure 10.3)

The drive pump is two-piston, it moves downward in the image of the piston 1 piston 5 with the return of the pusher 7 in the KamAZ engine to the cover of the frequency adjuster and creates a rarefaction in the space A. The inlet valve 4 rises by squeezing the tip of the piston, and fuel begins to flow into this gap.



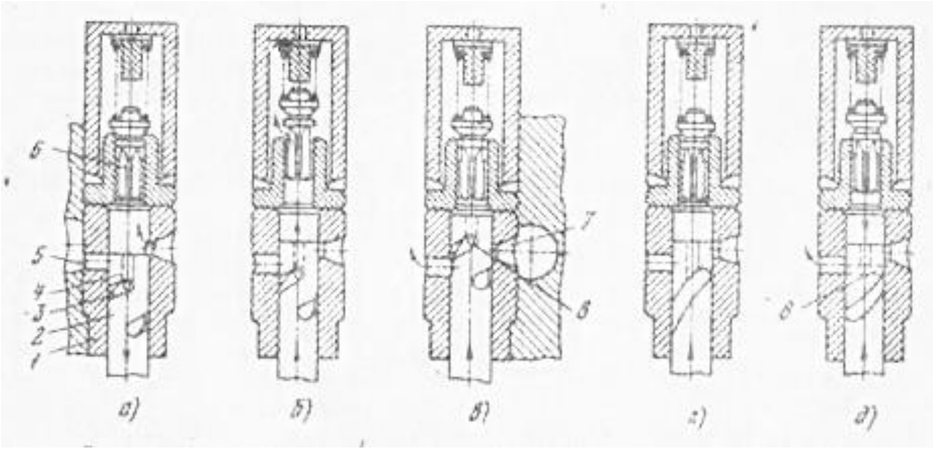
10. Figure 3 . Operation of the drive pump.
1- fuel coming from a coarse cleaner, 2- manual pump piston, 3, 5, 6, 10- springs, 4- intake valve, 7- pusher; 8-eccentric,
9-drive valve;

At this time, the fuel is squeezed from the space B into the driving main while the valve 9 is in the closed position. When the piston 1 moves up, the fuel passes from the space A through the drive valve 9 to the space V, while the inlet valve 4 is closed and the fuel is sent to the high pressure pump. To drive fuel into the system, the primary piston is moved together by hand, up-down and down-up. The high pressure fuel transfer manifold includes a high pressure pump, injectors and pipes.[16]

3. High pressure pump, nozzle design and operation processes.

Multi-chamber high pressure pump This pump is installed between the left and right rows of the cylinder block, moves through the gear of the distribution shaft, and serves to transfer the required amount of fuel with high pressure and in the specified time in accordance with the working order of the engine cylinders. It consists of a housing, a shaft with punches, chambers equal to the number of cylinders, an advance clutch that adjusts the number of revolutions of the crankshaft, a mechanism for turning the plungers, each chamber consists of a plunger, gas, a driving valve and a spool pusher (Fig. 10.4).

[16] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.



10. Figure 4 . The working form of the high-pressure fuel pump room:
a- fuel intake, b- fuel drive, v- fuel drive completion, g) full fuel supply, d) no fuel in transmission.
1- outlet window, 2- drive valve, 3- inlet window, 4- beveled edge of the plunger, 5- axially drilled hole in the plunger

.

When the plunger 4 moves down, the space above it comes under a pressure of 16-17 kg/cm ^{2} from the drive pump and is filled with incoming fuel through the upper hole in the sleeve 3. The pusher moves the plunger up as the shaft punch lifts the spool pusher. When the plunger closes the hole 3 in the sleeve, the fuel pressure increases, the drive valve 2 opens and the fuel enters the injector. When returning through the plunger, the fuel accumulated in the sleeve exits through the lower discharge window of the sleeve, passes into the return tube and is poured back into the fuel tank. The amount of fuel sprayed from the injector is changed by turning the plunger of the unit to the screw hole in it. When turning the plunger, sooner or later the lower hole of the sleeve that transfers fuel to the fuel channel is opened, in short, when the plunger is turned to the right, the fuel increases, when it is turned to the left, it decreases. Plungers are turned using a gear rack controlled by a system of levers or levers by pressing the pedal in the driver's cabin.

Forsunka . The injector is designed to inject fuel into the cylinders with high pressure and to treat it. The needle rises from the fuel pump compartment into the annular space under the needle with a pressure of 100-200 kg/cm ^{2} and is sprayed into the cylinders through the nozzle hole. Depending on the power of the engine, the number of holes can be 1, 2, 3, 4. After stopping the fuel supply at the pump, under the influence of the piston, the needle will return to its place, and the fuel will be stopped from coming out of the injector. The fuel that has passed through the injector housing and the needle is poured into the fuel tank through the channels in the injector housing. The nozzle is mounted on the block cover.

4. Adjuster of the number of revolutions of the crankshaft.

Adjustment of the crank and the frequency of revolutions with an all-round adjuster.

When the engine operates at different loads, the frequency of rotations of the crankshaft changes, that is, when switching from idle to load, the frequency of rotations of the crankshaft must be increased with additional fuel, or fuel when switching from load to idle It is necessary to reduce the frequency of rotation of the crankshaft. This task is performed by the driver through the pedal. To facilitate the work of the driver, an all-round adjuster is used. Adjusters 1, 2 and all are valid. In car diesels, all-speed adjusters are used (Fig . 10.5).

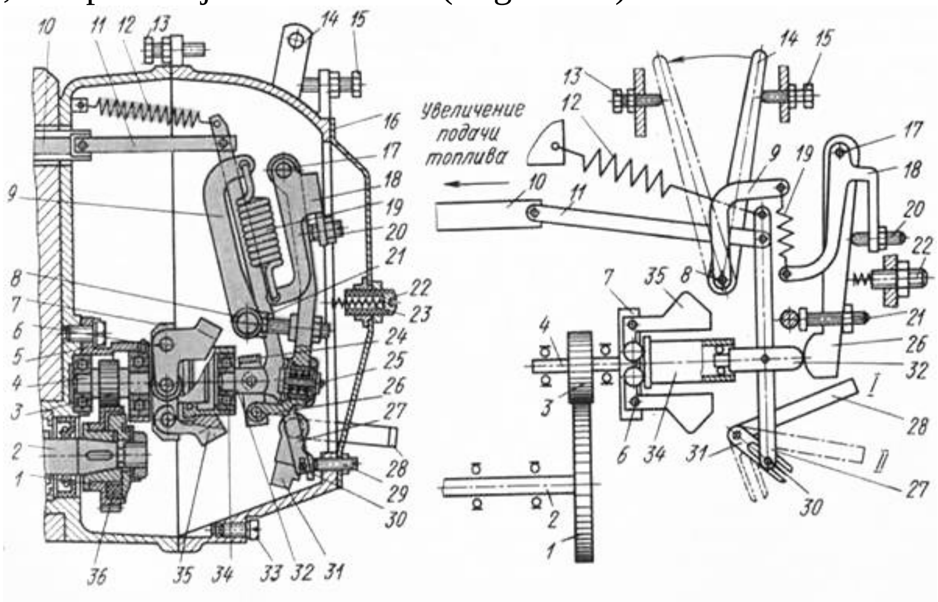
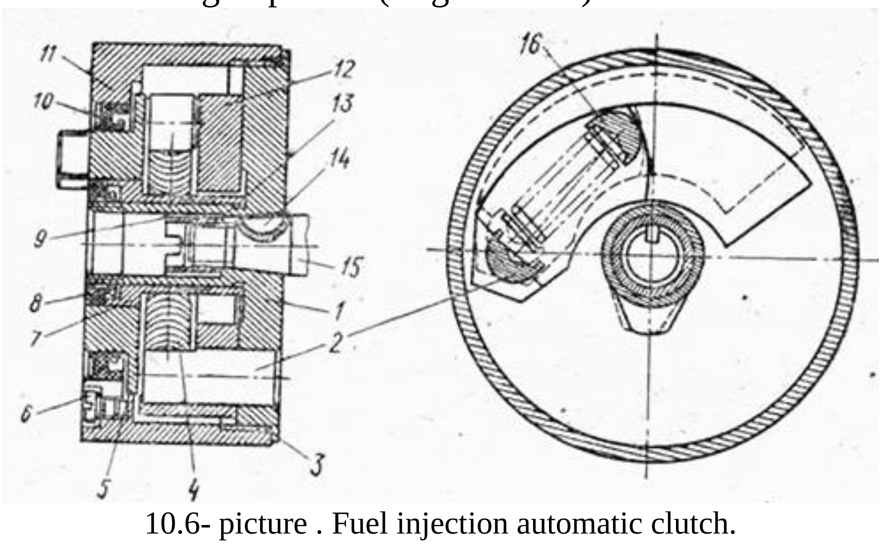


Figure 10.5 . All-round adjuster of crank and rotation frequency

5. Fuel injection advance automatic clutch.

Fuel injection automatic clutch. This clutch is designed to change the timing of the start of fuel injection depending on the change in the number of revolutions of the crankshaft when the engine load changes. As a result, the quality and efficiency of diesel driving improves (Fig. 10.6 - a).



10.6- picture . Fuel injection automatic clutch.

The coupling is made up of leading and leading parts. The driving half-coupling is mounted on the end of a punched shaft 15 of a fuel pump with a key and a washer, and it has bearings 12 moving in different directions under the influence of centrifugal force. Loads are conventionally attached to two axles. In the cut place of the yokes, the wedges 4 and the clamping fingers 16 are fixed. The driving half-coupling is driven from the intermediate gear by a shaft with a flexible coupling. Pins 4 clamp the shaft 2 on the one hand, and the fingers 16 on the other hand, connecting the leading leading parts of the clutch. As the number of revolutions of the crankshaft and the related pump shaft increases, the bearings in the clutch 12 move in different directions under the influence of centrifugal force. As a result of the movement of the bearings, the driven punch shaft rotates in the direction of rotation in relation to the leading part of the coupling, as a result of which the fuel injection angle increases. When the number of rotations decreases, the centrifugal force decreases and the pistons come closer to each other under the influence of the piston 4, the half clutch turns in the opposite direction to the rotation of the fuel pump shaft, as a result, the injection angle decreases, advancing the fuel.

Control questions.

1. Explain the function of fuel supply system of diesel engine?
2. Tell me about diesel fuel and its properties?
3. Explain the function of fuel suction and drive pump?
4. Explain the function and structure of coarse and fine fuel cleaners?
5. Explain the function of high pressure fuel pump?
6. Explain low and high pressure fuel pipes and their location?
7. Explain the structure and function of injector and air cleaner?
8. Explain combustion compartments?
9. Explain the formation of a combustible mixture in diesel?
10. How to adjust the frequency of crankshaft revolutions with an all-speed adjuster?

Topic 11: Transmission. Clutch coupling .

1. Function and types of transmission.
2. The structure and operation of the transmission.
3. Function, types and main parts of the clutch (frictional, hydraulic, electromagnetic).
4. Design of friction clutch and its operation
5. Clutch guides.
6. Clutch drive amplifiers.

Key words and phrases: Function and types of transmission, structure and operation of transmission, function and types of clutch, structure and operation of clutch.

1. Function and types of transmission.

As the vehicle moves on the road, the resistance forces acting on it are always continuously and arbitrarily changing.

The change in forces will depend on the speed, acceleration and load of the vehicle. In order to overcome the forces of resistance, it is necessary to change the torque coming from the engine. To perform this task, power transmission is used in cars. So, the power transmission serves to transfer the torque from the engine to the leading wheels of the car by changing its value and direction with the help of several mechanisms and devices. The power transmission is divided into mechanical, hydraulic, and mixed (hydromechanical, electromechanical) types based on the transmission of torque received from the drive to the leading wheels.[17]

Modern cars mainly use mechanical power transmission.

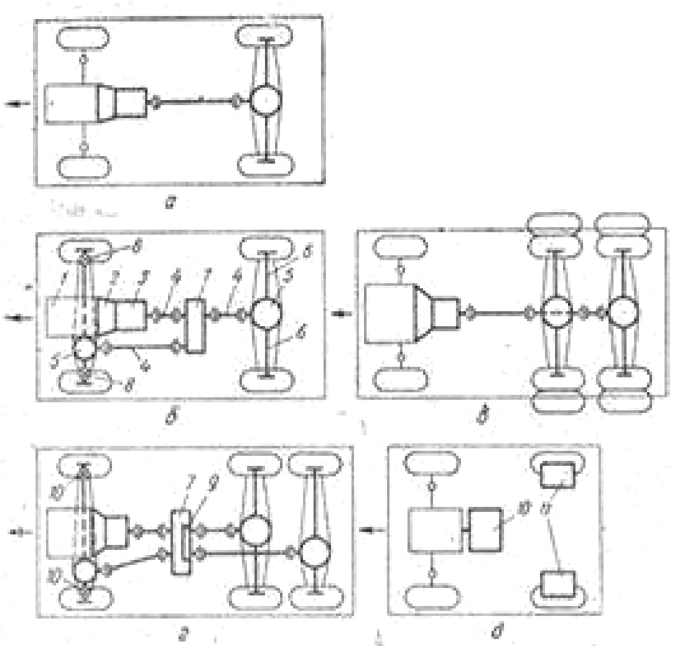
The power transmission is connected to each other, that is, it is composed of a clutch, a gearbox, a cardan shaft, a main shaft and half-shafts. Depending on the number and location of the engine, the power transmission can have a different design. The transmission also has a distribution box for cars, which distributes the torque to the leading axles.

2. Structure and operation of the transmission.

If the car is intended for driving under normal road conditions, the engine is in front and the leading axle is engaged, the torque is transmitted from the engine 1 through the clutch 2 to the gearbox 3. The amount of torque in the gearbox is changed depending on the road conditions. Later, with the help of the cardan transmission 4, the torque transmitted by the main transmission located inside the leading bridge 5 is changed to 90 ^{0} and, further increasing the torque, is transferred to the leading wheel through the differential mechanism and half-axes. 'is omitted (Figure 11.1).

Such cars have a 4x2 drivetrain designation, which means two of the four wheels are leading. Copies of this type of car: VAZ 2101, VAZ 2106, "Zhiguli", GAZ-24 "Volga" GAZ-53A, ZIL-130, DAMAS, PAZ and KAVZ buses Power transmission of ZAZ 968 passenger car and Ikarus buses in view b of drawing 9.1 is illustrated, showing the clutch 2, the gearbox 3, the main gear, the differential mechanism and the half-axles located inside the leading axle 5 in one unit with the engine 1.

[17] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.



11.1 - Types of power transmission (transmission) of cars.
a, b, v, g-mechanical, d-hydraulic and electric.

The power transmission of VAZ 2108, 2109 "Zhiguli" Moskvich 2141, Tiko, Nexia cars is described in view c of figure 11.1, in which the engine is installed transversely on the front leading bridge, which is assembled as a whole with the power transmission . Instead of half-axes, a cardan transmission with 6 cardan joints with the same angular velocities is used. In these models, the front wheels are leading and the rear wheels are steered.

If the car is intended for movement in difficult road conditions, the number of bridges with leading wheels can be two or three.

In this case, an additional aggregate distribution box is included in the power transmission, and the torque from the end of the drive shaft of the transmission neighbor is equally distributed to the leading bridges. This type of power transmission can be 4x4, 6x4. Figure 9.1 shows the power transmission of GAZ-66, UAZ-452, UAZ-469B, VAZ-2121, "NIVA" cars. The front wheels are leading and driven, and the rear is leading. Figure 11.1 shows the power transmission of ZIL 131, URAL 375D cars. The power transmission of the KamAZ 4320 car is depicted in view d of Fig. 11.1. The front wheels are both leading and steering, and the rear wheels are leading.

Structure and operation of hydraulic and electric power transmissions. Hydraulic or electric power transmission is used in large and heavy-duty quarry vehicles. (Fig. 11.1 d). In the hydraulic power transmission, the torque of the internal combustion engine of the hydraulic pump 10 generates fluid pressure in the tubes, and the hydromotor 11 converts the fluid pressure into torque and transmits it to the leading wheels of the car.

In the electric power transmission, the generator 10 uses the torque coming from the internal combustion engine 1 to generate electric current. Electric motors 11, in turn, convert electric current into torque and transmit it to the leading wheels of the car.

3. Function, types and main parts of the clutch (frictional, hydraulic, electromagnetic).

Function and types of clutch.

In order for the car to move, the torque on the shaft of the working engine must be transmitted to the drive wheels without jerks and vibrations. In addition, when the car moves in different road conditions, it is necessary to change the amount of force or the direction of movement of its leading leading wheels. To do this, it is necessary to disconnect the power transmission from the running engine for a short time and connect it again. To perform this task, a structure-coupling is needed, which engages or disengages the power transmission with the engine when necessary.

Therefore, the working clutch performs the function of temporarily disconnecting the engine from the crankshaft for a short time and smoothly connecting the power transmission to ensure that the car moves from a standing position without jerking and without shaking, and when changing speeds. The clutch drive and driven part are mounted on the end of the crankshaft when the engine is running so that the clutch stops rotating when the clutch is disengaged from the engine.

According to the method of connecting the driving and driven parts, the clutch is friction hydraulic and electromagnetic. Couplings are single-disc based on the number of leading disks, double-disc based on the type and location of the compression seals, with a circular spigot or with one central diaphragm spigot. Between the clutch and the gearbox is an engine flywheel.

The operation of the friction clutch can be ***mechanical*** , ***hydraulic, electromagnetic .*** Many cars and trucks use mechanical and hydraulic transmissions. Electromagnetic drives are mainly used in the automation of clutch control in passenger cars. Mechanical (servo springs) pneumatic or vacuum amplifiers are used to facilitate the control of the clutch.

Hydraulic clutch (hydraulic clutch) has leading and driven parts. The driving part consists of a pump wheel 3 (Fig. 11.2 a) and a cover 2 , which creates a volume filled with low-viscosity working oil . Turbine wheel 1 is the driving part. The pump and turbine wheels are installed between the outer 5 and the inner 6 threads and have blades 4, which form inter-blade channels for the working fluid with each other. Hydraulic clutch blades are usually made straight radially. The turbine wheel is located very close to the pump wheel.

While the engine is running, the pump wheel is rotating. Its hairs exert force on the liquid in the inter-hair channels, pushing it to the periphery. The liquid is ejected from the inter-blade channels of the pump wheel , hits the turbine blades of the wheel, passes through the inter-blade channels, and again falls into the inter-blade channels of the pump wheel. In the inter-blade channels, a closed circular flow of fluid is formed, which rotates with high speed and simultaneously with the pump (or turbine) wheel (indicated by an arrow in Fig. 11.2 a).

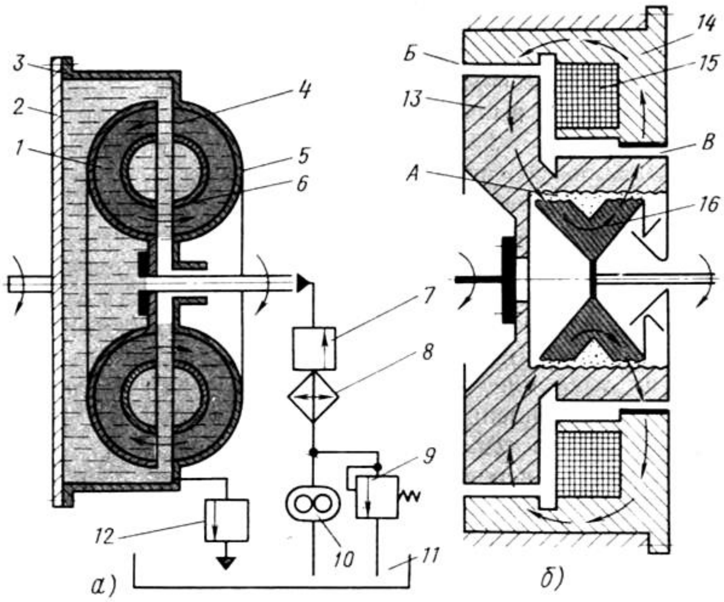


Figure 11.2 . a - hydraulic, b - electromagnetic powder clutch circuits

The fluid pump takes energy from the blades of the wheel, transfers it to the turbine wheel, and exerts a force on its blades, transmitting torque to this wheel. The faster the pump wheel rotates, the more torque the hydraulic clutch can transmit. During the rotation of the winged wheels, it is necessary to drain the fluid from the hydraulic clutch in order to fully engage it. For this, an advance valve 12, a tank 11, a supply pump 10 with a storage valve 9, a filling valve 7, and sometimes a radiator 8 are needed to cool the liquid. Due to this, the start and stop time of the hydraulic clutch will be longer.

The rotation frequency of the turbine wheel can be increased compared to the rotation frequency of the pump wheel, for example, when moving downhill. In it, the direction of rotational movement of the liquid changes to the opposite. The torque is transmitted from the turbine wheel to the pump wheel, thereby achieving braking with the daigatel.[18]

The electromagnetic powder clutch has 3 main parts: a drive winding 15 with a fixed body 14 (Fig. 11.2 b), a leading part 13 connected to the engine crankshaft, a guide that transmits torque to the leading shaft of the gearbox part 16.

When an electric current passes through the winding, a closed magnetic field is formed around it passing through the slots A, B and V (shown by the arrow). The interaction of details through the magnetic flux passing through the slits is very small, but if it is filled with a special iron powder, the interaction increases

---

[18] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.

Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

many times. With this powder, the gap A between the leading and driven parts of the coupling is filled. When a magnetic current passes through the powder, its particles are arranged along the lines of magnetic force, connecting the leading and leading parts, forming a "solid bond". When the electromagnet is turned off, the powder regains mobility and the engagement clutch is disengaged.

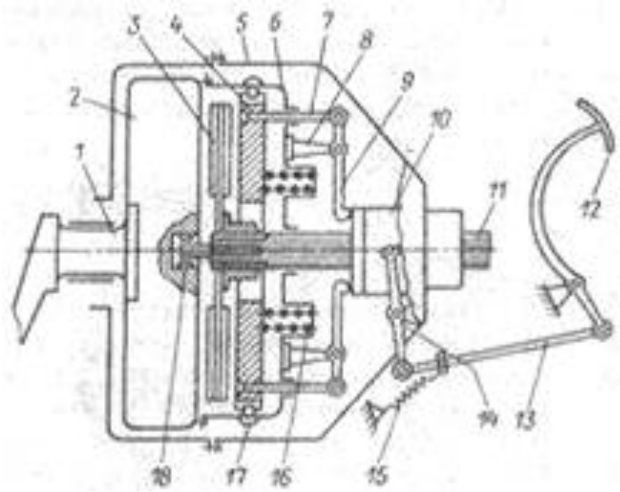
Automatic and semi-automatic clutches provide automatic control of start-up and disengagement. In semi-automatic clutches, the signal for starting and disconnecting is given when the driver pushes the lever for changing the number of transmissions or when a special button is pressed. In automatic clutches, the signal comes from the automatic clutch control system.

4. Design of friction clutch and its operation

Form, structure, operation and application of single disc friction clutch. Today's modern cars mainly use a friction clutch, which transmits the torque from the engine to the gearbox using frictional leading and driven discs. The working method of the friction clutch is based on the use of frictional forces.

Friction-type single-disc clutch is used in light and medium-duty vehicles (Fig. 11.3).

The clutch consists of a separation mechanism and a guide. The clutch is attached to the engine flywheel 2, and the main parts mounted on the car body or frame are the driving disc 3, which is mounted on the slot of the leading shaft in the gearbox, and the drive disc 16 with a spring, which is located in the case 5, in which the flywheel is tightly sealed. 4. The clutch case 12 hinged spacers 9 with a supported compression disc 4 are installed. The end of the drive shaft of the extension is mounted on the socket 16 in the flywheel, the transmission clutch is surrounded by the crankcase 5. The crankcase is mounted on the engine crankcase.



11.3 . Single disc clutch.

The separation mechanism consists of a compression separation bearing 10, a return spring 15, a fork (plug) 14, a puller 13, and a pedal 12. When the clutch pedal 12 is released, the drive disk 3 is constantly pressed by the pistons 16 between the flywheel and the compression disk. Such a state is called a connected state, when the engine is running, the torque on the crankshaft flywheel is transmitted from the compression disc 4 to the driving disc 3 due to the friction force and torque, and then to the drive shaft 11 of the gearbox.

If the clutch pedal 12 is pressed, the lever 13 moves and twists the fork 14 relative to its fixed position. The free second end of the fork pushes the pulley 10 towards the flywheel, and the bearing 10 presses the levers 9, and the levers push the compression disk 4 to ten. At this time, the drive disc 3 is freed from the force of the compression spring 16 and is separated from the flywheel, and the torque in the engine does not transfer to the drive shaft of the gearbox. To add traction, pedal 12 should be gently released.

Form structure, operation and application of double disc friction clutch. In MAZ, KrAZ, KamAZ cars with an engine torque value higher than 700-800 N·m in heavy-duty trucks, a two-disc friction clutch is used (Fig. 11.4).

The clutch is mounted on the housing 6, and the driving part includes a flywheel double-space disk 23, a compression disk 21 and a housing 6. The drive parts of the clutch include the drive disc 22 and 24. The spline of the driven discs is installed in the spline of the primary shaft of the gearbox. Compression springs 16 are installed between the casing 6 and the compression disc 21, and as a result of their influence, the driving discs 22 and 24 are compressed between the compression disc 21 and the flywheel. is separated from, as a result, a 3,2- 4,0 mmpull is formed between them, and due to this, the complete joining process of the splicing coupling is formed.

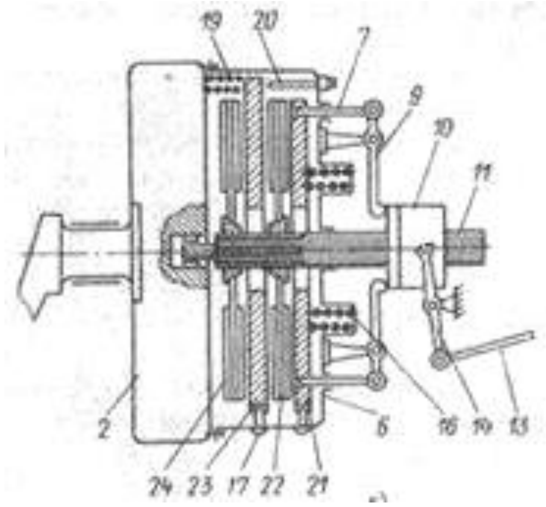


Figure 11.4 Double disc clutch

When the clutch is disengaged, the disengagement clutch bearing 10 is pressed into the bottom of the disengagement arms 9, and they rotate on their supports, changing their position. At the same time, the upper part of the separating arms 9 pulls the compression disc 21 back from the leading disc. In this case, the intermediate driving disc 23, under the influence of the lever mechanism installed on it, occupied a free position on the compression disc 21 and flywheel 2, and released the front driving disc.

The shape, structure, operation and application of hydraulic coupling. The hydraulic coupling is based on the use of the kinetic energy of the fluid, which generates hydrodynamic forces. It is composed of leading and driven parts. A hydraulic clutch includes a fluid-filled guide casing 2 and an associated pump wheel (Figure 11.5)

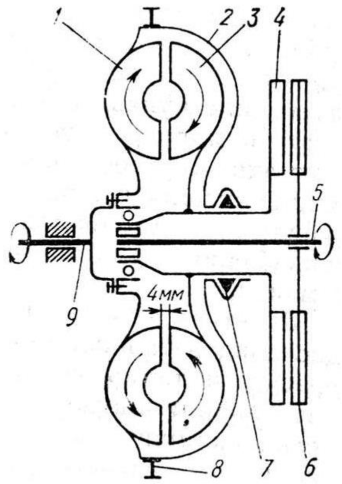


Figure 11.5 . Hydraulic coupling scheme.
1. Pump, 2. Hydraulic clutch base, 3. Pipe wheel, 4. Friction clutch guide disc, 5. Gearbox primary shaft, 6. Friction clutch guide disc, 7. Seal, 8. Gear for driving with engine starter flange, 9-engine crankshaft.

The turbine wheel 3 enters the driven part and joins the engagement point with the leading disk 4. The pump wheel is connected to the crankshaft 9 of the combined engine, and the turbine wheel is connected to the primary shaft 5 of the gearbox.

The primary shaft 5 with the turbine wheel 3 is mounted on bearings in the casing of the pump wheel. A seal 7 is installed between the hydraulic clutch housing and the guide disk hub . The drive disc of the engagement clutch is installed in the slot at the end of the primary shaft 5. To start the engine with the starter, a threaded flange 8 is installed in the clutch housing 2.

When the crankshaft of the engine rotates, the fluid between the blades of the pump wheel 1 moves, under the influence of centrifugal forces, it is ejected from the pump blades in a circle and hits the opposite turbine blades 3. When the liquid is moved by friction on the blades, the frictional force is created and rotates the blades. As a result, a torque is generated on the primary shaft 5. Due to the circular motion of the liquid between the blades, the torque is transferred from the leading part of the hydraulic coupling to the driven part. The advantage of the hydraulic clutch is that it dampens twisting vibrations, improving the car's smooth start and smoothness. But the fuel consumption is high, the structure is complicated and the weight is big.

Hydraulic couplings of this type are installed on light "Chayka" heavy-duty BelAZ vehicles and other types of vehicles.

The function and structure of the screw vibration damper. When the engine is transmitting torque from the crankshaft to the clutch or when engaging the clutch, torque vibrations and impulses occur, especially when the power is suddenly released from its pedal. The gears, hinges and cardan shafts of this power transmission were driven by impulse. As a result, it causes them to quickly spread or break. In order to eliminate these defects, holes are opened in the core of the driving disk of the clutch, and a spring (damper) that dampens torsional vibrations is poured into them. Slightly compressed cylindrical damping springs are placed on the windows, and when the clutch is connected, the torque on the splined shaft is transmitted from the drive disk through the damper spring. Then, due to the compression of the springs, the driven disc turns to a certain angle relative to its hub, reducing the amplitude of torsional vibrations and softening them to the power transmission parts under the influence of thrust and vibration. As a result, the spread of power transmission parts is reduced and the service life is increased.[19]

5. Clutch guides.

Mechanical and hydromechanical methods of clutch control . Clutch control mechanisms are divided into mechanical hydraulic or hydromechanical types. Many heavy duty trucks use power steering.

The mechanical clutch (Fig. 11.6, a) consists of a pedal return spring 2, a lever of the pedal shaft 6, a release lever of the operating clutch 5, a plug lever 3, a release plug 7 and a release podipard. This type of drive is installed on the ZIL 130 truck.

When the pedal is pressed, power is transmitted to the pedal from the shaft through the separation plug 7, the lever 5, the fork lever 3, and the separation plug is transmitted to the power separation clutch. The separation clutch pushes the ends of the separation arms through a ball bearing. As a result, the other ends of the levers pull the compression guide disc back, releasing the guide disc and the operating clutch disengages.

When the pedal is released, the separation clutch is retracted by the tension spring. As a result, the force acting on the end of the separating levers is lost, and the compressible guide disk is pushed towards the flywheel by the action of the springs, compressing the drive disk, and the working clutch is engaged, the torque is transmitted through the guide disk to the drive shaft of its gearbox starts

[19] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

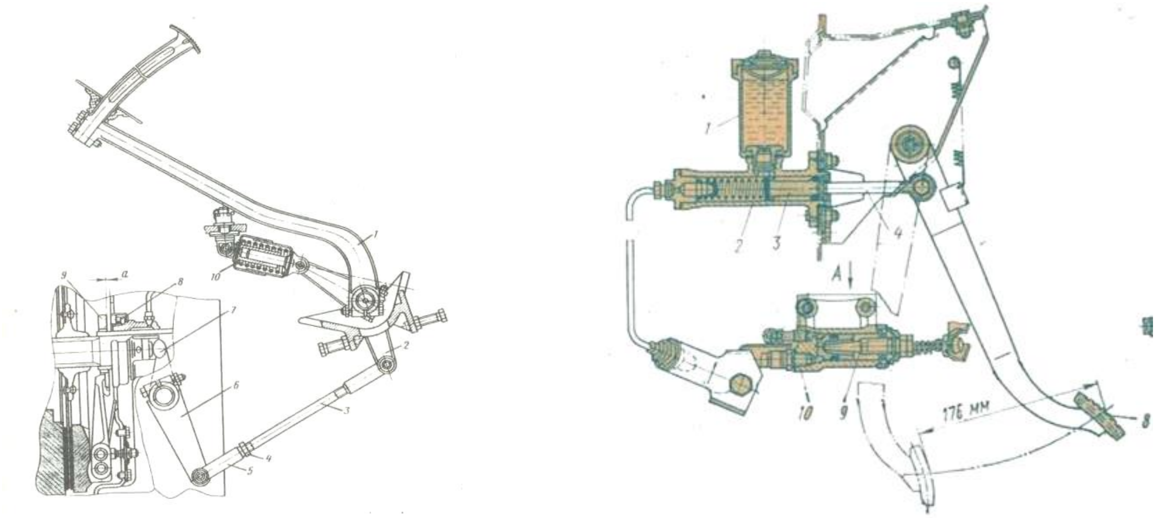


Fig. 11.6 - control procedures of the clutch.
a- mechanical control procedure; b-hydromechanical control system;

The clutch with hydromechanical operation (Fig. 11.6 b) is mainly installed on passenger cars (GAZ 24, VAZ, Moskvich, Tiko, Damas, Nexia and GAZ 53A, UzOtoyol).

When the pedal is pressed, the pusher pushes the piston 4 in the two main cylinders 3 to the left, so that the cylinder hole B is closed, and the fluid in the tube 11 and the working cylinder 10 is compressed. As a result, under the influence of fluid pressure, the piston 7 in the working cylinder activates the plug 9 through the pin 8.

When the pedal is released, the separation plug returns to its place under the influence of the piston 12 and the moving parts come into place, and the torque begins to be transmitted to the leading shaft of the gearbox through the guide disk. At this time, the liquid that flows from tank 5 to the back of the piston through the return hole A of the cylinder limits the occurrence of rarefaction in the network.

Control questions.

1. Explain the function, types, structure of the transmission?
2. Explain the function, types, structure of the coupling?
3. Explain the structure of mechanical clutch?
4. Explain the structure of hydraulically actuated clutch?
5. Explain the working of friction disc clutch?

Topic 12: Transmission box and distribution box.

Plan.

1. Function of gearbox, types (step, two and three shafts).
2. Construction and operation of the gearbox.
3. Structure and operation of hydrotransformer.
4. Function, structure and operation of synchronizers.
5. Function, structure, types of distribution box.
6. Construction and operation of the distribution box.

6. Functions and operation of fasteners, locks.

Basic words and phrases: Function, types of gearbox (step, two and three shaft), construction and operation of gearbox, structure and operation of hydrotransformer, function, structure and operation of synchronizers. function, structure, types of distribution box, construction and working process of distribution box, function and operation of latch, locks.

1. The function of the gearbox, types (step, two and three shafts)

Transmission box . The gearbox is used to change the torque and speed of the driving wheels of the car, to change their direction when necessary, and to isolate the crankshaft of the idle engine for a long time without power transmission when the car is stationary or moving with inertia. performs the function of putting.

2. Construction and operation of the gearbox.

The structure and mode of operation of a step-by-step manual transmission. In cars, a gear box with a gear mechanism is mainly used. In such a gearbox, several pairs of gears with different gear ratios are used to ensure different speeds and accelerations of the vehicle in different road conditions. The transmission used in passenger cars has three, four, or five gears, and in trucks it can have four, five, sometimes eight or even more. The more gears the transmission has, the more easily the car can adapt to different road conditions, which improves the efficient use of engine power and reduces fuel consumption.

3. Structure and operation of hydrotransformer.

The structure and operation of the stepless gearbox. The use of such a gearbox changes the torque on the leading wheels of the car, automatically providing the number of optional gears depending on the road conditions within a limited range. Stepless gearboxes are divided into mechanical (impulse, frictional and other), hydraulic (hydrodynamic, hydrovolume), electric and mixed types, depending on the method of operation. Until now, a mixed, that is, a hydromechanical gearbox has been widely used, which consists of two parts, namely a stepless hydrodynamic transmission (hydrotransformer) and a step mechanical gearbox connected to it in series.

A hydrotransformer is a hydraulic mechanism that changes motion under the influence of fluid, and it is located between the engine and the step-by-step manual transmission. The hydrotransformer is similar to the hydrocoupling in its structure and operation and is made up of wheels. The difference between the hydrotransformer and the hydrocoupling is that, in addition to the leading pump and driven (turbine) wheels, it also has a third fixed impeller wheel (receiver of reactive torque) - a reactor. The reactor, in turn, is mounted on a fixed bushing through a freewheel coupling. The freewheel clutch rotates the reactor in one direction only (the direction of rotation of the pump wheel). The reverse rotation is not allowed by the sticking of the coupling. Thus, a wheel-pump connected to a leading shaft and an engine, a wheel-turbine connected to a driven shaft, and a fixed wheel with water-distributing blades are called reactors.[20]

The construction of the transmission box. Four-speed gearbox. Most modern passenger cars are equipped with four- and five-speed, three-shaft transmissions. For example, the GAZ-24 "Volga" has four gears for forward movement and one for reverse. Such a gearbox is called a three-way, because two synchronizers and one driving back drive are brought down to the gears through a gear. In the case of the gearbox there are three shafts: drive (primary), driven (secondary) and intermediate shafts, as well as the axis of the reverse gear. The two ends of the drive shaft rest on two ball bearings, the front end of which rests in the bearing located in the groove on the crankshaft flange, and the trailing end rests in the bearing located in the front wall of the gearbox housing. The primary shaft is integrally machined with a bevel gear, which is constantly in mesh with the leading gear of the gear block on the intermediate shaft. A toothed flange is machined on the back of the primary shaft gear to engage the correct gear . The primary shaft ball bearing is bolted to the side cover. The intermediate shaft is a block of gears consisting of four bevel gears and one spur gear and has three splines on its axis (the first is in the front part of the axle, and the second and third are located in series in its rear part) mounted on bearings. A disc detent at the rear end of the axle prevents it from twisting on its axis. The drive shaft also rests on two longitudinal supports, the front end of which is inserted into the groove from the rear side of the primary shaft, and the trailing end is mounted on a ball bearing placed on the wall of the gearbox housing. The splined parts of the drive shaft are equipped with synchronizer clutches used to connect the first, second, third and fourth gears. On the splined necks of the shaft, the bevel gears, which are constantly meshed with the intermediate shaft gears, are placed in the bushing so that they can rotate freely around their axis. All gears designed to move the car forward, i.e. I, II, III and IV gears, are made with the help of synchronizers, and the reverse gear is made with a gear wheel (Fig. 12.1).

The main difference of the gearbox in VAZ-2108, Nexia, Tiko cars is that the number of shafts is not three, but two - leading and driven. At the right end of the drive shaft there is a cylindrical gear that is integral with it. It constantly meshes with a gear wheel mounted on the half-cup of the differential case, and this mechanism serves as the main gear on the front drive axle.

---

[20] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

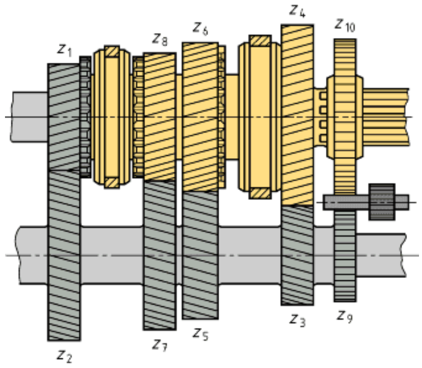
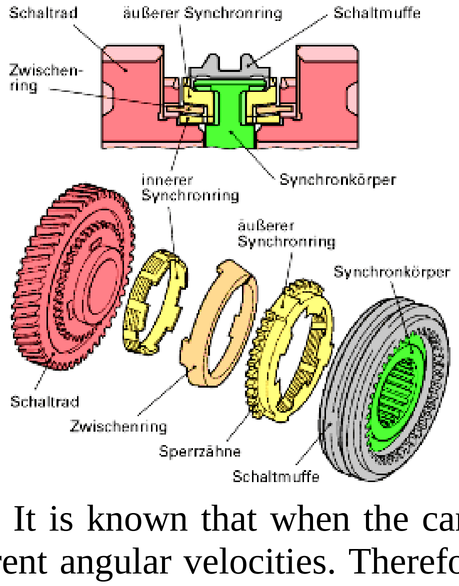


Figure 12.1 . Illustrative drawing of the gearbox.
1 primary shaft, 2nd-14th primary and intermediate shafts always meshing gears, 3rd gear clutch, 4th and 7th forks, 5-13th always meshing 2 transmission gears, 6-12th first transmission gears, 9- 11-reverse drive gears, 8- secondary shaft, 10-reverse drive gear axle, 15-intermediate shaft, 16- crankcase.

The drive shaft gears are fixedly mounted on the shaft and are permanently meshed with the driven shaft gears. Because these gears are mounted on the shaft parts so that they can rotate freely. The process of torque transmission through these gears is carried out by means of synchronizers that are splined to the secondary shaft. To connect the reverse gear, the toothed flange of the gear and the synchronizer clutch is meshed with the intermediate gear wheel .

4. Function, structure and operation of synchronizers.

Structure and operation of synchronizers. The use of synchronizers in the gearbox makes it easier to control the car and increases the service life of the gears that are connected to the gears (Fig. 12.2).



1 2 .2. The structure of the synchronizer

It is known that when the car is moving, the gears in the gearbox rotate at different angular velocities. Therefore, when they are added, the teeth of the gear wheels collide with each other and spread faster. In addition, the percussive beating of the teeth of the chestnuts makes a noise. In order to eliminate these shortcomings, it is necessary to equalize their angular velocities. This task is performed by the synchronizer. Inertial synchronizers are used in cars. Such synchronizers allow full meshing when the angular velocities of the connecting gears are equal. Conical rings are installed on both sides of the synchronizer ball, and their inner surfaces are made in the shape of a cone. These rings are connected to each other by means of three fingers passed through the hole of the synchronizer clutch, in the middle of which a conical bifurcating surface is made. Mating surfaces are also made in the hole of the disk in the hub of the synchronizer clutch, which is installed in the slots on the drive shafts through the hub, and this disk has the ability to move along the axis. The disk and rings of the synchronizer clutch ball are connected to each other by means of three hollow registration fingers. Balls and springs are installed in the hollow of each finger. A support is inserted into the ring, which ensures that the balls are fixed. Synchronizer gears have conical surface lines, just like gears.

For example, when the clutch of synchronizers is pushed to the left, the conical ring slides with the clutch and does not scratch the conical surface of the pinion. But at this moment, due to the difference in angular speeds of the clutch and the pinion, the connecting fingers together with the ring turn relative to the clutch and are pressed into its holes. As a result, the clutch gets stuck to the connecting grooves of the fingers , that is, it gets stuck, and in this way, it cannot move further towards the connecting gear, even if excessive effort is spent on its movement. But together with the force generated in this way, the force exerted by the driver to push the clutch begins to press the ring further into the conical surface of the gear. As a result, the engagement between them increases, and the angular velocities of the connecting gear and the coupling are equalized. In this case, the tension of the clutch fingers in the holes of the disc decreases, allowing the clutch to slide freely against the fingers, and its toothed flange meshes with the internal small teeth of the gear without noise (Fig. 1 2.2).

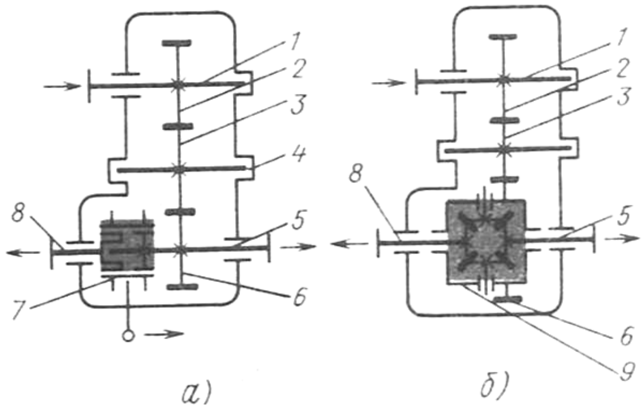
5. Function, structure, types of distribution box.

Task and main types. The distribution box serves to distribute the torque coming from the gearbox directly or by increasing its value to the leading axles.

A transfer case is not necessary if a single lead bridge is used, or if the lead bridges lie on the same side of the gearbox. If the front and rear axles are leading, but the gearbox drive shaft is not aligned with the leading shaft, but is located below and has flanges on both sides, a transfer case is not necessary. In this case, the function of the distribution box is performed by the gearbox.

6. Construction and operation of the distribution box.

A typical distribution box (Fig. 12.3) consists of leading 1, intermediate 4 and driven 5 shafts, front axle driving shaft 8, gear wheels 2, 3, 6 and front axle connecting gear 7. The torque is transmitted from the gearbox to the leading shaft 1. Val 5 car leading rear axle is always connected with the main gear. Adding the front axle drive, the shafts 8 and 5 are connected by means of a mutual gear coupling 7 and rotate with the same angular speeds. When cornering, the front steered wheels have more clearance and must turn faster than the rear steered wheels. Therefore, when shafts 5 and 8 are connected together, the wheels slide relative to the road, resulting in increased fuel consumption and strain on transmission components. To eliminate such negative situations, the front axle is disconnected when driving on hard surfaced roads and added on heavy sections.



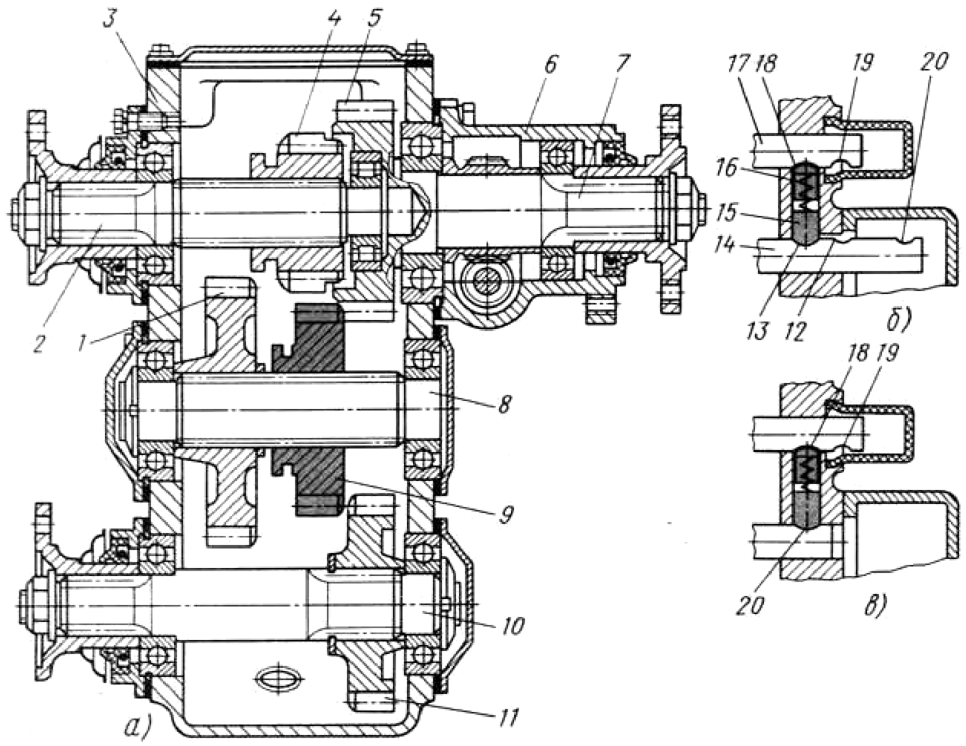
12. Figure 3 . Schemes of distribution boxes:
with α-blocked conduction; with β-differential processing.

The listed negative situations can be eliminated by using an inter-axle differential in the distribution box (Fig. 1 2.3 b). They allow 5 and 8 shafts to rotate at different frequencies.

Construction of distribution boxes. Blocked distribution box with front and rear axle drives is shown in Fig. 1 2.4. Transfer case 3 is fixed to the cross member of the car frame. The leading shaft 2, the rear bridge guide shaft 7, the intermediate shaft 8, and the front bridge guide shaft 10 are installed in the crankcase housings on ball bearings. In addition, the radial roller bearing located in the housing of the rear axle guide shaft 7 acts as a support for the leading shaft, and the ball bearing located in the cover 6 serves as a support for the shaft 7. Transfer case gears are spur gears.

When gear 4 is pushed to the extreme right position and its teeth mesh with the internal flange of gear 5, the second direct gear of the distribution box is added. The torque is transmitted from shaft 2 directly to shaft 7, and from there to the rear leading axle of the car.

To add the front bridge, the gear 9 is pushed to the right and meshed with the wheel 11. In this case, the torque is transmitted to the front axle drive shaft 10 from the leading shaft 2 through gears 4, 5, 9 and 11.



1 2 . Figure 4 . Distribution box of the GAZ-66 car: a-construction; b-the state of the lock details in the correct transmission; The position of the v-lock details in the reduction gear

To add the first-reduction gear, the gear 4 is pushed to the extreme right position and meshes with the wheel 1. Torque is transmitted from the leading shaft through gear 4 to wheel 1, to shaft 8, and through gear 9 to wheels 5 and 4 and to shafts 7 and 10, respectively.

The gear shift mechanism of the transfer case has a locking device-lock. The lock prevents engagement of first gear when the front axle gear is disengaged, and disengagement of the gear when first gear is engaged. Such a lock protects the drive wheels of the car's rear leading bridge from heavy loads. The lock crankcase channel has two screws 15 and 16 located between the bolts 14 and 17. Under the influence of the return spring, the chips enter the pits of the polzuns. Polzun 14 has three pits. In the neutral position of Шesternya 4, the sukhar 15 enters the middle pit 12, and when the straight and reducing gears are added, it enters the pit 13 and 20, respectively. Between pits 12 and 13, ditches were made in the soil. Two pits are made in the front bridge addition belt 17: 18, which is deeper for adding the front bridge, and 19 for separating the front bridge. In the case of Polzuns , shown in Fig. 12.4, b, the second - straight gear and the front bridge are added, and in the case of Fig. 12.4, c, the reducing gear and the front bridge are added. In the second case, it is not possible to add a front bridge, because the slot between the locks is less than 18 deep.

When the front bridge passage is separated, it is possible to move the sukhar 15 from the pit 12 along the grooves in the polzun 14 only to the pit 13.

The control mechanism of the distribution box has two levers: a gear change lever connected to a lever 14, a lever for adding a front axle connected to a lever 17. Since the angular velocities of gears 9 and 11 are the same, the front axle can be added without disassembling the clutch.

Distribution box with differential drive (with inter-axle differential) to front and rear axles 12 . Figure 5 shows. The torque comes from the gearbox to the leading shaft 2. On the drive shaft, the lower transmission gear 5 and the upper transmission gear 3, which are in constant engagement with the corresponding wheels of the intermediate shaft 6, are freely mounted. The intermediate shaft upper transmission wheel is also in constant contact with the wheel 12 mounted on the differential case. Satellites 9 rotating on axis 10 mesh with differential gears 8 and 11. The bevel gear 11 of the differential is mounted on the front axle drive shaft 14, and the other bevel gear 8 is mounted on the rear axle drive shaft 7. The differential is locked with clutch 3, and the upper and lower gears are engaged with clutch 4.

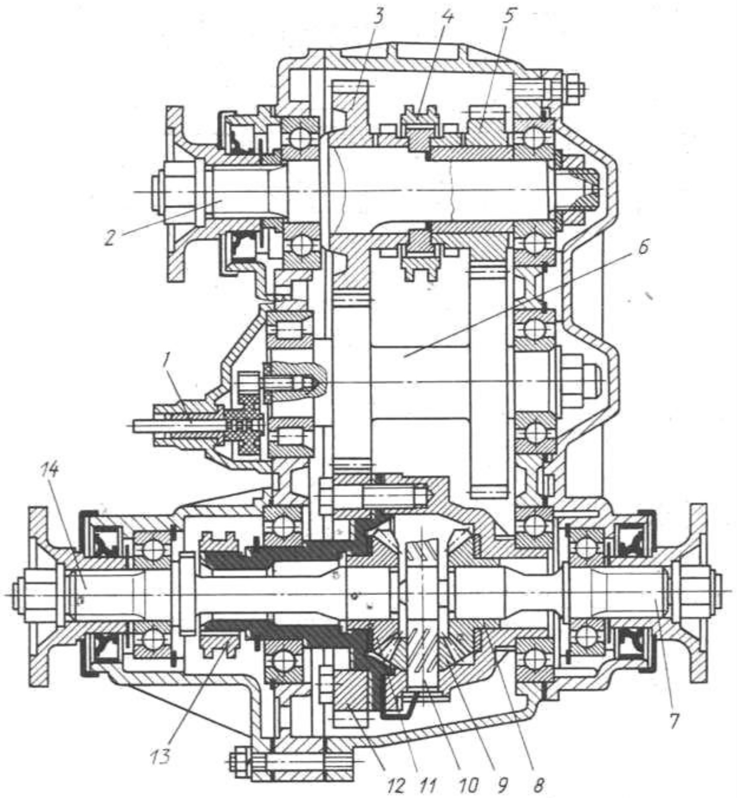


Figure 12.5. Distribution box of the VAZ-2121 "Niva" car: 1-speedometer drive; 2nd drive shaft; 3rd high transmission gear; 4-gear coupling; 5th lower transmission gear; 6th intermediate shaft; 7-rear axle drive shaft; 8th and 11th differential gears;
9th differential satellite; 10-satellite axis; 12th differential case gear wheel; 13-differential locking clutch; 14-front axle drive shaft.

Control questions.

1. What are the functions and types of gearboxes (stepped, two- and three-shaft)?

2. What is the construction and working process of gearbox and explain it?

3. How is the structure and operation of the hydrotransformer implemented?

4. Explain the function, structure and operation of synchronizers?

5. Tell the function, structure, types of distribution box?

6. How is the construction and operation of the distribution box?

6. Explain the functions and working process and construction of latch, locks?

Topic 13: Cardan transmission .

Plan.

1. Function, types, general structure of cardan transmission.
2. Cardan joints with uniform and non-uniform angular velocities.
3. Operation process of cardan transmission structure.
4. Spliced connection of cardan transmission.

Basic words and phrases: Cardan transmission function, types, general structure, cardan joints with the same and non-uniform angular velocities, operation process of cardan transmission construction. splined joint of cardan transmission.

1. Function, types, general structure of cardan transmission.

Cardan shafts transfer torque from one unit of the power transmission to another unit using shafts that are misaligned and can change their position. The cardan transmission installed in the power transmission of the car must transmit the torque from the engine through the gearbox to one leading bridge with the help of a distribution box to several bridges.

When the car drives on uneven roads, the leading bridge oscillates in a vertical plane relative to the frame, and the transmission angle changes. Therefore, a cardan transmission is used to transmit the torque from the gearbox (or distribution box) to the leading bridge at a variable angle. Cardan hinges are used for mutual transmission of torque from shafts whose axes are misaligned relative to each other. To reduce the risk of kicking and torsional vibrations, most modern cars use a cardan transmission consisting of a cardan joint and two shafts and an intermediate support. It has a splined joint that allows extension and contraction of the transmission.

2. Cardan joints with the same and non-uniform angular velocities .

There are two types of cardan joints used in automobiles: universal joints and non-uniform angular velocities. Cardan joints with unequal angular velocities, in turn, can be elastic (elastic) and bikr (cross-shaped) (Fig. 13.1).

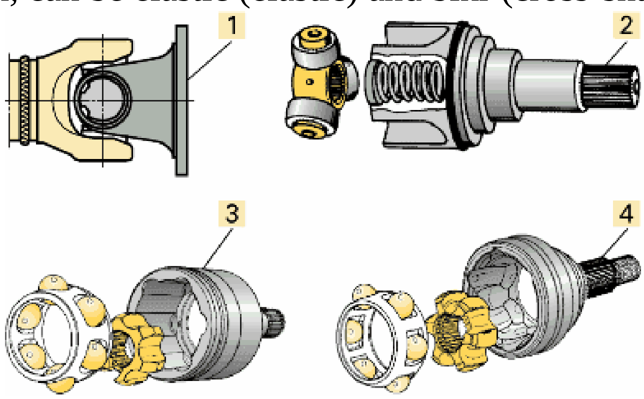
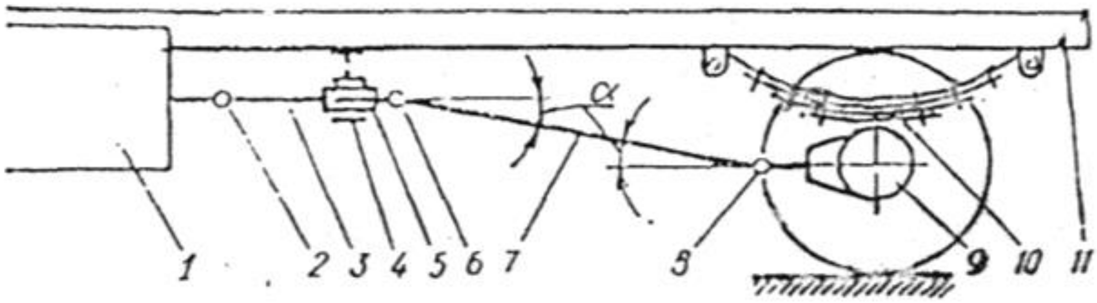


Figure 13.1 . Construction of cardan transmission

Cars use one- or two-shaft cardan transmissions with joints with unequal angular velocities to transmit torque from the gearbox to the main gear of the leading axle. If the car is equipped with a single cardan transmission, the plug attached to the front of the cardan, one plug of the cardan joint, and the secondary plug of the gearbox are welded to the splined triple. The splined triple is inserted into the splined bushing of the cardan and forms a joint that moves along the axis. A bushing with a slot is welded to the front part of the cardan shaft, and the end of the shaft is welded to the front part of the cardan shaft, and the end of the shaft is welded to the plug of this cardan joint (Fig. 1 3.2). The rubber casing protects the threaded joint from dirt particles from the outside environment.



1 3 .2. Cardan transmission scheme of the car.
1-transmission box, 2-cardan joint, 3-cardan shaft, 4-intermediate shaft,
5-split joint, 6-cardan joint, 7-cardan shaft, 8-cardan joint,
9-leading bridge, 10-spring, 11-frame.

The Weis type universal joint with the same angular speed is used in ZIL-131, GAZ-66, UAZ-469 cars with a leading front axle. (Figure 13.3). Shaft 1 (short half-axle) is made integrally with a guide fork, and a wheel hub is mounted on the splined end. The long semi-axle 5 is made integrally with the leading plug, and the inner splined end is connected with the semi-axle pinion in the differential box with a splined key. The forks are mated with each other using four guide balls 3 with grooves 2 and 4. In order to centrally connect the plugs with each other, the central ball 6 is tightly placed on the ground of the pin 7 in the spherical recesses at their ends. When the car turns, the torque in the forks is transmitted through only two balls, that is, one of the balls in each fork. Separating wedges have such a shape that the two leading spheres, regardless of the angle of each fork, always lie on the bisector between the axes of forks 1 and 5. Therefore, the forks rotate at the same angular speed. If the steering wheels of passenger cars are leading, their drive is equipped with a cardan transmission consisting of two cardan hinges and a shaft with a ball structure with the same angular velocities.[21]

[21] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

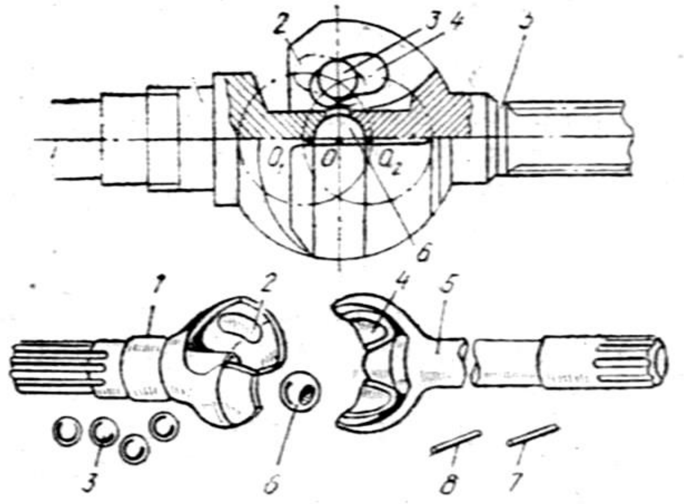
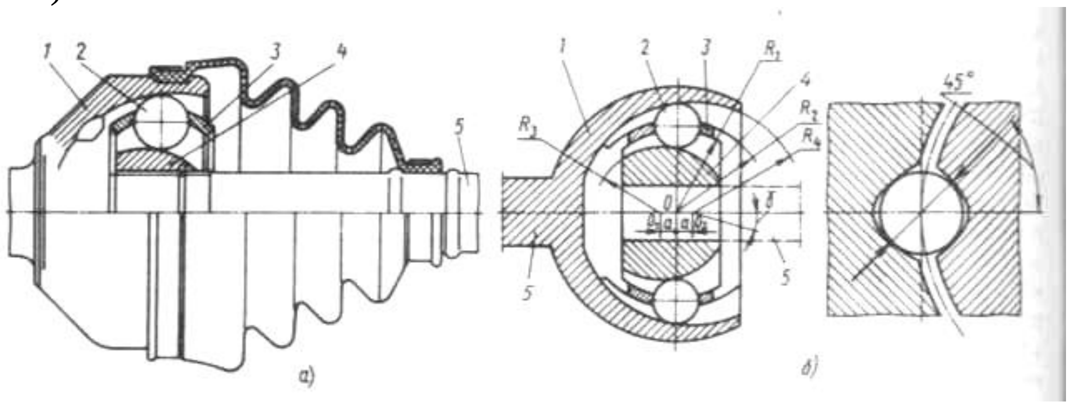


Fig. 1 3 .3 . With the same angular velocity
ball joint:
1 and 5 – semi- axes ; 2 and 4th bee calls; 3- leading spheres; 6- central sphere; 7 and 8 - stud;

Bifield six-ball cardan joint is used in Matiz, Tiko, Nexia, VAZ-2108, Moskvich 2141 front-wheel drive cars.

In punch 4 (see Fig. 1 3 .4), six grooves of radius R_1 (center 0) are assembled with a spherical surface. The grooves in the fist have a variable depth due to the fact that they are piled at a radius of R_3 (the center O_1 *is moved to the center* O by a distance a).



1 3 .4. (Birfield Type) Hex Ball Joint:
a – construction; b – scheme;
1st corps; 2 partners; 3-separator; 4th fist; 5th shaft.

The inner surface of the body 1 is in the form of a sphere with a radius of R_2 (the center is " O "), *and six grooves are piled in it at a variable depth* with a radius of R_4 *(the center of* O_2 is moved to the center O of the hinge by a distance " *a* "). Balls 2 are located in the separator 3 and have spherical surfaces with an inner radius of R_1 and an outer radius of R_2 . When the axles of the hinge lie in one line, the balls are placed in a plane perpendicular to the axis of the shafts from the center of the hinge.

4. Spliced connection of cardan transmission.

If a single cardan transmission is installed on the car (Fig. 13.5 a), the plug 1 attached to the front of the cardan and one plug of the cardan joint 2 is welded to the secondary plug of the gearbox with a splined triple 5. The splined bushing of the splined triple cardan is inserted into 4, and a joint that moves along the axis is formed. The slotted bushing is welded to the front part of the cardan shaft 8, and the end of the shaft is welded to the front part of the cardan shaft, and the end of the shaft is welded to the plug 9 of this cardan joint. A case made of rubber protects the 7-slot joint from dirty particles from the outside environment. For regular lubrication of this joint, the oil stored in the tank 3 is introduced, and the cuff 6 is designed so that it does not flow into the cardan tube. This type of cardan transmission is installed on MAZ cars. In cases where the distance between the transmission box and the main transmission is large, a cardan transmission with an oar support is used. This reduces the daily crushing of the shafts under the influence of centrifugal force and leads to a reduction of torsional vibrations.

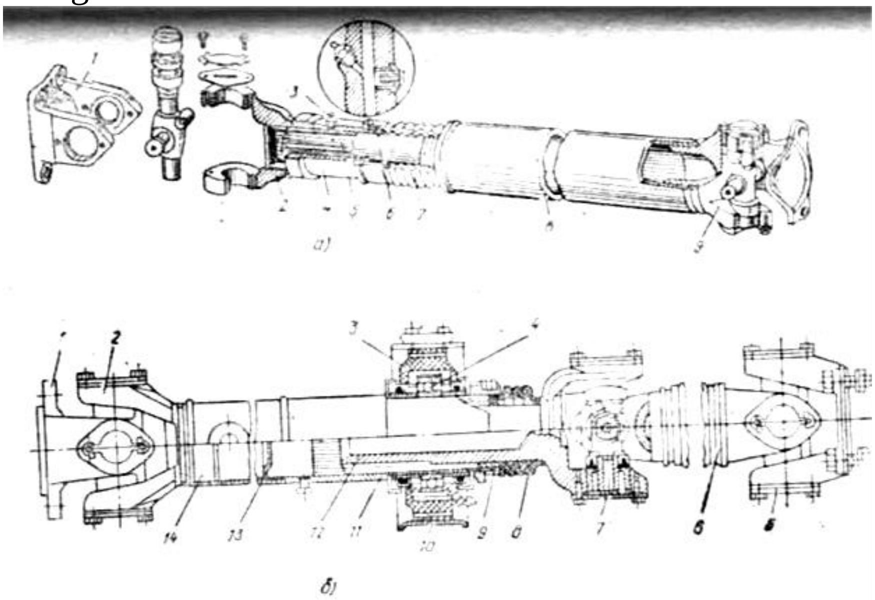


Figure 13.5. Cardan transmission of cars:
a- one shaft; 1 and 2- plugs; 3- square; 4- slotted bushing; 5- slot; 6- cuff; 7-rubber case; 8- cardan shaft; Plug of the 9th hinge.
b- two shafts: 1-flanets; 2, 7 and 5 cardan hinges; 3-rubber pad; 4- ball bearing; 6 and 14 shafts; 8- sheath; 9- cuff; 10th intermediate support; Bushing with 11-slot; 12-slot; 13 - plug.

In this type of cardan transmission, if the cardan joint is attached to both sides of the shaft, such a cardan transmission is called a double-sided transmission. In the example, we will get acquainted with the construction of this type of cardan transmission used in the ZIL-130 car. It consists of two shafts, an intermediate shaft 14 and a drive shaft 6, as well as three shaft joints 2, 7 and 5, as well as an intermediate support 10. The intermediate support of the cardan transmission consists of a ball bearing 4 placed on a rubber pad 3 with a metal body .

3. Operation process of cardan transmission structure

The shafts of the cardan transmission are made of 14 and 6 thin-walled steel tubes. Two plugs 2 and 7 are welded to the ends of the intermediate cardan shaft, forming a cardan joint. A sliding triple with a slot 12 is located inside a bushing 11 with a slot. This sliding spline joint stabilizes the position of the axle shaft by extending and shortening the propeller shaft. The plug 2 at the front end of the intermediate shaft 14 is hingedly connected to the plug connected to the flange 1 on the secondary shaft of the gearbox . The part of the shaft is transferred to the ball bearing 4, which forms the intermediate support, and the ball bearing is mounted on the rubber pad 3 of the intermediate support 10, and all of them are fastened to the transversely located frame. The bearing is closed on both sides with flanged caps. In order to reduce wear of the slotted joint and to increase its service life, oil is filled into it under pressure. Plug 13 and cuff 9 are designed so that the oil in it does not leak out of the pipe . Also, the oil in the splined joint is protected from the environment by means of a rubber casing 8, which ensures that the oil is not contaminated. In passenger cars, the splined joint is often located in the extension of the gearbox, which is lubricated with oil in the crankcase. In order to ensure the rotation of the cardan extension without shaking, it must be balanced . Otherwise, the forces acting on the plug in the direction of the field will cause torsional vibrations. This condition causes quick rotation of cardan joints. For this reason, balancing plates are welded to the ends of the propeller shaft. Sometimes the balancing process is done by burning special plates under the cap of the universal joint bearing. In addition , the installation of the rubber pad 3 inside the support housing 10 of the external bearing partially suppresses the lateral vibrations generated in the cardan transmission .

Control questions.

1. Tell the function of cardan transmission?
2. Explain the types of cardan transmission, general structure?
3. Explain cardan joints with uniform and non-uniform angular velocities?
4. Tell me the working process of the cardan transmission structure?
5. How is the splined joint of the cardan transmission constructed?
6. Explain Weis type cardan transmission?
7. Explain elastic cardan transmission?

1 4 - Topic: Main transmission . D differential and semi-axes.

Plan.

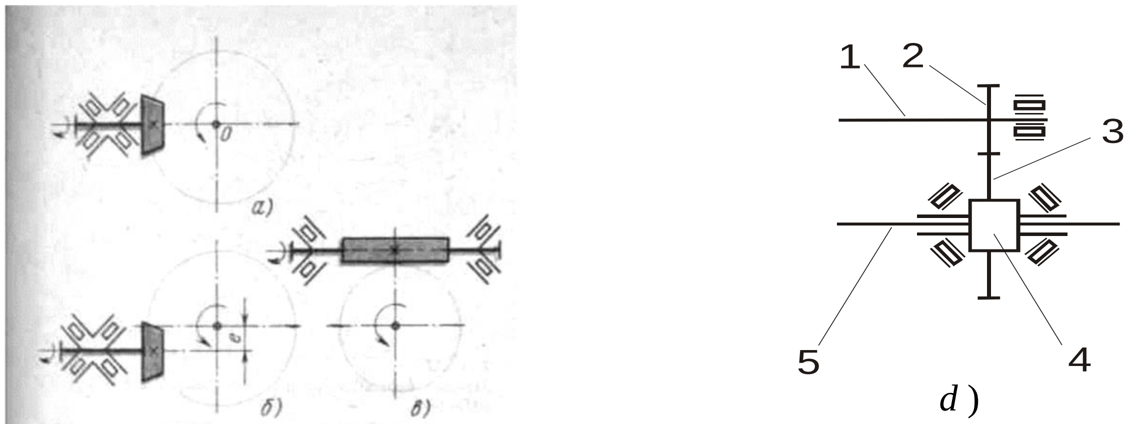
1. The function of the main transmission, types.
2. Difference and advantages of conical and hypoid main gear.
3. Main transmission design and structure and operation process.
4. Function, types, structure of differential and semi-axes.
5. The working process of the differential construction.
6. Types of semi-axes, installation, their scheme.
7. Function, types, structure of the running part of the car.

Basic words and phrases. Function, types of main gear, difference and advantages of bevel and hypoid main gear, construction and structure of main gear and operation process. function, types, structure of differential and semi-axles, working process of differential construction, types of semi-axles, installation, their scheme .

1. The function of the main transmission, types.

Function and types of main gear. In modern cars, engines of relatively small size and mass, which generate high power due to their speed, are used. However, the torque generated on the shafts of these engines (if this torque is directly transmitted to the leading wheels of the car without changing it) is not enough for the car to drive in different road conditions. It has been mentioned above that increasing the torque on the leading wheels of the car for moving is partially done with the help of a gearbox. However, the car moves in the correct gear with a relatively high speed during operation. Therefore, in a correct transmission, the torque on the engine shaft would be transmitted to the driving wheels without changing, i.e. not enough to drive the car. For this reason, to increase the torque on the leading wheels of the car (at the expense of reducing the frequency of revolutions) to the necessary amount, the main gear is introduced into the transmission.

The main transmission gears have a small diameter and a large diameter, so the frequency of revolutions of the semi-axes (depending on the number of gears *u) is less than the frequency of revolutions of the propeller shaft.* The lower the rotation frequency of the half-axles and the related leading wheels compared to the rotation frequency of the crankshaft, the more torque they have. Therefore, the increase of the torque on the leading wheels, compared to that of the cardan shaft, depends on the number of transmissions of the main gear (Fig. 14.1).[22]



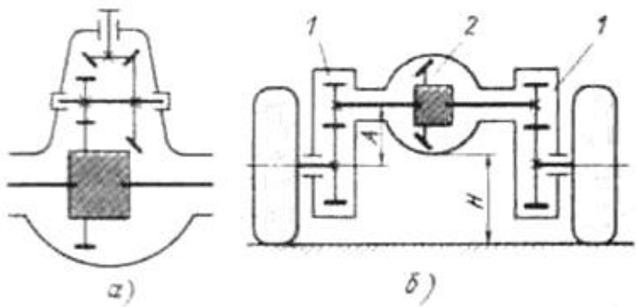
. 1 4 .1 Single main transmission scheme:

[22] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

a – conical; b – hypoid; v – wormy; g – cylindrical;
1 – drive shaft of the gearbox; 2 – cylindrical gear of the main transmission; 3 – cylindrical gear wheel of the main transmission; 4 – differential; 5 - drive shaft of the wheel

The number of transmissions of the main transmission mainly depends on the power and speed of the engine, as well as the mass of the car and the type of work it is intended for, it is 6.5...9.0 in trucks; and in passenger cars it is in the range of 3.5...5.5.

Main gears can be single or double, depending on the number of gears in the mesh.



1 4 . Figure 2. Types of double idler main gears:
a-integrated central transmission;
b-divided into two parts - split transmission;
1-cylinder wheel drive; 2-bevel center gear.

A single gear consists of one pair of gears, while a double gear consists of two pairs of gears. Single gears, in turn, can be cylindrical, conical, hypoid or worm. (Fig. 14.1) Double gears usually consist of a pair of conical and a pair of cylindrical gear wheels, which in turn are integrally located in the middle of the bridge - a central gear (Fig. 14.2, a) or two it can be divided into parts, isolated transmission (Fig. 14.2, b). Single transmissions are often used in light or medium-duty vehicles. Bevel or hypoid gears are used in cars with the engine in front and the drive axle in the rear. Cylindrical transmissions are used in passenger cars with front-wheel drive (Nexia, Tiko, VAZ-2108).

2. Difference and advantages of conical and hypoid main gear.

The specific characteristics of the operation of **the conical main gear** (Fig. 1 4.1 a,) is that it exerts large forces on three surfaces perpendicular to each other on the shaft supports. Under the influence of these forces, the shafts of the gear wheels tend to move along the axis. In addition, the support bearings of the leading gear wheels are located on one side of the shaft, which causes an uneven distribution of the forces acting on the teeth during the operation of the transmission, which causes the appearance of additional dynamic forces. For the long-term operation of the conical main gear, it is necessary that the starting cone ends (vershina) of the teeth are at the *0* point, and their operation must be accurate. The displacement of the starting cone tips accelerates wear and increases the noise of the transmission, which quickly deteriorates its working conditions. In order to ensure accurate engagement of gear wheels and therefore reliable operation, their bearings are pre-tightened and the integrity of the crankcase is increased. In addition, in the conical or hypoid transmissions used in cars with high throughput, as well as in trucks, when working at high loads, additional supports are used for the leading gear wheel shaft and the driven gear wheel in order to maintain the accuracy of the engagement.

In the hypoid main gear, the axles of the pinion and driven gears do not intersect, but are moved relative to each other by a certain distance (e) (Fig. 14.1, b). This arrangement of axles relative to each other lowers the rear end of the cardan drive, which in turn lowers the car's center of gravity and increases its stability. In addition, since the spiral angle of the teeth in the hypoid gear is large, their length is also large, and the number of teeth meshing at the same time is greater than that of the conical teeth, which reduces the load corresponding to each of the meshing teeth. . When comparing two gears with the same number of gears and the diameter of the driven gear, the diameter of the leading gear in the hypoid gear is larger than that of the leading gear in the bevel gear, i.e. it is higher. All this is the advantage of the hypoid transmission, which ensures its durability and long-term reliable, noise-free, smooth operation.

Disadvantages of the transmission: due to the large spiral angle of the wheel teeth, the tooth surfaces slide against each other, as a result, they spread relatively quickly; in order to prevent spreading, it is necessary to use a special hypoid oil, which forms a solid layer of oil on the sliding surfaces of the teeth. In addition, it is relatively difficult to make the gears of this transmission, the accuracy of their assembly is high, because the effect of a small inaccuracy is quickly felt. However, these disadvantages do not detract from the advantages of the hypoid transmission.

The cylindrical main transmission is used in front-wheel drive passenger cars (Nexia, Tiko, VAZ-2108) with a transverse engine. Such a transmission is placed together with a gearbox and a clutch in a common calculated crankcase (Fig. 1 4 .1). The drive gear is bolted to the rear end of the gearbox drive shaft or integral with it . In order to ensure smooth operation of the transmission, often the wheels are beveled and its gear ratio is selected in the range of 3.5...4.2. For the smooth operation of the double wheel, the number of teeth of the leading wheel should not be less than ten. Otherwise, when the number of transmissions is large, the dimensions of the driving gear wheel will increase, the distance between the transmission case and the road (road clearance) will decrease, and the noise will increase during operation. The fik of the cylindrical pair is not less than 0.98.

The central double main gears (Fig. 14.2,a) located integrally between the bridge are used in large and some medium trucks (ZIL-130, KamAZ-5320). Such transmissions consist of a pair of conical and a pair of cylindrical gear wheels and are placed in the crankcase in the middle part of the driving bridge of the car.

In two parts split main gears (Fig. 14.2,b) are mainly used in large trucks (MAZ, BelAZ), as well as long buses (LAZ, Mercedes), as well as some passenger cars (UAZ-469). The division of the main gear into two such parts, i.e. central 2 and wheel 1 gears, reduces the loads on the differential with half axles. Because the value of the torque transmitted from the half-axes and the differential, the part of the transmission located in the middle of the bridge, is increased according to the number of 2 transmissions of the conical pair. The remaining value of the screwdriver momet is increased by 1 in the wheel drive. In addition, the central transmission in the middle part of the bridge is compact, since it consists of only one pair of toothed wheels. This, in turn, increases the distance *N* (clearance) between the bridge and the road, increasing the vehicle's passability on bad roads and off-road areas.

Worm main drives differ from gear drives in their compactness and noiseless operation. But this transmission is small compared to conical and hypoid transmissions, and due to the use of expensive metal (bronze) in its manufacture, it is hardly used in cars.

3. Main transmission design and structure and operation process.

Hypoid main gear. Such transmissions are used in all cars with the engine in front and the driving bridge behind, as well as some trucks (GAZ-53A). As an example, we see the main transmission of the Damas car (Fig. 14.1, b). In such a transmission with a gear ratio of 5.125, the axis of the leading gear wheel made with the shaft 31,75 mmis shifted lower than the axis of the driven wheel. The drive gear shaft is mounted on two tapered roller bearings in the gear case. A bushing is installed between the bearings. A special feature of the bushing is that when the bearings are tightened with a nut during assembly of the transmission, the bushing, which has a certain elasticity, is deformed in the middle towards the outer diameter. As a result, the bearings are always clamped to a certain degree and do not allow the shaft to slide along the axis. The drive gear is bolted to the differential case. The differential box is bolted to the gear case on two tapered roller bearings using covers. The initial tightness of these roller bearings is adjusted with nuts. The correct position of the drive gear relative to the driven is performed by an adjusting ring. Together with the assembled main gear housing, it is mounted on the housing of the leading bridge and fastened with bolts.[23]

Cylindrical main gear. Such transmissions are used in front-wheel drive passenger cars with a transverse engine. Figure 14.1 shows the basic transmission of the Nexia car. The main gear, consisting of a pair of bevel gears with a gear ratio of 3.94, is housed in a common crankcase together with a gearbox and a clutch. The gear small wheel of the transmission is integrated with the transmission drive shaft and is mounted in the crankcase on cylindrical roller bearings on one side and ball bearings on the other side. The large gear wheel of the transmission is bolted to the differential case. The differential box is mounted on tapered roller bearings with one end in the clutch housing and the other end in the gearbox housing. These bearings absorb the axial force generated by the meshing of the

---

[23] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.

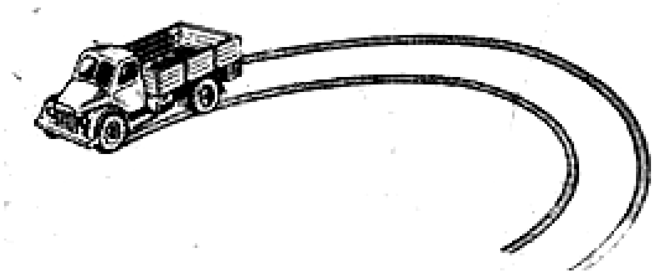
Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.

Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

bevel gears.

4. Function, types, structure of differential and semi-axes.

The mechanism of differential power transmission is to distribute the torque equally to the leading wheels through the semi-axes when the car moves on smooth and smooth roads, and when the car turns and turns at different angular speeds of the leading wheels when driving on uneven roads. allows (Fig. 14.3).



1 4 .Figure 3. Car turning diagram

According to the function of the differentials, the wheels are divided into symmetric axles. Differentials are mounted in the center housing of the leading axle or, if the front axle is leading, in the housing slightly shifted to the right side of the axle.

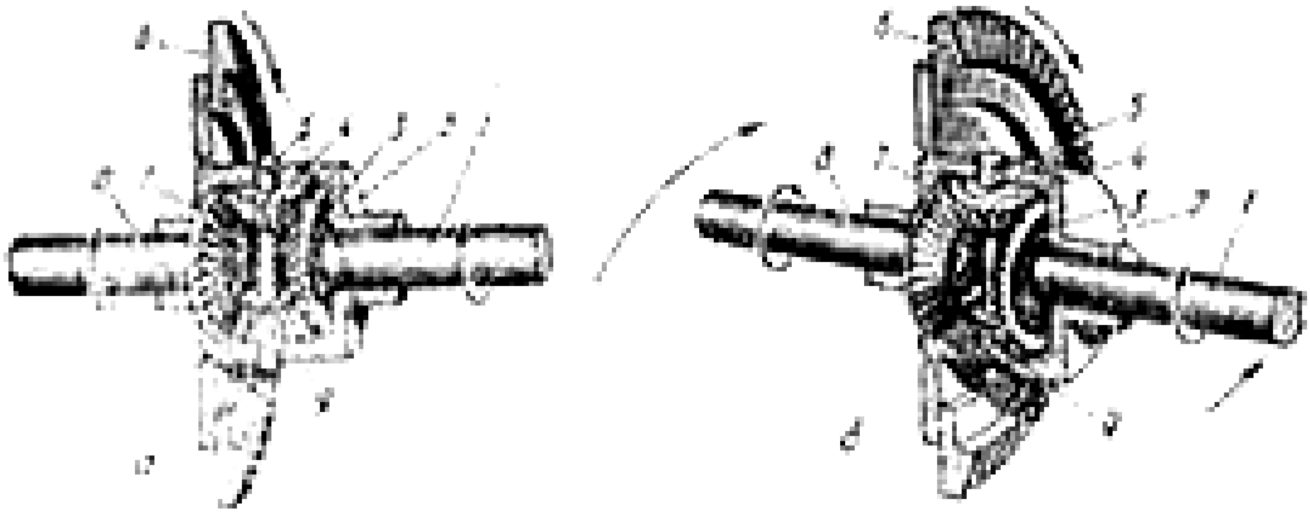
If cars have three or four bridges, the intermediate bridge is also installed on the crankcase differential.

5. The working process of the differential construction.

The differential consists of a box, in which the satellites are installed in a small cone-shaped (chesternya) finger or in a kristovina. The satellites are interlaced with the shesternias of the semi-axes. In trucks and cars, the number of satellites will be three, and in medium passenger cars, two (Fig. 1 4.4).

The box of the differential rotates on two bearings with a conical roller, to which the leading cylinder of the main gear is fixed.

When the car is moving on a straight and level road, the satellites do not rotate around their axles, because the shesternias of the half-axles have the same resistance. In this case, the leading wheels rotate at the same angular speed. When the car turns, the inner wheel axle has a greater resistance compared to the outer wheels of the chassis. Because of this, the satellites and the inner wheel begin to rotate along the semi-axle of the outer wheel, thereby forcing the outer wheel semi-axle to rotate at a large angular velocity.

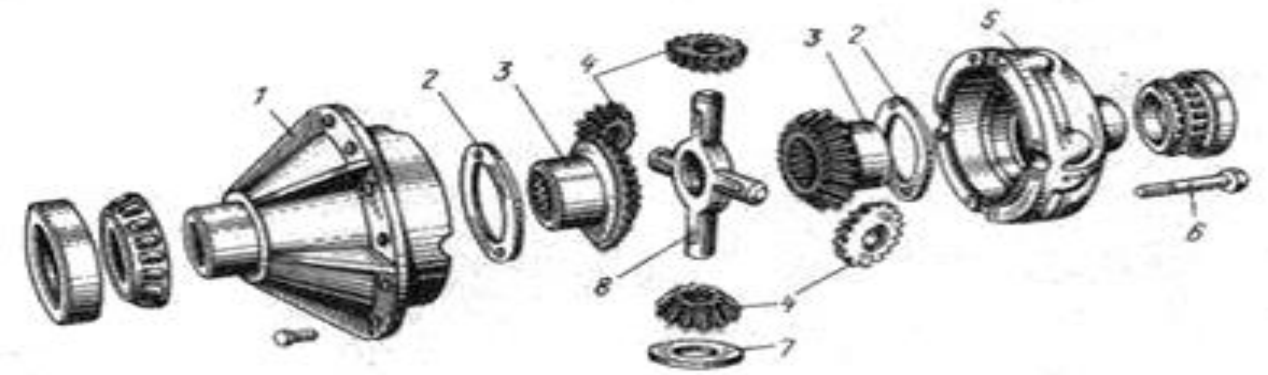


1 4 .Figure 4 Operation of the differential.
1 and 8 semi-axes; 7 differential box. 2 and 9 semi-axle gears;
4 and 9 satellites; 5- small krestovina.

As a result, the number of rotations of the inner wheels decreases and the rotation of the outer wheels increases, the moving car changes the direction of movement and turns to the left or right.

Shape and characteristics of bevel gear wheel symmetrical differential. Currently, almost all cars have wheel differentials, and mostly bevel gear differentials are used.

Conical gear differentials are common in cars (Fig. 1 4 .5), it consists of half axles 6 and 8, gears 4 and 5, satellites 2 and 7, finger 3, differential box 1. The number of satellites in such vehicles is 3 or 4 in trucks and buses, and 2 in passenger cars. The satellites are freely mounted on the cylindrical fingers of the crossbar 3. It is inserted into the hole in the walls of the differential box through the fingers, assembled with the satellites of the krestovina.



1 4 .Figure 5 Between wheels with bevel gears
form of the symmetric differential.

When a car turns to the right, the inside wheel has less travel than the outside wheel due to the greater friction between it and the road. The satellites 2 and 7 ozrotate around the axis, and the second semi-axle gear 5 rotates faster with less torque, as a result, the outer wheel rotates faster and covers more distance.

Symmetrical differential between the wheels distributes torque equally to the leading wheels. But such a distribution has a negative effect on the dynamic quality and handling of the car. For example, if one of the leading wheels falls on a slippery surface, and the second wheel falls on a hard surface, the torques on the wheels will be the same. As a result, the sum of the torques on the wheels is unable to overcome the road resistance, and the car does not move from its position, and the wheel on the slippery road keeps spinning in its place, and the wheel on the hard road is either Unable to overcome his resistance, he remains motionless in his place. For such a coupling, the semi-axle axles must be rigidly attached to the differential coupling. (the differential is blocked).

The form and characteristics of interaxle differentials.

The inter-axle differential is essentially a wheel formula. It is used in overpass vehicles (6x4) and (6x6). The first type of car includes KamAZ 5320, and the second type includes ZIL-133GYa and KrAZ. On uneven roads, the wheels on the middle and rear leading axles can travel in different ways with different contact with the road surface. The shape of the inter-axle differential is shown in Fig. 14.2. In this case, the two rear bridges are leading, and accordingly, the torque from the transmission input is designed to be transmitted to the middle leading bridge.

The satellite 7 crosshead is attached to the interaxle differential leading shaft 3.

Adjacent to sattelites and shesternyas. Right side bevel gear 6 is made with cylindrical gear 8, left side bevel gear 6 is made with cylindrical gear 1. Gear 8 is connected to the leading shaft of the middle bridge with gear 10, which is set in two. The gear 1 is adjacent to the gear 5 mounted on the leading shaft 4 of the rear axle.

When the car is driving on a flat road, the wheels of the middle and rear leading axle rotate at the same speed.
Krectovina satellites and conical shesternias become 1 as a whole.

The torque is distributed equally between the leading 2 bridges.

Since the intermediate and final axle wheels rotate at different speeds when the vehicle is on the road, the side bevel gear connected to the wheels rotates slower than the other. This causes movement along a slowly rotating shesterinium. Due to the rotation of the satellites around its axis, the speed of rotation of the wheel of the 2nd side wheel increases accordingly.

Construction and operation of a self-locking differential.

The locking mechanism in an independent box fastened to the flange of the leading conical gear of the middle bridge is designed for equal distribution of the torque between the middle and the leading leading bridges and differential forced locking (see Fig. 14.2). Gear gear 8 with gear gear 10 and shesternia 1 is always connected with shesternia 5. The gear 8 has external teeth with which the gear coupling 9 engages.

When we move gear 9 to the left with a fork, it engages with gear 8. Шesternya 8 is formed by the rolling process of the differential. By lowering the swing mechanism to the left, compressed air goes through the nozzle to the drive mechanism and pushes the fork.

When the driver is driving the car on slippery and wet dirt roads, in order to eliminate the slippage of one of the leading wheels of the middle leading bridge, the braking mechanism is activated using the release lever.

Mandatory locking of the differential is carried out when the car is moving on slippery and wet roads.

6. Types of semi-axes, installation, their scheme.

Half axles serve to transfer the torque from the differential to the leading wheels. In addition, each half-axle is affected by the bending moment generated by the forces acting on the wheel (Fig. 1 4.6).

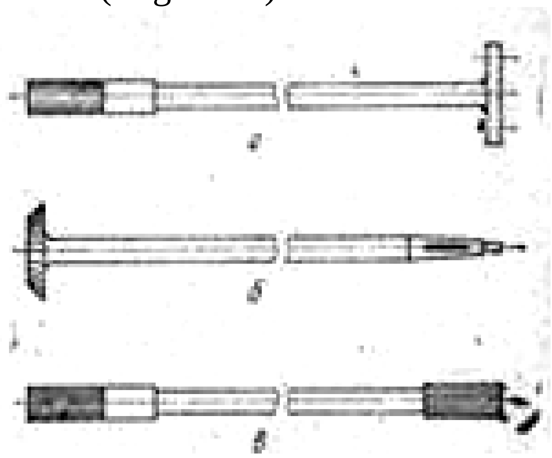
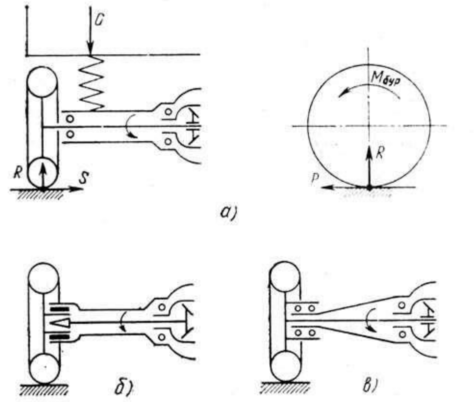


Figure 14.6. Semi-axles of cars

Bending moments are generated by the following forces acting on the leading wheels of the vehicle. (Fig. 1 4 .7)



1 4 . Figure 7 . Methods of location of half-axles on the rear bridge
a – half unloaded, b – ¾ part unloaded, v – fully unloaded

1) Radial force directed to the center of the wheel in the vertical direction – R (the reaction force resulting from the weight of the vehicle *G)*

2) Traction force created when the leading wheels of the car are said - R

3) Centrifugal forces in the turn and lateral forces generated by the slope of the road – S

By choosing the method of placing the bearings from the outer end of the axle to the side of the leading bridge, the influence of the bending moments acting on the bearing can be completely or partially unloaded. Each half-axle is fitted with a bevel gear with an internal spline, which is housed in the differential case. A flywheel is made on the outer end of the semi-axle, which is fixed to the wheel socket with the help of pins. The torque is sent from the semi-axle to the leading wheel socket through a bearing.

Depending on the method of mounting the bearings, half-axles are divided into semi-unloaded, 4/3 unloaded and fully unloaded.

When the bearing at the outer end of the half-axle rests next to the guide bridge housing, it is called a semi-unloaded half-axle. This type of semi-axis is affected by torques generated by R, P and S forces.

These half-axles are used in light and light duty trucks.

If the outer end of the half-axle is attached to the spigot of the leading wheel, and the spigot itself is mounted on a bearing on the side of the bridge casing, then 4/3 of it is unloaded. are called semi-axes (diagram 14.6, b). In this case, most of the bending moment is transferred through the bearing to the housing, and a small part affects the half-shaft. Half-axles of this type are mainly installed in high-class passenger cars. If the outer end of the semi-axle is in contact with the pin of the leading pulley, and the pin lies on two bearings inserted into the casing of the leading bridge, it is called a fully unloaded semi-axle (Fig. 14.6, v). In this case, all the forces are distributed to the semi-axle case.

This type of axles are widely used in medium and large trucks and buses.

Control questions.

1. Tell the function of the main gear?
2. Tell me the types and structure of the main gear?
3. Tell the function, types and structure of the differential?
4. Explain inter-axle differential?
5. Tell the function, types and operation of semi-axes?

1 5 - Topic. The running part of the car .

Plan.

1. Function and types of the lifting system. Types and construction of the function of the frame.

2. Osma's structure and types of duties. Osman's construction. Operation and construction of the shock absorber.

3. Functions and types of wheels. Tire function, types and sizes. 4. The structure of the hub and connecting elements of the wheel.

5. Angles of installation of steering wheels.

6. Body functions and types: passenger car bodies: bus bodies: truck bodies and cabs. Body ventilation and heating system.

Basic words and phrases. The function, types, structure of the running part of the car, the function, types and structure of the frame, the function, types and structure of the bridge, the structure of the leading bridges that can be divided into two parts and those that cannot be divided, the structure of the leading bridge.

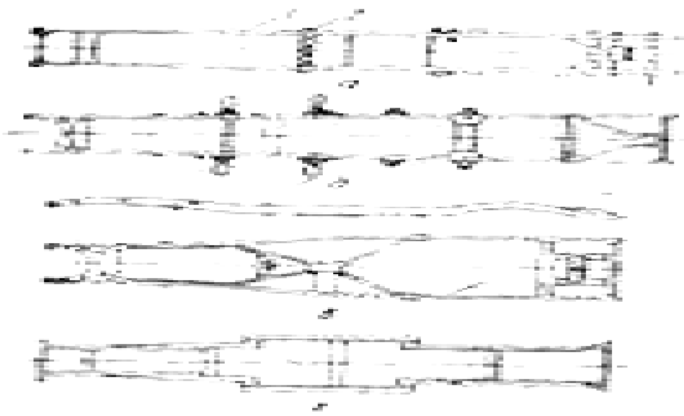
Suspensions, non-independent suspensions, independent suspensions, balancing suspension, shock absorber, transverse stability stabilizer, wheels and tires, mounting angles of steered wheels.

1. Function and types of the lifting system. Types and construction of the function of the frame.

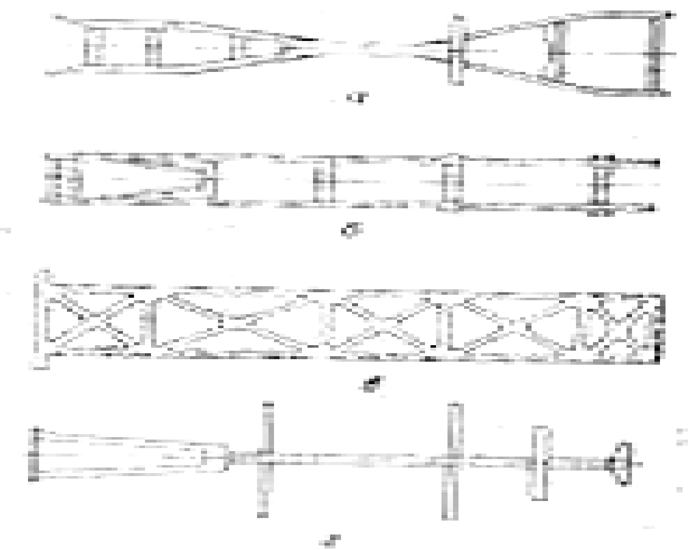
Raman function, salts and structure.

A car frame is a device designed to mount and carry the engine, front and rear axles, cabin and bodies together. The torque transmitted to the frame from the engine to the wheels is affected by the thrust and vibration forces of the road, the weight of the load on the car, and the inertial forces of the car. That's why the frame is strong enough and needs to be carefully prepared. There is no frame in passenger cars and buses, the body performs the function of the frame.

Trucks used frame with struts. A frame with spars is made up of a longitudinal channel-like hammer (from spars). the place where the load falls more on the spar is made wider. spars and cross beams are made of steel by stamping method. They are attached to each other using rivets. A limiter (bumper) and hooks for racking are installed on the front transverse bar, and a hook for racking is also attached to the rear crossbar. Light struts (trucks, buses) have different shapes depending on the loading order of ZOK cars and depending on the type of car. ladi (Figures 15.1 and 15.2).

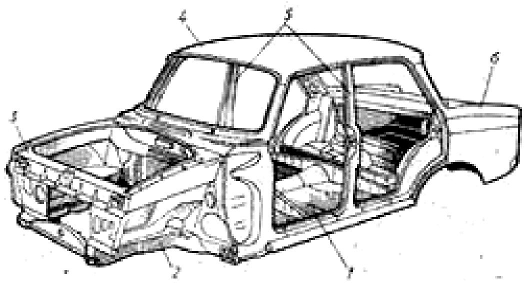


1 5 . Figure 1 . Types of frame construction.
1st spar, 2nd cross bar,
with a-parallel spar,
b- one end with an approaching spar,
with v-bent spar.

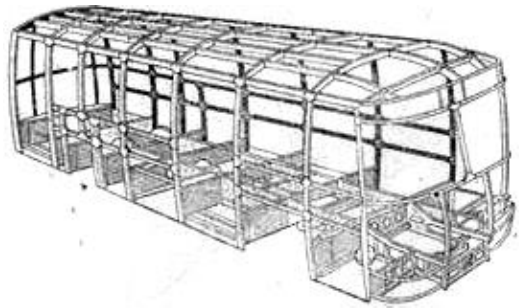


1 5 . Figure 2 . Types of frame construction.
aX-shaped, b-ladder-shaped,
vX-shaped cross beam,
g-spine shaped

L ongerons are parallel (a), inclined spars (b), double-stepped (g), keeled x-shaped (g), ladder-shaped (e), x-shaped cross-beam (y) and keeled (j) Used in buses, trucks or passenger cars (Ford, Skoda) produced on the edge of the frame shown in Figure 17 b .



1 5 . Figure 3 . Car body frame.
1-base, 2-frame, 3-front, 4-roof, 5-pillars, 6-back



1 5 . Figure 4 . The body of the bus is a wagon type with a frame.

Car bodies. Light car bodies are divided into specialized bodies that are installed on taxi, private and racing cars according to their function.

When passenger cars move at high speeds, almost all of the engine's power is used to overcome air resistance. Therefore, the form (shape) of the bodies of modern passenger cars is designed based not only on the requirements of aesthetics, but also on the basis of the requirements of aerodynamics.

At present (according to the size, number of doors, shape and aspects of the upper part), there are the following types of passenger car bodies:

SEDAN-three-size passenger body with closed top 2 or 4 side doors (NEKSIA, GAZ-24 "Volga)

COUPE - two- or three-size passenger body with closed top and 2 side doors, rear seats. (ZAZ-968 "ZAPOROJETS").

HARDTOP - SEDAN - a sedan body of a passenger car without a side pillar when the side windows are lowered.

HARDTOP-COUPE - a coupe body of a passenger car without a side pillar when the side windows are lowered.

FASTBACK is a two-volume passenger body with 2 or 4 doors and a smooth, flat roof. (AZLK-2141 "Moskvich")

KOMBI is a two-volume passenger body with rear doors and designed for passenger or cargo transportation (rear seats are removed).
(IJ-21251)

LIMOUSINE - three-volume, the first row of seats is separated by a partition with opening windows, the top is closed, with four side doors, the interior is extended with high comfort, there are three rows of seats, sometimes middle rows of seats reversible passenger body (ZIL-114, ZIL-117, ZIL-4104)

UNIVERSAL - passenger body with two volumes, rear doors, a trunk not separated from the passenger compartment by a special barrier, rear seats (GAZ-24-02 "Volga", VAZ-2102 "Zhiguli")

FAETON is a passenger body with a soft-top awning, removable side windows. (UAZ-469, LuAZ-969)

FAETON - UNIVERSAL - a cargo passenger body with a removable or removable awning and a side window with a door frame.

CABRIOLET-passenger body with soft folding awning, retractable side window.

CABRIOLET-HARDTOP - a passenger body with a removable top bikr roof.

RODSTER is a two-seat, open-top passenger body with a retractable soft top, with the rear trunk roof open to reveal two uncomfortable seats.

BROGHAM is a combined passenger body with a certain part of the roof of the front seats opening and closing.

LANDO is a combined passenger body with a certain part of the roof of the rear row seats opening and closing.

TARGA is a combined passenger body with a removable middle roof.

PICKUP is a cargo-passenger body on a passenger car chassis with an open platform for cargo and a cab for the driver, and they are separated from each other by a stationary barrier. (IJ – 27151)

Bus bodies can be single- or double-decker, closed-top, and sometimes open-top.

Modern buses have a body with a closed frame in the form of a metal wagon. This type of body allows you to place the engine in a convenient place (inside the body, that is, in the front part, in the back part or under the floor), to make the most of the space in the body compartment intended for passengers. The total weight and cost of bus bodies is half the weight and half the cost of a bus. Wagon-type bodies do not have a frame, so all loads are taken by the body itself. It should be noted that all the units of the bus are attached to the bottom of the body. It is made of cross - sectional and longitudinal frame bars and large - shaped columns connected to them as a whole . the stem in the form is used. Sheet metal or aluminum is used to cover the body frame with a frame .[24]

City buses have two rows and rows of seats, a wider central aisle, larger entrance and exit areas, wider doors, and lower stairs for passenger entry and exit. made. Bus bodies traveling to the border of the city differ from bus bodies traveling within the city by the large number of seats, the compactness of the rear and front compartments for entry and exit. Intercity and tourist buses are distinguished by the comfort of their seats, the presence of ventilation, heating and radio devices, as well as the presence of some cargo space for passengers. Abroad, especially in European countries, such buses are also produced for disabled people.

Bridge task types and structure.

---

[24] A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.

A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.

Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998

Vehicle axles receive the thrust forces acting between the suspension and the wheels. According to the function of the bridges, they are divided into leading, controlled mixed leading and controlled and carrying types. The steering axle transmits pushing forces from the leading wheels and braking forces to the frame when the vehicle brakes. It is a hollow single block, on the ends of which are mounted wheels leading to bearings with bearings. In the structure of the main transmission differential and half-shafts, the leading bridge is divided into two parts, and the non-separable bridge is a non-divided bridge.

Construction of separable and non-separable leading bridges. Split leading bridges are used in light and medium-duty trucks and buses (Fig. 15.5).

This type of lead bridge is made of short and long 3 pieces, and the long piece is the main gear tube. Semi-axle cases 1 and 4 are inserted using a press. Pads for springs 5 and support disk 6 of the brake mechanism are attached to the casings.

Figure 15.5. Leading bridge types
a- the leading bridge, which is divided into two parts; b- well-made leading bridge by welding and stamping; v-cast lead bridge.

Non-separable leading bridge (Fig. 15.5 b) is used in light small and medium-sized trucks. cast bridge (Fig. 15.5, c) is used in cars with a large load.

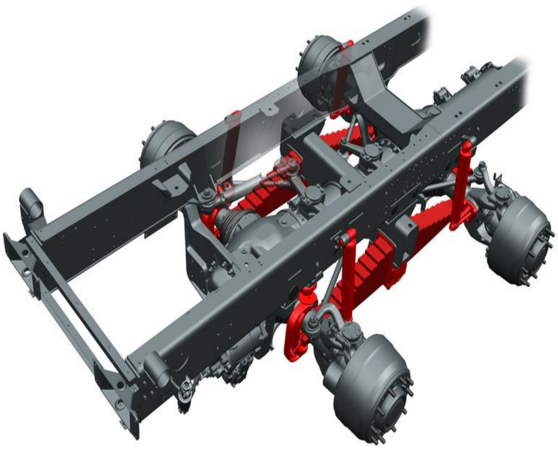
The structure of the leading bridge.

A drawbridge. The bridge girder is made in the form of a compound, its middle part is bent down. It was possible to install the engine lower. At both ends of the bridge, a screw is forced into it, and a wheel turning fist is installed on it. There is a shaft in the turning fist and it is mounted on it with a bearing on the hub of the wheel. A mixed-type leading bridge also acts as a guide. In this bridge, the main gear is ball-bearing on the differential and half-axle housing, in which there is a cardan joint between the ball bearing with a splined finger and the screw punch.

The lifting bridge is used in front-wheel-drive cars with trailers and semi-trailers.

2. Osma's structure and types of duties. Osman's construction. Operation and construction of the shock absorber .

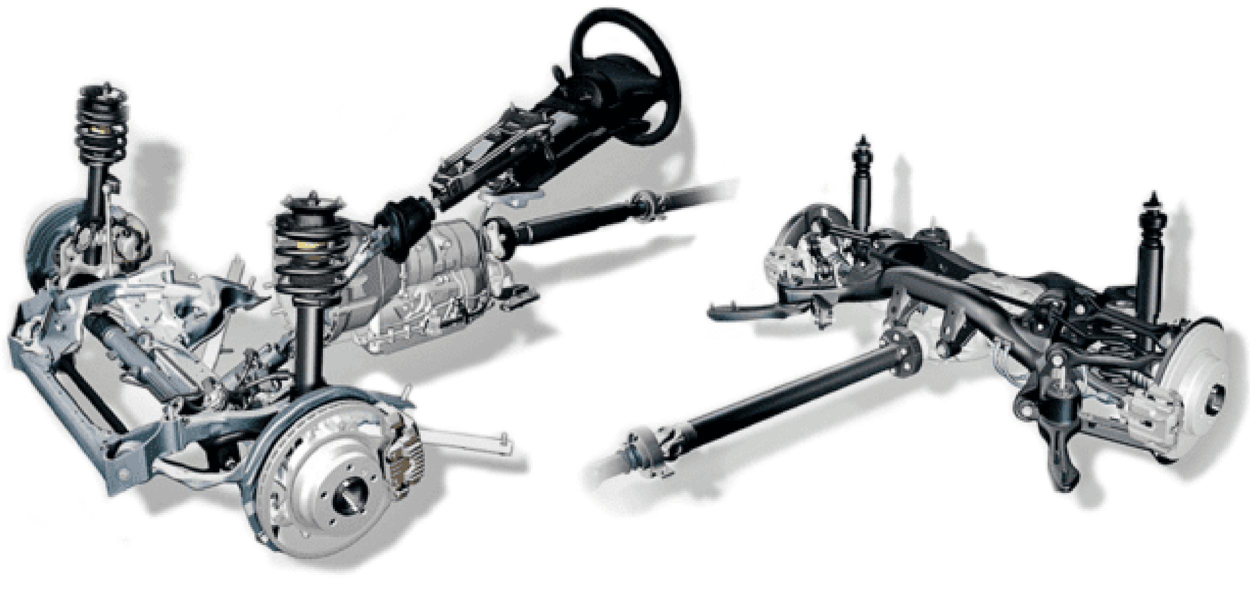
When the car is moving on uneven roads, shocks and impulses are applied to the wheels, causing the car to shake and vibrate. In order to avoid collisions, the frame or body of the car is mounted on bridges using elastic elements (springs, shock absorbers, rubber cushions). These elastic elements form the suspension of the car. The main task of the suspension is to reduce the variable loads affecting the car, dampen the vibration of the car, and keep the car body level during movement. Bridges or wheels are directly connected to the frame or body with the help of suspensions.



Suspensions always provide an elastic connection between the frame or body of the car and the axles, dampening the shocks and vibrations transmitted from the wheels, and ensure the smooth movement of the car. Depending on the method of operation, suspensions are divided into independent and non-independent types.

1. Structure, operation and application of independent suspension.

In the independent suspension, the left and right axles are separately attached to the body with the help of links, and the wheels are independent of each other and shake vertically in relation to the body. In this case, the vibration of the wheel on one side is not felt on the wheel on the other side. (1 5 . 6 - picture , a and b)



1 5 . Figure 6 . Types of independent suspension.
a-one-sided, b-double-sided.

Depending on the kinematic structure, the independent suspension is single-link and double-link.

In a single-link suspension, the wheel vibrates at an angle relative to the axis of the vehicle. In a suspension with two equal arms, the wheel vibrates in a parallel (parallel) plane relative to the longitudinal axis of the car.

The levers are attached to the body with a hinge.

The load is transferred from the mass of the car to the wheel through the body and the spring. When the car drives on an uneven road, the spring compresses and softens the impulses from the wheel to the body. When the spring is stretched, it vibrates the body, and these vibrations are damped in time with a shock absorber. Single-link suspensions are installed on the front axle of Moskvich and Zhiguli passenger cars. Double-link suspensions are installed on the front axle of passenger cars GAZ-24, Volga and GAZ-3109, 3110.

2. Structure, operation and application of independent suspension.

It is known that when the car drives on uneven roads or moves at different speeds, push and pull forces are transmitted to the body through the wheel. In order to mitigate these forces, the suspension uses elastic differentials that change shape. The elastic parts use a digital spring, a spiral spring, and a torsion bar that works to turn.

In independent suspension, the left and right wheels are mounted on the bridge, and the bridge is attached to the frame or body by means of springs. The shaking and vibration of one wheel is also transmitted to the other wheel. (Fig . 15. 7). In this suspension, the wheel moves and oscillates perpendicularly to the longitudinal axis of the car.

This type of suspension is installed on the rear axle of passenger cars and on the rear and front axles of trucks and buses. When the car is traveling on a bumpy road, the spring or spring loosens and softens the impulses from the wheel to the frame or body.

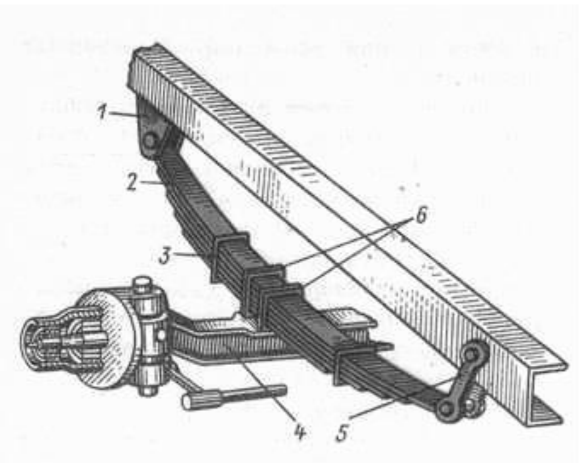


Figure 15.7. Non-independent suspension.

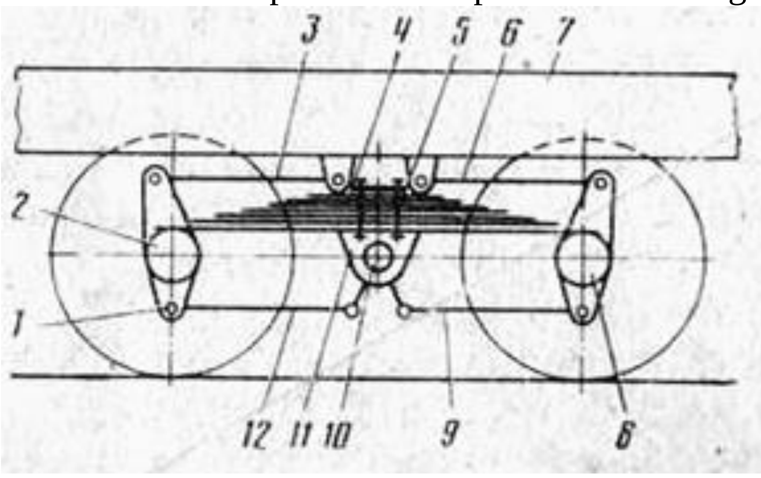
When the spring is stretched, the frame or body vibrates, and these vibrations are damped in time by a shock absorber installed on the rear axle of passenger cars and the front axle of medium-duty trucks (GAZ-53A, ZIL-130). will be released. Truck and bus loads on bridges vary. For this reason, in addition to the main resource, additional sub-resources have been installed. Additional springs are activated when the car is driving under heavy loads and on flat roads.

Only the main resources will work when the downloads are not full. This ensures smooth operation of the car.

4. The function, structure and application of the middle and rear bridge balancing suspension.

Three-axle trucks have a balancing suspension between the middle and rear leading axles, which equalizes the wheel loads and helps to overcome the resistance caused by the roughness and low height of the road. provides

1 5 . Figure 8 shows the shape of the independent balancing suspension.



1 5 . 8 - drawing. The shape of the independent balancing suspension.

Ressora 4. acts as a balancing and elastic part at the same time. The balance suspension is unloaded from the longitudinal force and reactive moments using rods 3, 6, 9 and 12 and a ball finger 1.

The middle 2 and rear 8 leading bridges of the cars are mounted on the frame 7 by means of a semi-elliptical sheet spring 4. The middle part of the spring is hinged to the axis 10 of the oscillating support 11, which is fixed using a clamp 5.

So, the balancing is mounted on the bearings on the intermediate axle 10, which is fastened to the suspension frame.

The ends of the springs are supported on the brackets on the bridges so that they can move along the longitudinal plane.

Pushing forces and reactive moments are transmitted from the bridges to the frame of the car by means of 6 reactive rods, which are attached to the frame and bridges by means of hinges.

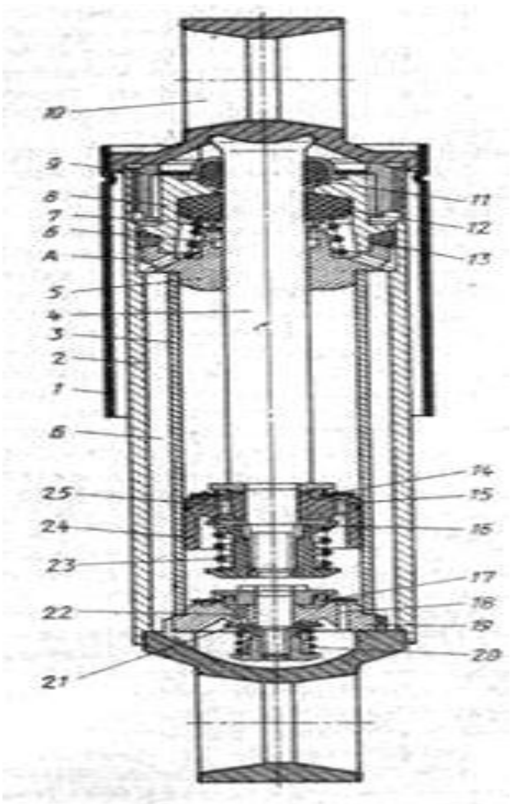
Balancing suspension is installed on three-bridge KamAZ-5320 and other types of trucks.

5. The function, types, structure and operation of the shock absorber.

A shock absorber improves the wheel's contact with the road surface by eliminating the wheel's deflection when the car is traveling on an uneven road, and prevents the car's frame and body from vibrating. The shock absorber dampens the vibrations generated in the suspension in two ways. Shock absorbers are divided into spring-loaded and liquid-operated telescopic types. The shock absorber consists of a protective cylinder 17 (Fig. 15.9), to which a ring with an ear and the first one are welded.

1 5 . Figure 9 . Telescopic car shock absorber

1-case, 2-tank base, 3-working cylinder, 4-shaft, 5-shaft guide, 6-shaft guide cuff, 7, 20 and 23 spring, 8-cuff hanger, 9-tank nut . compression transfer valve bottom, 21 compression valve, 22 and 25 inner row hole, 24 piston.

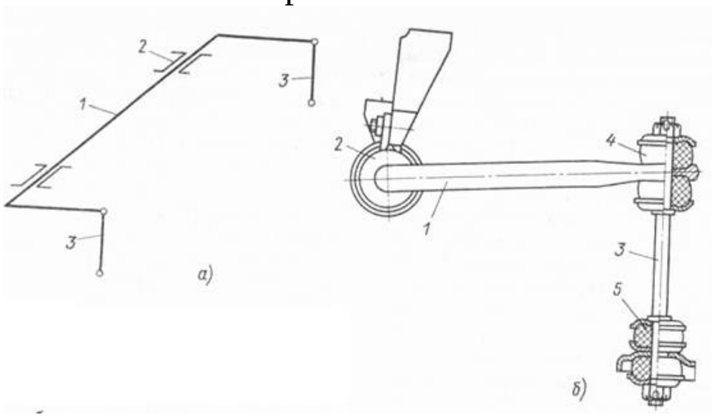


A cylindrical container 16 with one side open is inserted into the cylinder. A ring 11 is welded to the bottom of the container. A grooved cap is inserted into the opening of the container by screwing the end. A working cylinder is inserted into the cylinder vessel 16, and the body of the compression valve 13 is pressed into the lower part of the cylinder. Inside the working cylinder 7 there is a piston with a rubber ring, which is fastened in two, and a transfer valve 8 and a transfer valve 15 are installed on the piston.

The method of operation of the shock absorber is based on the use of hydraulic resistance, which is created when the fluid flows from one cavity of the cylinder to another cavity through the small holes 12 opened by the compression and return valves. When the wheels go over the obstacle, the cylinder container 16 quickly rises up (compression path), liquid pressure is created under the piston 9, the liquid overcomes the resistance of the spring and flows through the transfer valve 15 into the cavity above the piston. At the same time, part of the liquid passes through the compression valve 8 to the cylinder container 16. After the wheels cross the road, the cylinder tank 16 moves down (return path), rarefaction occurs at the base of the piston, under its influence, the return valve 15 opens and the liquid flows into the cylinder cavity at the base of the piston. At the same time, the inlet valve 13 opens, and the liquid flows out of the cylinder tank 16 and fills the space under the piston.

6. The function, structure and operation of the transverse stabilizer.

When the car moves on low-high and bumpy roads, especially in light cars and buses, the suspensions should be almost soft. When the car moves from the above roads and turns, there is a sudden severe situation of the body to the left or right. In order to eliminate this situation, a transverse stability stabilizer is installed in passenger cars and sometimes in buses. The transverse stabilizer serves to reduce the vibration and deviation of the body in the transverse plane and to ensure the stability of the vehicle. 1 5 . 10 - picture .



1 5 . 10 - picture . Transverse Stabilizer:
1-P-shaped bar, 2-rubber bushing, 3-pillars,
4 and 5 rubber pads.

Stabilizer bar 1 consists of spring steel P-shaped steel with a round cross-section, which is installed in two places with the help of rubber bushing 2 on the strut frame or the front wheel suspension. Its two ends are attached to the lower arm of the suspension with the help of pillars 3 and rubber pads 4 and 5.

When the left or right wheel of the car goes down, the body deviates to a certain angle and the bar 1 turns. As a result, an elastic force appears and this force resists the deflection of the body and reduces the angle of deviation of the body. In this case, the upper pad 4 is crushed more than the lower pad. The stabilizer is mounted on independent suspensions.

Control questions.

1. Explain the function of the vehicle chassis?
3. Tell the function, types and structure of the car frame?
4. Tell the function, structure and types of car bridges?
5. Name the structure of separable and non-separable leading bridges?
6. Tell the types of leading bridges?

7. Explain the function of suspensions?
8. Tell me the types of suspensions?
9. Balanced suspension?
10. Explain Transverse Stabilizer?
11. Explain the function of wheels and tires?
12. Why do steering wheels have mounting angles?

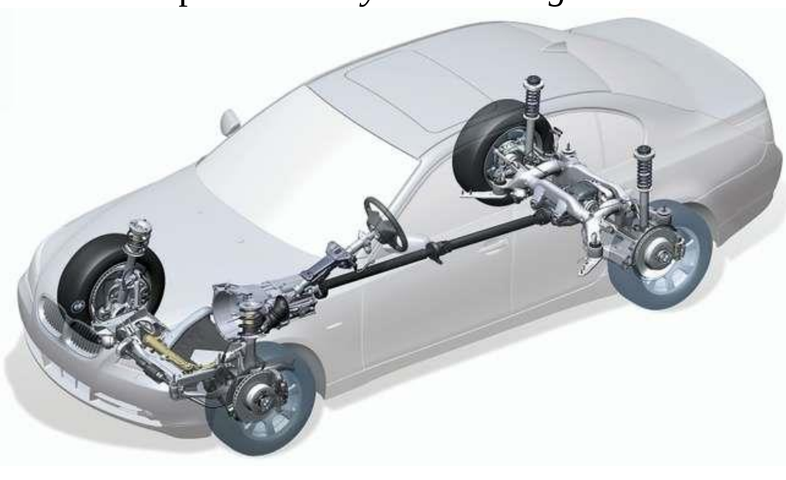
1 6- Topic: Steering.

Plan.

1. The function, types, structure and operation of the steering board.
2. The function, types, structure and operation of the steering mechanism.
3. Function, types, structure and operation of the steering wheel.
4. Function, types, structure and operation of hydraulic power steering.
5. The structure and operation of the power steering mechanism.

Key words and phrases: The function, types, structure and operation of the steering control, the function, types, structure and operation of the steering mechanism, the function, types, structure and operation of the steering wheel. function, types, structure and operation of hydraulic power steering. structure and operation of the power steering mechanism.

When the car is moving, its direction is changed by turning the front wheels. This task is performed *by the Steering Board* .



When the car is turning, all its wheels should move along the circles drawn at one point so that they do not slip to the side (Fig. 14.1). This point (o) is called *the pivot point* .

The movement of the wheels around one pivot center is achieved by turning the steered wheels to different angles. In this case, the turning angle of the inner driven wheel (θ_I) $\theta$is greater than that of the outer wheel ($_T$). The relationship between these angles is:

$$ctg\theta_m = ctg\theta_u + \frac{B}{L}$$

where V is the distance between the axles of the torsion bars, L is the base of the vehicle.

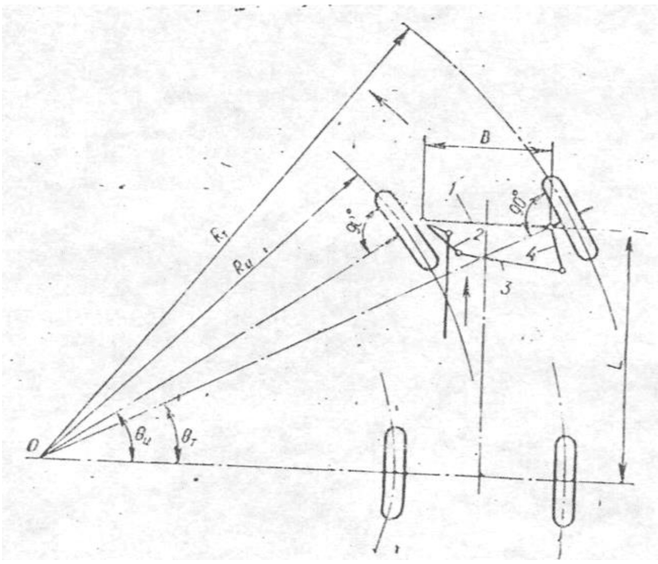


Figure 16.1 . Car turning scheme and steering trapezium
R_I and R_T are the turning radii of the driven wheels,
θ_I and θ_T are the turning angles of the driven wheels.

The steering trapezoid turns the steered wheels to different angles at the same time. The steering trapezoid consists of a transverse steering rod 3, the arms of the torsion bars 2 and 4, and the front axle 1. The minimum turning radius of the car is determined as follows:

The smaller the turning radius of the car, the better its ability to turn. Steering control - consists of a steering mechanism and a steering mechanism, its general scheme is shown in Fig. 1 6.2 .

The steering wheels are mounted on the turning axle, and the axles, in turn, are hingedly attached to the front axle 11 with a shaft 8. The torsion bars are connected to each other by the levers 9 and 12 and the crossbar 10. When the steering belt 1 turns, the movement from it is transmitted to the sector 4 through the shaft 2 and the worm 3. From the sector through the power shaft to the shaft 5, then through the longitudinal steering wheel 6 and the turning lever 7 to the turning pin 13, the driven wheels are turned.

Steering gear-Steering gear provides smooth turning of steered wheels. The easy turning of the steered wheels depends on the number of transmissions of the steering mechanism, the larger the turn, the easier the turn of the steered wheels. But the size of the transmission number, in turn, increases the time spent turning the driven wheels. This makes it difficult for modern fast cars to turn in a short amount of time. Therefore, the number of gears of the steering mechanism is limited, it is 12...20 in cars and 15...25 in trucks.

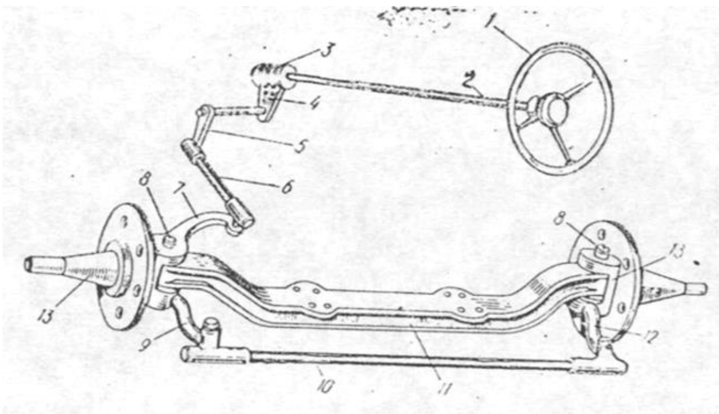
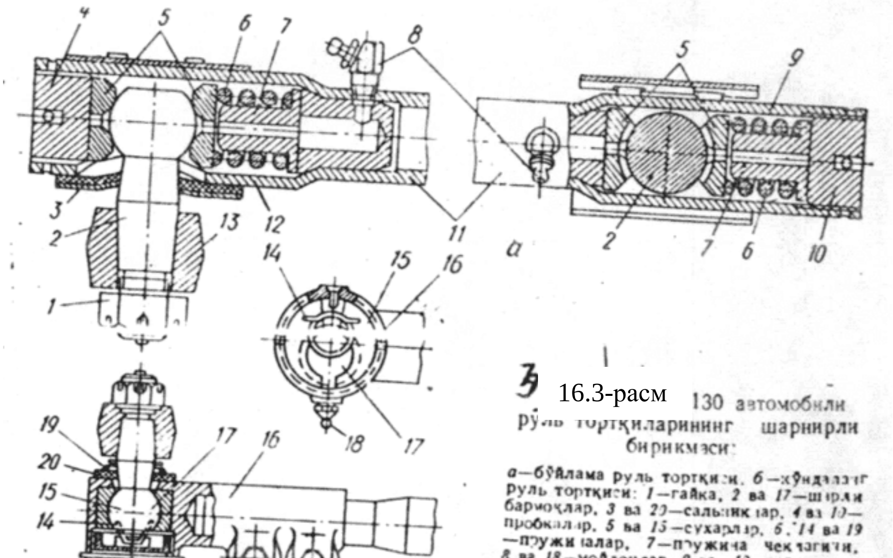


Figure 16.2. The scheme of the steering board:
1-steering belt, 2-shaft, 3-worm, 4-sector, 5-spike, 6-longitudinal steering rack, 7-9-12-turning shaft levers, 8-shaft, 10-transverse steering rack , 11-front axle, 13- turning shaft.

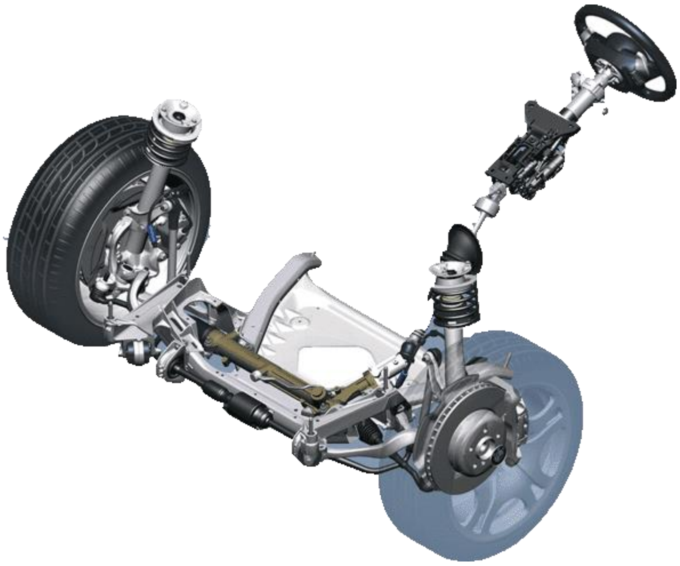
Globoid worm-roller, cylindrical worm-sector, and screw-sector type ul mechanisms are mainly used in cars. Among them, the globoid worm-roller steering mechanism is the most common.

Steering gear - the steering gear transmits the power from the axle to the axles of the driven wheels (Fig. 16.3). The details of the drive must be connected in such a way that when the driven wheels are turned, the levers and pullers can easily deviate in different directions relative to each other, and also they must be able to transmit the necessary amount of force from their connections. For this, the details of the steering wheel are hinged together with the help of round-headed



fingers.

The steering wheel of the Nexia car. The steering control of the "Nexia" car is of the rack type and consists of a gear and a gear rack. The steering mechanism converts the rotational movement of the pinion on the shaft into the forward and backward movement of the rail. Turns the wheels, which are controlled by a hinged towbar located next to the rail.



The power steering has a hydraulic booster, which has a hydraulic distributor with a rotor and controls the flow of oil in the trunks. When the steering wheel is turned to one side or the other, the hydraulic distributor connects the high pressure line to one side of the hydraulic cylinder, and the other side to the oil return pipe. Since the piston of the hydraulic cylinder is fastened to the shaft of the gear rack, under excess pressure it moves it in one direction or another, as a result of which the driven wheels turn.

If the booster fails, the steering will continue to function. A vane pump was used in the hydraulic booster system. It is worth saying that the parts of the hydraulic booster are not repairable, so they are replaced with a new one along with the steering mechanism.

Review questions.

1. The function, types, structure and operation of the steering control, the function of the steering mechanism.
2. Types , structure and operation, function, types, structure and operation of steering.
3. Function, types, structure and operation of hydraulic power steering.
4. power- assisted split steering mechanism.

17 - Topic: Brake control

Plan :

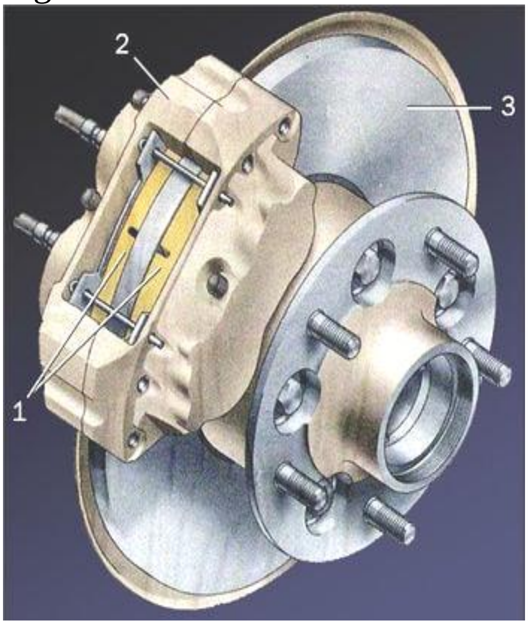
1. Function, types, structure and operation of the brake control.
2. Types, shape, structure and operation of the brake mechanism.
3. The function, types, form, structure and operation of the brake system.
4. The function of the hydrothinning amplifier is the form, structure and operation.

5. Function scheme and principle of operation of the anti-blocking system.

Key words and phrases : Function, types, structure and operation of the brake control. types, shape, structure and operation of the brake mechanism. the function, types, form, structure and operation of the brake system, the function, form, structure and operation of the hydraulic booster.

1. Function, types, structure and operation of the brake control.

Function, types, structure and operation of the brake control. There are cases of the car moving uphill with acceleration at a flat or variable speed and downhill with the force of inertia. In all cases of motor vehicle movement, it is necessary to slow down or stop, as the case may be, and maintain the stopped vehicle in its position without moving it. For this purpose, every car has two brake systems: service and suspension. Heavy and heavy-duty models of cars also have additional, auxiliary and emergency braking systems, each of which performs its function in a certain situation. From this point of view, a set of systems performing the function of braking a car or motor vehicle is called *brake control* .



vehicle consists of four brake systems:

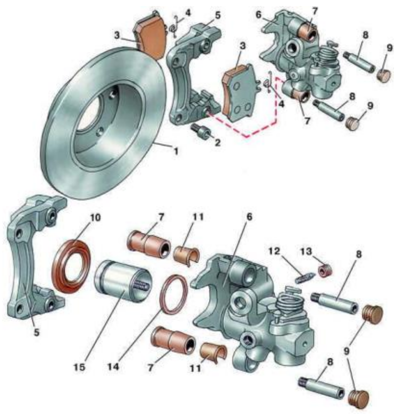
The service brake system serves to reduce the speed of the car or stop it immediately when it moves in various conditions.

The backup brake system is needed to stop the vehicle when the service brake fails.

The suspension brake system ensures that a parked vehicle remains in place without moving.

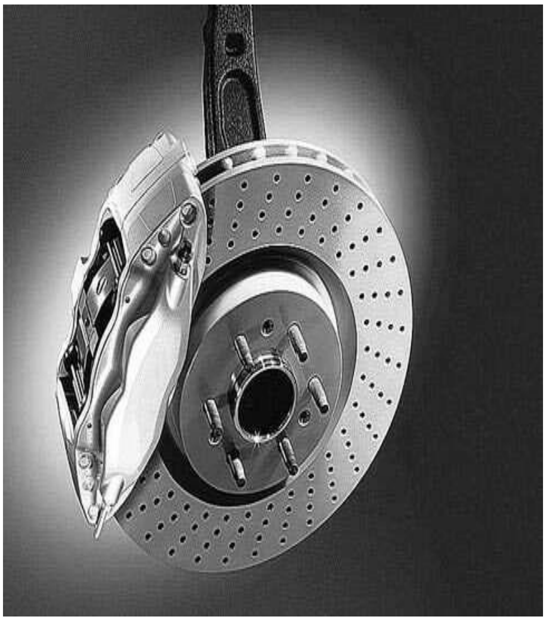
The auxiliary brake system is responsible for keeping the car moving at the same speed for a long time or correcting its movement at a very low speed.

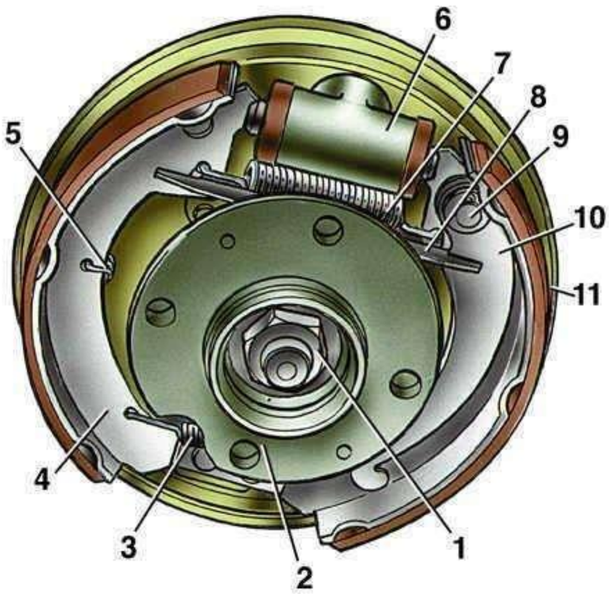
In most cars, the function of the auxiliary brake system is performed using the engine braking mode. In heavy trucks, buses and trailers, a special brake system - retarder is used for this purpose. Regardless of the function of brake systems used in cars, they consist of a power source and one or more brake mechanisms.



The set of energy-supplying structures necessary for the operation of the braking system is called *the energy source* . The set of structures that transmit energy from the energy source to the braking mechanisms is called *the brake system* .

The drum brake consists of two symmetrically located pads, and a friction brake pad is fixed on the outer cylindrical surface. A hydraulic service brake system uses a brake mechanism with a single hydraulic cylinder and pads mounted on one or two support fingers. Sometimes a double-reciprocating hydraulic cylinder brake mechanism is also used.





In the main brake system of pneumatic drives, a brake mechanism with a single piston rod and pads resting on one or two supporting fingers is used more often.

Brake control of Nexia car. The braking system of the "Nexia" car is equipped with disc brakes on the front wheels and drum brakes on the rear wheels, and consists of a two-circuit system with a diagonal layout.

The braking system uses a two-section brake cylinder, which includes a sensor indicating the level of additional brake fluid and proportional valves of the brake force adjuster.

The inner pad of the disc brake mechanism is pressed against the disc by a piston under fluid pressure, and the outer one is compressed by a movable scoop installed in the cylinder moving along the guide finger. This ensures that the gap between the disk and the pad is automatically kept stable and unchanged during the operation of the car.

The brake drum brake mechanism consists of active and inactive brake pads, and it is no different from other mechanisms of this type. restricts heat and prevents condensation.

When the level of the brake fluid in the main brake cylinder of the brake control falls below the norm, the VRAK Ye signal lights up. If additional liquid is poured, the alarm goes off.

Function scheme and principle of operation of the anti-lock braking system.

Modern ABS systems formed the basis for the appearance of additional electronic systems in brake control. These systems are called EBM (Electronic Brake Management) - electronic control of braking or DBC (Dyna-mic Brake Control) - dynamic control of braking. ABS systems are activated when at least one of the vehicle's wheels is locked . When the car moves, the vertical load on each wheel changes, and if the braking torque is generated according to this vertical load, the braking efficiency and stability of the car is improved.

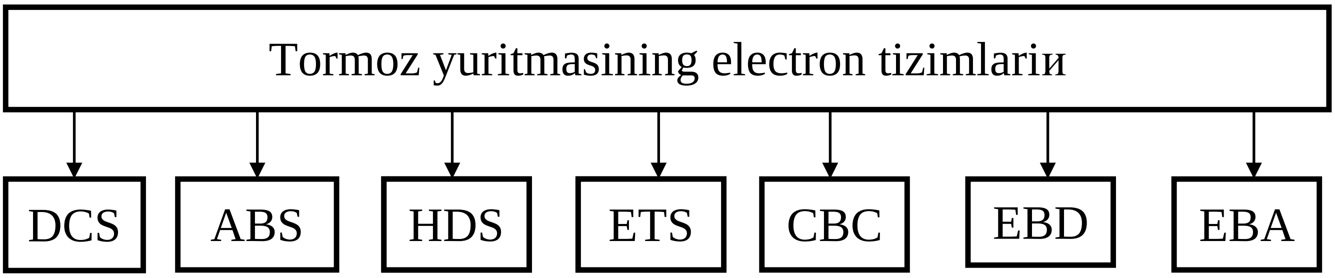
Another direction of improving the braking system is YeVA (Electronic Brake Assist). The YeVA system was first used in Mercedes cars, and later this system was installed on other cars. In order for the system to start, the computer detects the beginning of a sharp braking process, for which it must analyze a number of factors. For example, in BMW cars The EBA system is activated in the following cases:

- when the pressure in the main brake cylinder exceeds 3 MPa;
- when the rate of pressure increase is 600 MPa/s;
- when the speed of the car is greater than 5km/h;
- when the car is not moving backwards;
- when at least one of the wheels does not work in ABS mode;

Only when the above conditions are met, the computer starts braking. The system stops when the driver releases the brake pedal or when the speed of the car drops to 5 km/h.

Electronic braking control systems are widely used in modern cars. These systems are:

Electronic control systems of brakes



DSC - stability control system;
ABS - anti-lock braking system;
HDS (Hill Descent Control) is a system that automatically brakes the car on a slope;
ETS - the system that ensures the absence of delays;
SVS (Cornering Brake Control) controls braking forces when turning a car distribution system according to;
EBD (Electronic Brake Distribution) is an electronic brake force distributor system;
EVA (Electronic Brake Assist) - sudden braking system;
YeRV (Electronic Parking Brake) - simple electronic parking brake system;
ARV (Automatic Parking Brake) - automatic electronic parking brake system.
To improve car braking systems, cable-controlled braking systems can be used VVW (Brake By Wire). In these systems, there is no mechanical connection between the brake pedal and the brake mechanism. The driver's commands are carried out via a cable. The BMW company produced an experimental car with electric braking system based on the VVW system. The car has the following advantages:
- reduced braking distance;
- adjustment of the brake pedal;
- absence of pedal vibrations;
- quiet operation;
- lack of hydraulic system;
- the compactness of the structure
- more perfect systems (ABS, YeSR, TSS, YeVA, YeVD) ensuring operation and others.

Control questions.

1. Function, types, structure and operation of the brake control.
2. brake mechanism.
3. The function, types, form, structure and operation of the brake system, the function, form, structure and operation of the hydraulic booster.
4. Function scheme and principle of operation of the anti-blocking system.

1 8-Topic: Specialized vehicles.

Plan :

1. Types of specialized vehicles.
2. Purpose, types, advantages and disadvantages of auto trains.
3. Types of one- and two-axle trailers and ways of their effective use.
4. Transportation of building constructions and heavy and long-sized cargo in motor trains.
5. Van, refrigerators, tanks.
6. Body and cabins.

Key words and phrases : Types of specialized vehicles, the function, types, advantages and disadvantages of road trains, types of single and double-axle road trains and ways of their effective use. transportation of construction structures and heavy and long-sized cargo in road trains. vans, refrigerators, tanks, bodies and cabs.

1. Types of specialized vehicles.

A set of vehicles (trains) equipped with special devices for loading or unloading a certain type of cargo (or a group of similar cargoes) is called a specialized vehicle (ITV).

Based on the above, ITV is divided into the following types: tippers (dumpers); self-loaders (samopogruzchiki); cisterns; vans; carriers of long dimensions, heavy weight and construction structures. According to the basic chassis, ITV can be divided into cars, trailers and semi-trailers.

According to the number of connecting links (elements) with the traction structures, ITV is divided into single cars and auto-trains.

ITV has the following advantages compared to general-purpose on-board platform vehicles:

- Keeping the quality and quantity of cargo at a high level during cargo transportation (isothermal vans, tankers);
- Unloading - the possibility of mechanizing the loading process (self-tipping, self-loading cars, tankers);
- Ability to transport specific cargo (liquid, long, heavy, etc.)
- Reducing the cost per container (vans);
- Exclusion of additional operations during cargo transportation (ready-made clothes);
- Increasing safety and improving sanitary-hygienic conditions in the transportation of certain cargoes (chemical substances and dust-dispersing cargoes).

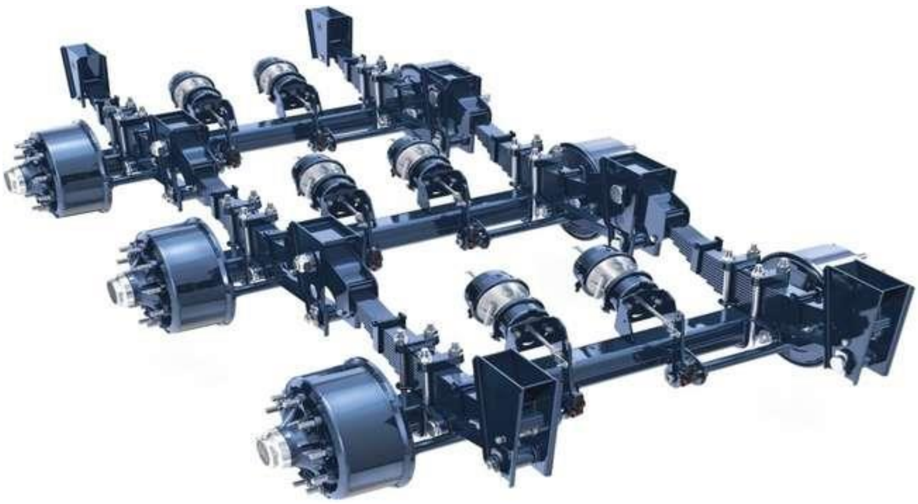
2. Purpose, types, advantages and disadvantages of auto trains.

Along with the advantages, ITV also has a number of disadvantages:

- The production price is much higher than the basic car;
- Nominal load carrying capacity is in some cases lower than the base car;
- The possibility of deterioration of loading and unloading conditions;
- High volume of technical service;
- Involvement of highly qualified drivers;
- It is difficult to rule out unladen traffic, and in some cases there is no possibility at all.

However, despite the indicated shortcomings, the tendency of ITV usage in car transport to increase from year to year indicates that their advantages prevail. Currently, about 75% of cargo is transported by ITV.

At present, ITV is carried out with the help of tractors based on KamAZ, MAZ, Mercedes-Benz, vans - MAZ, Mercedes-Benz, refrigerators - KamAZ, MAZ, etc.



3. Types of one- and two-axle trailers and ways of their effective use.

Unlike a single car, a motor train consists of two or more transport links (elements) that are hinged to each other. If the driving unit is considered as the leading link in the train, the leading link is the trailer, semi-trailer and flatbed trailer.

Using auto-trains has the following advantages:

1. The shooting weight is low;
2. The excess power of the engine is somewhat fully used;
3. Vehicle productivity is twice or more than a single car;
4. 20% less fuel consumed per ton of transported cargo;
5. The container (tare) coefficient (the ratio of its own weight to the carrying capacity) and the price of the movable joint are low;
6. Depending on the transportation distance, the cost of transportation is reduced by 20-30%.

According to their function, freight vehicles are divided into universal, specialized and special vehicles.

Universal buses are designed for transportation of various goods (buses with an on-board platform and universal vans);

4. Transportation of building constructions and heavy and long-sized cargo in motor trains.

Specialized motor trains are designed to transport certain types of cargo (tanks, refrigerators, tippers, carriers of construction structures, etc.);

Special motor trains are a rolling stock with fixed equipment, equipment (mobile power plants, compressor units, repair shops, etc.) that cannot be transported.

Freight cars are trailers, semi-trailers (with seats) and flat trailers.

Trailer trains consist of a flatbed truck or van and one or more trailers (Fig. 18.1 a and b);

Semi-trailer trucks consist of a semi-trailer and a semi-trailer (Fig. 18.1 c);

Auto-trains with spreader trailers consist of a towing vehicle and a trailer with an extendable (conical) column on both sides without an on-board platform (Fig. 18.1 d).

It is used for towing transport trailers from a towing device. It is characterized by the fact that the main type of loading for the towing device is the longitudinal force.

The towing device is used for towing semi-trailers. In addition to the longitudinal force, this towing device absorbs the vertical load from the weight of the towing semi-trailer and transfers it to the towing vehicle and at the same time acts as a turning mechanism.

4. Van, refrigerators, tanks.

There are two types of towing devices of motor trains according to their design options:

1. Pulling (warming); 2. Support (saddle) - attachment (warming). The towing device consists of:

- separation - attachment knot;
- amortization - absorption mechanism;
- turning - release mechanism;
- fastening knot.

The support-towing device consists of the following:

- mechanism of separation - attachment;
- the mechanism that ensures flexibility of the vehicle;
- fastening knot.

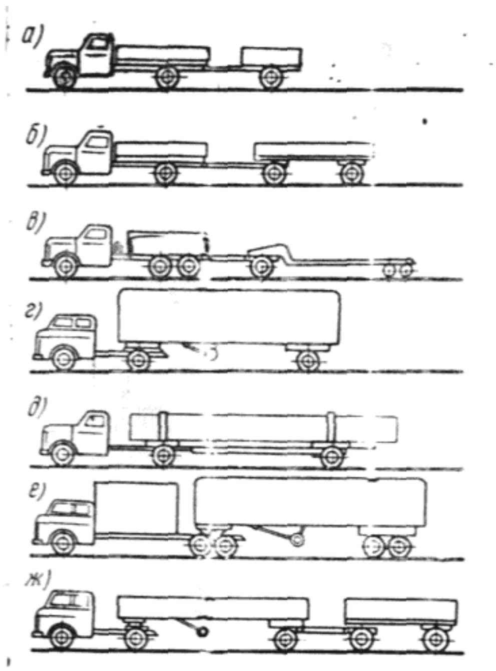


Figure 18.1. According to the method of distribution of vertical load, motor trains are divided into the following types:
a) the load is distributed independently (Fig. 16.1 a, b, c); non-independent (dependent) distributed (Fig. 16.1 g, d); mixed distribution (Fig. 16.1 j).
The following restrictions are imposed on motor trains:
a) the maximum full weight of the train is 40 t if the number of axles is 5, 52 t if the number of axles is 6 or more;
b) width 2.5 mand height of the vehicle 3.8 m; the length of a two-link train is 20 m, and a three-link train is 24 m.

Control questions:

1. Give the definition and types of specialized vehicles.
3. Describe the advantages of specialized vehicles over base vehicles.
4. Define auto trains.
5. Describe the traction and support device.

1 9 - Topic: Operating characteristics of the car. Speed characteristics of the engine.

Plan.

1. Development of the car theory
2. Operating characteristics of the car
3. Gauge and indicators, GOSTs, standards
4. Traction-speed characteristics of the car, evaluation parameters.

Basic words and phrases. Perspectives of the development of the theory of the car, operational characteristics of the car, gauges and indicators, GOSTs and standards, traction-speed characteristics of the car, traction-speed characteristics of the car, evaluation parameters.

1. Development of automobile theory .

This science is a science that studies the laws of vehicle motion, and analyzes the factors affecting the vehicle based on these laws, research, and experience. Thanks to this science, ways of improving the structure of the car, choosing a car and movement for different working conditions, and pre-selection of its operational characteristics in the design of the car are studied.

The creation of the theory of operational characteristics was based on NE Zhukovsky's 1917 book entitled "The movement of a car in a turn".

Ye.A. Chudakov, an academician of automobile theory, worked out the issues of automobile dynamics, fuel economy, and stability.

VMPevzner developed the theory of sideslip and stability theory of automobile wheels. VMPevzner published the book "The Theory of Automobile Stability".

Scientific research works of BSFalkevich, NKKulikov are of great importance in solving the issues of car dynamics and fuel economy.

The problem of car braking was researched by NA Bukharin, the problem of driving smoothness by RVRotenberg, and the problems of controllability and stability by ASLitvinov.

BAIlarionov, VVOsepchugov, AKFrumkin, BMFitterman, AAXachaturov and other scientists made a great contribution to the theory of operational characteristics of the car.

Among the scientists of the Republic of Uzbekistan, TSHudoyberdiev, Kh.Mamatov and MOKodirov, based on their scientific research, created educational manuals entitled "Tractor and automobile theory and calculation" and "Automotive construction and theoretical foundations".

2. Operating characteristics of the car.

The theory of operational characteristics of a vehicle is a science that studies the laws of motion of a vehicle, based on theoretical research and experimental data, it analyzes the effects of construction, working conditions, technical maintenance and other factors affecting the operational characteristics of a vehicle, and further improves the structure of a vehicle. identifies ways of improvement. This science determines the issues of effective organization of cargo transportation and obtaining the greatest profit.

The operational characteristics of the vehicle include traction and braking dynamics, fuel economy, controllability, stability, ability to overcome road obstacles, smoothness of movement and safety of movement.

Vehicle dynamics is the ability to move cargo and passengers at maximum and average speeds in given road conditions, maintaining safety. The better the car's dynamics, the less time it spends on transportation and the more productive it is.

3. Gauge and indicators, GOSTs, standards

The requirements for the car can be divided into the following:

- general requirements;
- operational requirements;
- economic requirements;
- requirements for a "safe" car.

vehicle requirements include:

1. Vehicle construction and dimensions must be in accordance with the requirements of the type;

2. Must fully meet the requirements of GOST and Euro, Euro-1, Euro-2 and

3;

3. The future of automotive design must be;

4. Vehicle construction must be compatible with high-tech equipment;

5. It is expedient not to use rare materials in car aggregates, units, parts;

6. It should be convenient and comfortable as necessary;

7. Must be "clean" in terms of patenting, etc

It is necessary to meet the state standards and requirements of international documents for the designed and manufactured automobile structures. The fact is that the fulfillment of the standard conditions opens the way for cars to enter the world market.

The requirements of the operators of the vehicle structure are as follows:

- vehicle operating costs should be minimal;
– the average speed of the vehicle must be high;
- there must be opportunities for effective use of the car's load-carrying capacity;
- low consumption of fuel and oil is desirable;
- there should be few lubrication points in the construction;
- it is easy to carry out technical maintenance of aggregates, nodes, parts;
- it is desirable that it is easy to load and unload the cargo.

The satisfaction of the above requirements can be achieved on the one hand by the car design, on the other hand by its effective operation.

Environmental requirements for the construction of the car are to ensure the minimum emission of air polluting gases into the environment during its operation.

The economic requirements for car construction are as follows:

- small size and mass;
- low production cost;
- very high fuel-oil economy;
- rare materials should not be used.

Economic requirements can be achieved due to high-level technology, use of the latest achievements of science and technology, high level of knowledge of employees.

4. Traction-speed characteristics of the car, evaluative parameters.

Vehicle dynamics consists of traction and braking dynamics.

of the car is the ability of the car to move at the maximum average speed under certain operating conditions.

Braking dynamics - shows the car's ability to slow down and brake effectively.

Fuel economy is the ability of the car to perform transport work with minimal fuel consumption.

Car controllability - shows the ability of the car being driven to change the position of the steering wheels and, accordingly, to change the direction of movement at the will of the driver.

Stability of the vehicle - indicates its ability to resist side sliding, overturning and pushing.

Cross-road capability - indicates the vehicle's ability to drive in difficult road conditions and off-road areas.

Driving smoothness - shows the ability of the car to move on a rough road at high speed without excessively shaking the body, not to spoil the quality of the transported cargo, ease of walking, and not to tire the driver and passengers too much.

Traffic safety - shows the ability of the driver, cargo and passengers to be transported without road traffic accidents.

Control questions.

1. Who are the founders of car theory?
2. Operating characteristics of the car?
3. What is taken into account in the operational indicators of the car?
4. Meter and indicators, GOSTs and standards?
5. Traction-speed characteristics of the car?

20 - Topic: Traction speed feature. Traction characteristics of the car. Wear resistance bands.

Plan:

1. Calculation of vehicle towing capacity.
2. Calculate the power of the engine satisfying the given dimensions.
3. Determining the number of transmissions of the main transmission, determining the number of intermediate transmissions.
4. Arithmetic, geometric and harmonic series.
5. Diagram of forces and moments acting on the car
6. The engine is a source of energy.
7. Description of the external speed of the motor.
8. Resistance forces acting on the vehicle.
9. Climbing resistance force, rolling resistance force, rolling resistance coefficient.
10. Air resistance, resistance coefficient, energy required to overcome resistance forces.

Basic words and phrases. Calculation of the vehicle's towing capacity, calculation of the power of the engine satisfying the given dimensions, determination of the number of transmissions of the main transmission, determination of the number of intermediate transmissions, arithmetic, geometric and harmonic series, the effect of factors encountered in operation on the traction-speed characteristic, the force acting on the vehicle and torque diagram, engine energy source, description of external speed of the engine, maximum power at maximum speed, specific fuel consumption, hourly fuel consumption, power of the crankshaft at any number of revolutions, torque of the crankshaft at any number of revolutions, pressures at the number of crankshaft revolutions to determine, engine external speed characteristic graph, engine external speed characteristic table, drag forces acting on the car, drag force, rolling resistance force, rolling resistance coefficient, air resistance force, drag coefficient, to overcome the resistance forces power consumption.

1. Calculation of the towing capacity of the car.

The dimensions of vehicle dynamics determined by calculation or experiment shown above represent the behavior of the vehicle under certain conditions. At the time of calculation, the engine runs when the cylinders are fully fueled and its power is equal to the value in the external speed specification. Therefore, the dynamics of the car determined by calculation determines its highest value. Dynamic indicators that occur in practice and dynamic indicators determined by calculation and experiment are different from each other. The reason for this is a change in the vehicle's technical condition and operating conditions.

When the car is used for a long time, the piston and piston rings are worn, the wrong choice of fuel combustion time, etc. cause the engine power to decrease. If the air filter is dirty, the filling of the cylinder will be worse, the formation of the combustible mixture will be difficult and the power of the engine will be reduced. When using the car, if the chassis, hub and mechanisms are poorly adjusted, for example, if the head gear bearings are tight or the teeth of the bevel gears are incorrect, the power spent to overcome the friction in the transmission will increase, and the dynamics of the car will deteriorate. The misalignment of the front wheels also has a bad effect on the dynamics of the car.

Deterioration of car dynamics, increases maximum speed and reduces acceleration. The car's maximum speed will decrease along the way before the current repair, while its fuel consumption will increase. Most of the engine's power is spent on sprinkling the oil in the transmission units. That's why the use of liquid winter transmission oil in the winter causes less power consumption during the start of the car.

The above examples show that the advantages of the car design satisfy the requirements of a working car only if it is in good technical condition. For this, it is necessary to carry out timely and high-quality technical maintenance, to use fuel and oil suitable for the operating conditions of the aggregates .

The purpose of calculating the towing capacity of the car is to determine the parameters that ensure the maximum acceleration of the engine and transmission to the car, its movement on the roads at the maximum speed, and the smooth movement on the roads with excessive resistance.

cake of the car that is being muddled Three parameters are used to calculate q ability :

1. Given parameters: vehicle, its engine and type, rated load- $G_{carrying}$ capacity, maximum speed it can have when the right gear is added V_{amax} it can overcome when moving at the maximum speed The total resistance of the path is

ps_{amax}, the total resistance of the path that can be overcome by moving in the first gear is ps_{max}.

2. Accepted parameters: self-weight of the car - G_0 the coefficient of overcoming air resistance - K, the surface of the car when viewed from the front - F, weights corresponding to the front and rear axles of the unloaded and loaded car - G_{01}, G_{o2}, G_{al}, G_{a2}; tire sizes, the frequency of rotations of the crankshaft corresponding to the maximum power of the engine - n_{gNmax}.

3. Parameters that need to be determined by calculation: maximum power of the engine - N_{gmax} and the working surface is F, the main transmission is U_{bu}, the gearbox is U_{uk}, the distribution box is U_{tq} transmission numbers of .

It is necessary to make a critical analysis of the technical specifications of the cars used in the national economy, and to adopt advanced design methods taking into account the future of automobile transport.

2.1. A car with a mechanical transmission cake sh Calculate the ability of q by h

capacity of a car with a mechanical transmission begins with the calculation of its total weight G_a:

$$G_a = G_0 + G_{load}, \text{ N.} \tag{8.1}$$

$_{load}$ G for cars and buses is equal to the number of passengers (including passenger loads) multiplied by their weight (750 N). Tire size is correct for each wheel. depending on the weight of the load is selected from a special table, the static radius of the wheel is determined and it. *the rolling radius of the wheel* r_g is called

2. Of the engine satisfying the given dimensions power calculation.

To find the maximum power N_{gmax} *of the car engine, first the power* N_{gvmax} required for the car to move at a speed V_{amax} is analyzed:

$$N_{gv\max} = \frac{G_a \cdot \Psi_{v\max} \cdot V_{a.\max}}{1000 \cdot \eta_{ky}} + \frac{W \cdot V^3{}_{a.\max}}{1000 \cdot \eta_{ky}}, \text{ kW} \tag{8.2}$$

Wanted. N_{gmax} value is calculated using the empirical formula:

$$N_{g\max} = \frac{N_{gv\max}}{a \cdot \lambda + b \cdot \lambda^2 - c \cdot \lambda^3}, \text{ kW}; \qquad \lambda = \frac{n_{gv\max}}{n_{gN\max}} \tag{8.3}$$

where n_{gvmax} is the frequency of rotations of the crankshaft when the car is moving at maximum speed;

n_{gNmax} is the frequency of revolutions of the crankshaft when the engine has maximum power. For an engine with a carburetor without a limiter, l = 1.1...1.3; for a carburetor engine with a limiter l = 0.8...0.9; for diesels l =0.9...1.0; *a, b, s* - coefficients; a= 0.5 for diesels with fuel injection ; b = 1.5; s = 1; Combustible mixture agglomerates. for diesels a =0.7, b= 1.3, s =1; a *=0.65* for diesels with reciprocating pistons ; b = 1.35; s =1.

Determined N_{gmax}, n_{gNmax} using the values N_g and M_g the values for all ranges of are determined and the external speed characteristic graph of the engine is constructed.

3. Determination of the number of transmissions of the main transmission, determination of the number of intermediate transmissions.

Sometimes in the design of a car, the power obtained by the engine at the stand is N_{ct} is given the value of The value of N *ct is 1.08...1.15 times greater than* N_{gmax} , because the engine power is determined without installing the extinguisher, generator and other devices. At this point, the calculation of the drag dynamics is the opposite of the one shown above. the maximum speed of the car is determined. The transmission number of the main transmission is determined as follows:

$$U_0 = \frac{n_{g\max} \cdot r_k}{V_{a\max} \cdot U_{у.к.} \cdot U_{т.к} \cdot U_к}, \tag{8.4}$$

where $U_{т.к}$, $U_к$ - the number of transmissions in the upper gear of the distributor and auxiliary gearbox. n_{gmax} =83...100 s -1 for passenger cars , n_{gmax} =44...58 s $^{-1}$ for trucks and buses with carburetor engines , n_{gmax} = 34...58 s $^{-1}$ for diesel trucks and buses . If. U_{uk} =1, U_{tk} = 1, *He* $_{.k}$ = 1 and $\eta_n = \dfrac{n_{g\max}}{V_a}$ If b , then the above equality holds for q :

$$U_o = r_г \cdot \eta_n \tag{8.5}$$

If the correct gear of the gearbox is an accelerating gear, $U_{uk\,.}$ =0.7...0.85 is acceptable. The main difficulty in determining the number of gears of a gearbox is to find the number of gears U *ukI of the first gear* . *He* *is UKI* The value of is chosen by fulfilling two conditions:

1. When the first gear is added, the car must be able to overcome the maximum total resistance of the road, that is $P_{k\max} \geq P_{\psi\max}$, based on:

$$U_{I\psi} = \frac{G_a \cdot \psi_{\max} \cdot r_k}{M_{g\max} \cdot \eta_{к.у.} \cdot U_0 \cdot U_{у.к.} \cdot U_к}; \tag{8.6}$$

where is the transmission $U_{I\psi}$ required to overcome the maximum total resistance of the road .

2. When the first gear is added, the leading wheels of the car must have the ability to move without jerking, $P_{k\max} \leq P_{\varphi\max}$ i.e. That's basically $U_{I\varphi} \leq \dfrac{G_2 \cdot m_2 \cdot \varphi \cdot r_k}{M_{g\max} \cdot \eta_{к.у.} \cdot U_0 \cdot U_{т.к.} \cdot U_k}$. This expression is for a car with front wheels. If the front wheels of the car are leading, G_2 , t_2 instead of G_1 , t_1 *it is assumed* that all wheels are leading $G_a \cdot \cos\alpha$, where G_1 , G_2 are weights on the front and rear leading axles, t_1 , t_2 are the redistribution of reactions on the front and rear axles of the *car* coefficient. As noted above $P_{\varphi\max} \geq P_k \geq P_{\psi\max}$,

$$U_{I\varphi} \geq U_I \geq U_{I\psi}, \tag{8.7}$$

where- U_I *is* the value of the extension being selected.

Example 1. $U_{I\psi}$ =5 and $U_{I\varphi}$= 5.5 were calculated. For the first transmission of the designed transmission box, U_I=5, $U_{I\psi} < U_{I\varphi}$ so $U_{I\varphi} \geq U_I \geq U_{I\psi}$ the condition is fully fulfilled. If a number between the $U_{I\psi}$ and $U_{I\varphi}$ values is accepted for the first gear, the dimensions of the gearbox will increase, the material will be consumed more, and there will be an excessive traction force on the wheels. This is appropriate. it's not.

the first transmission is assumed to be U_I=5.5, both conditions are fulfilled, but the dimensions of the box become larger.

$U_I = U_{I\varphi}$ because the leading wheels are at the limit of wobble and the traction force is slightly increased, this process starts. If such a transmission box is built, constructive solutions limiting the movement of the wheel in the box are implemented.

Example 2. $U_{I\psi} = 5{,}5$, $U_{I\varphi} = 5$. If $U_{I\psi} > U_{I\varphi}$ accepted $U_I = U_{I\psi}$, this box design would also be inappropriate, as the box dimensions would increase, and at or near the maximum traction force, the wheel would begin to wobble. In this case, $U_I = U_{I\psi} = 5$ it is reasonable to say that in order to improve the engagement of the leading wheel with the ground, it is necessary to increase the weight of the load on it, the engagement coefficient. For this example , the middle value of $U_{I\psi}$ and $U_{I\varphi}$ cannot be accepted because both conditions are not met. To determine the number of remaining transmissions, U_I it is necessary to distribute the chosen according to a certain law. This issue is one. how many different solutions are possible. Let's consider one of the accepted methods. We use the given initial conditions below.

4. Arithmetic, geometric and harmonic series.

If the acceleration of the car increases in the same interval of the crankshaft, the number of gears of the gearbox must change according to the law of geometric progression, that is, the value of all the gears of the gearbox is the denominator of the geometric progression, which is calculated as follows:

$$q = U_k = \sqrt[n-1]{U_I^{n-k}} \; ; \tag{8.8}$$

where *k* is the desired transmission index, *n* is the number of steps in the gearbox, and *n* can be calculated for three-, four- and five-step gearboxes.

5. Scheme of forces and moments acting on the car.

The forces acting on the car when it moves on the road are mainly divided into three groups:

Driving forces acting on car wheels; forces resisting the motion of the vehicle and reactive forces (Figure 20.1).

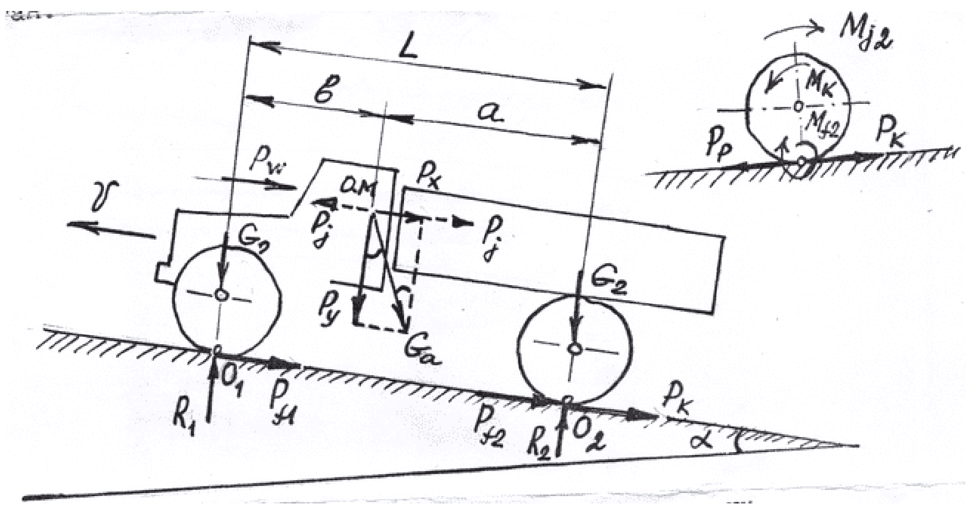


Fig . 20.1 . Forces and moments acting on the vehicle

The driving force of the car includes torque and traction forces on the wheels .

The forces resisting the movement of the car : the force resisting the rolling of the car wheels, the resistance force when climbing the height, the air resistance force, the force resisting the acceleration of the car (inertia force), g of the front and rear wheels includes the moments of resistance to rolling, the moments of inertia that resist the rolling of the front and rear wheels.

Reactive forces include the reaction forces generated by the weight forces distributed on the wheels between the road surface and the front and rear wheel surfaces under the influence of the vehicle's gravity.

Let's look at the forces acting on the front and rear wheels and the car separately.

1.1 Forces and moments acting on the driven front wheel.

A part of the weight of the car G_1 acts on the front wheel of the car. Under the influence of this force, the wheel tire and the road surface are deformed (Fig . 2 0 . 2 , a.).

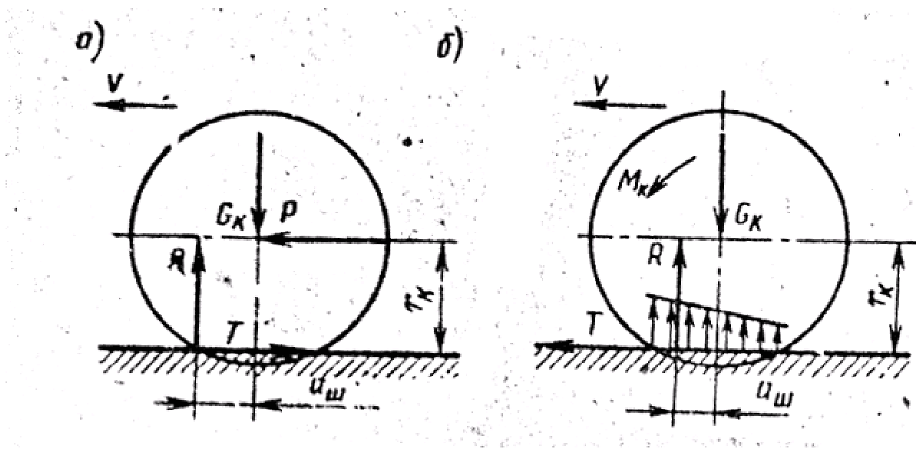


Figure 20.2. Forces and moments acting on the leading and leading wheels: a-forces and moments acting on the leading wheel, b-forces and moments acting on the leading wheel.

When the wheel rolls on a hard road, as a result of its deformation, internal friction is created in the tire section, the temperature of the tire rises, and the part of the tire in contact with the road surface is eaten a little.

When the wheel rolls, the front part of the tire in contact with the road is deformed more, and the rear part in contact with the road is deformed less. As a result of this, the reaction force R_1 formed between the tire and the road is slightly moved forward from the axis of rotation of the wheel by a distance a_{sh}. (Fig. 2 0 . 2. a.).

is created that opposes the wheel's rotation . $M_{F_1} = R_1 \cdot a_{ш_1}$

R pushing against the wheel axis, the sum of the moments generated by the forces must be equal to zero, that is:

$$R_1 \cdot a_{ш1} + P_{y1} \cdot r_F = 0 \text{ from this}$$

$$P_{y1} = R_1 \cdot \frac{a_{ш1}}{r_F}, \text{ N} \tag{2.1}$$

Here R_{u1} is the reaction force of the road to the driving wheel, N.

The reaction force $R_{u1 \text{ of the road}}$ is equal to the pushing force R *, which is in the opposite direction to the rotation of the wheel.* This force is called the force against the rolling of the wheel.

displacement a_{sh1} to the wheel radius is called the coefficient of resistance to rolling, that is:

$$f_1 = \frac{a_{ш1}}{r_F} = \frac{P_{y1}}{R_1} \tag{2.2}$$

(2.2) it can be seen that the coefficient of resistance to rolling is equal to the ratio of the force causing uniform rotation of the wheel to the reaction force of the road.

The anti-rolling force is defined by the following expression:

$$P_{f1} = R_1 \cdot f_1, \text{ N} \tag{2.3}$$

rolling moment is equal to:

$$M_{f1} = R_1 \cdot f_1 \cdot r_F \quad , \text{ N·m} \tag{2.4}$$

r_F - wheel radius, m.

The rolling resistance coefficient depends on the type of road on which the wheel rolls, and its values are as follows:

for asphalt road…………0.018-0.020
for dirt road…………...0.02-0.035
for gravel road……………0.02-0.025
for sandy road………………0.10-0.30

1.2. Forces acting on the leading wheel

The reaction force acting on the leading wheel is directed in the direction of the vehicle (Fig. 2.2, p.).

The balance equation of moments for uniform rotation of the wheel is as follows:

$$M_{F2} - p_{y2} \cdot r_F - R_2 \cdot a_{ш2} = 0 .$$

Drive wheel torque:

$$M_{F2} = P_{y2} \cdot r_F + R_2 \cdot a_{ш2}, \text{ is equal to N·m.}$$

The test reaction force is determined as follows:

$$P_{y2} = \frac{M_{F2}}{r_F} - R_2 \cdot \frac{a_{ш2}}{r_F} = \frac{M_{F2}}{r_F} - R_2 \cdot f_2, \text{ N} \tag{2.5}$$

here, a_{sh2} - rolling resistance shoulder.

The reaction force R_{u2} is a pushing force, which is transmitted from the leading wheel to the frame of the car, and after the frame to the front wheel. The ratio of the torque of the wheel to its radius is called the traction force of the leading wheel, i.e

$$P_T = \frac{M_{F2}}{r_F}, \text{ N} \tag{2.6}$$

$R_2 \cdot f = P_{f2}$ since (2.5) the expression will have the following form:

$$P_{y2} = P_T - P_{f_2}, \text{ N} \tag{2.7}$$

P_f is different for the leading and leading wheels, because the values of a_{sh1} and a_{sh2} are different depending on the loading of the wheels, therefore the values of the coefficients of resistance to rolling are also different f_1 and *f will be* $_2$, they will not be equal to each other.

f_1 and f_2 are small on hard roads and large on soft roads.

1.3 Traction force of the car and its description.

of the variation of the vehicle's traction force with respect to the vehicle's speed is called the vehicle's traction profile.

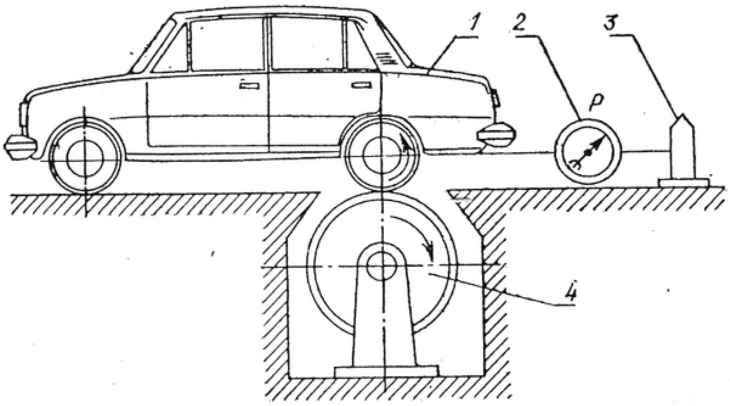
Traction force R_T *is the main driving force, which is equal to the moment* M_f transmitted from the crankshaft to the wheel of the engine divided by the radius of the wheel r_F and occurs due to the interaction of the wheel with the road and the gearing. (Fig. 20.2, p.)

The driving force R_t is opposite to the direction of movement of the car.

the wheel affects the road with force R_t*, its value is aks* R_u is equal to the impact force. So R_u the reaction force moves the car forward and it is R_t Since it is equal to R_k, it is called the pulling force.

The traction force of the car can be determined experimentally (Fig. 2 0 . 3).

The car is mounted on a fast rotating drum device with leading wheels. The rear part of the car is fixed to a fixed column (3) by means of a dynamometer (2) using a cable. When the engine is running, the throttle valve of the carburetor is fully open. With the help of an electric braking device, resistance to the rotation of the drum is created and its smooth rotation is achieved.



2 0 .3. Determination of traction force in a rotating drum device

R indicated by the dynamometer is the pulling force. If the rotation speed and radius of the drum are known, the number of revolutions of the traction wheel and the speed of the car can be determined. Traction force can be determined on the road using a dynamometer by measuring the torque on the propeller shaft or half-axles. If there are no experimental values of thrust force, it is determined by calculation using the external speed description of the engine.

6. The engine is a source of energy.

The power transmitted from the car engine to the driving wheels through the power transmission is the driving force of the car.

The amount of this force depends on the power of the engine, and the power depends on the number of revolutions of the crankshaft.

Effective N_{e} *of the engine* power, efficient comparative fuel g_{or} *The curves representing the change of* consumption and torque M_{e} depending on the number of revolutions of the crankshaft are called external speed characteristics of the engine.

The description of the external speed of the motor can be obtained by experiment and by calculation.

When obtaining the external speed description of the engine experimentally, the engine is installed on a special device and warmed up by running it. At this time, the throttle valve is fully open. With the help of a separate braking mechanism, the load is applied to the engine and the stable operation of the engine is ensured at a certain number of revolutions of the crankshaft. By changing the load, the effective torque M_{e}, effective power N_{e}, effective specific fuel consumption g_{or} and hourly engine fuel consumption G_{yo} is determined.

The main parameters of the engine are determined experimentally as follows:

Effective engine power:

$$N_e = 0{,}7355 \cdot 10^{-3} \cdot P \cdot n \text{, kW} \tag{2.8}$$

here; *R* - engine braking force, kg.

n - the number of revolutions of the crankshaft, ayl /min;

Effective torque:

$$M_e = 9554 \cdot \frac{N_e}{n}, \text{ N·m} \tag{2.9}$$

Hourly fuel consumption

$$G_{ё} = 3{,}6 \cdot \frac{\Delta G_{ё}}{\Delta t}, \text{ kg /hour;} \tag{2.10}$$

ΔG $_{yo}$ - fuel consumed during the experiment, g.

Δt - the time to continue the experiment, s.

Effective comparative fuel consumption:

$$g_{ё} = 10^3 \cdot \frac{G_{ё}}{N_e}, \text{ g /(kWh);} \tag{2.11}$$

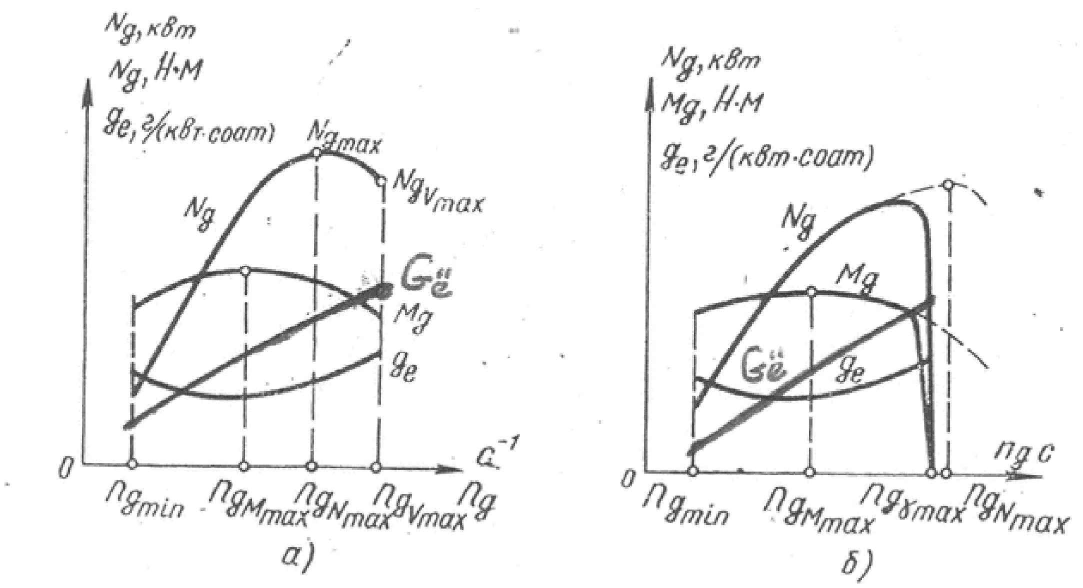


Figure 20.4, *a* and *b* show the external speed characteristics of a carburetor engine without a speed limiter (*a*) and with a speed limiter (*b)*

7. Description of the external speed of the engine.

minimum number of revolutions of the crankshaft n_{min} , the engine works stably at full load. As the number of revolutions of the shaft increases, the effective power and torque also increase.

$n_{N.max}$ of the crankshaft corresponding to the maximum value of the torque M_{emax} and the maximum power $N_{e.max}$, the corresponding number of revolutions $n_{N.max}$ indicators, specified in the technical description of the engine.

The number of revolutions corresponding to the maximum torque $n_{m.max}$ and the revolutions corresponding to the maximum power n *N.max in the operating conditions of the car engine* works more between the thighs.

The number of revolutions of the crankshaft is the number of revolutions at maximum power $n_{N.max}$ exceeds , filling of the cylinder with the fuel mixture worsens, engine power decreases as a result of incomplete combustion of the mixture and increased mechanical resistance, and increased load accelerates the wear of parts.

Therefore, when designing a car, the number of rotations suitable for driving it on a horizontal road with the maximum *speed* V *amax is* 10-.20% more than *N.max* .

moves at the maximum speed V_{amax} *, its maximum power is* N_{evmax} and the number of revolutions of the crankshaft at maximum power $n_{N.max}$ *is* the power in the desired number of revolutions of the car engine n_x according to the SRLeyderman formula N_e *The value of* N_{ex} at any point of the curve is determined by the following expression:

$$N_{ex} = N_{ev\max} \cdot \frac{n_x}{n_{N\max}} \left[a + b \cdot \left(\frac{n_x}{n_{N\max}} \right) - c \cdot \left(\frac{n_x}{n_{N\max}} \right)^2 \right], \text{kW} \qquad (2.12)$$

here, N_{eumax} - the maximum power of the car at the maximum speed, kBt;

a , *v* , *s* are the coefficients determining the type of engine,

- for a carburetor engine, *a* =*v* =*s* =is equal to 1;

a =0.87 for a diesel engine ; *v* =1.13; *s* =will be equal to 1.

Vehicle maximum speed $V_{a.max}$ The maximum engine power N_{evmax} when moving with is determined by the following expression:

$$N_{ev\max} = \frac{G_a \Psi V_{a.\max}}{1000\eta_{ky}} + \frac{KFV^3{}_{a.\max}}{1000\eta_{ky}}, \text{ kW} \qquad (2.13)$$

here, G_a - full weight of the car;

Ψ - road resistance, $\Psi = f \cdot \cos\alpha + \sin\alpha$, the slope of the road for the 2nd category road is equal $i = tg\alpha = 0{,}04$ to $\alpha = 2^0 18^1$;

K - air resistance coefficient,

- for a passenger car $K = 0{,}20....0{,}35$;

- for a truck $K = 0{,}55...0{,}60$;

- for the bus $K = 0{,}24....0{,}40$;

f - coefficient of resistance of the road to the rolling of the car wheel on the road, depending on the type of road, it is 0.018-0.020 for asphalt roads; ш 0.02-0.025 for gravel roads; 0.025-0.035 for a dirt road; for a sandy road is equal to 0.010-0.030;

F is the transverse surface of the car, m:

- for a passenger car, $F = 0{,}78 \cdot B_1 \cdot H$, m ^{2},

- for a truck, $F = B \cdot H$, m ^{2},

V_1 - the largest width of the car, m;

N - the maximum height of the car, m;

V - the distance between the front wheels of the car;

$\eta_{ку}$ - FI K of the car power transmission:

- for a passenger car - 0.90-0.92;

- for a cargo car - will be equal to 0.82-0.85.

The intervals of the number of revolutions of the crankshaft are taken as follows:

A) For carburetor engines:

$n_1 = n_{\min} = 400 \div 1200$ayl /min

$n_{max} = (1{,}1 \div 1{,}2) \cdot n_N$ up to eight intervals are accepted,

that is; $n_2 = 0{,}2 \cdot n_N$; $n_3 = 0{,}4 \cdot n_N$; $n_4 = 0{,}6 \cdot n_N$; $n_5 = 0{,}8 \cdot n_N$; $n_6 = 0{,}9 \cdot n_N$; $n_7 = 1{,}0 \cdot n_N$; $n_8 = 1{,}1 \cdot n_N$; and $n_9 = 1{,}2 \cdot n_N$;

B) For diesel engines:

$n_1 = n_{min} = 350 \div 700$ ayl /min n_N to four intervals, ie; $n_2 = 0{,}43 \cdot n_N$; $n_3 = 0{,}65 \cdot n_N$; $n_4 = 0{,}86 \cdot n_N$ and $n_5 = 1{,}0 \cdot n_N$ s are accepted, because the number of revolutions in diesels cannot be increased excessively, because the inertial force increases;

n_N – the number of revolutions at maximum power.

The desired effective torque of the engine at the desired number of revolutions n $_x$ of the crankshaft is determined by the following expression:

$$M_{e.x} = 9554 \cdot \frac{N_{e.x}}{n_x}, \text{N·m}, \tag{2.14}$$

The desired effective specific fuel consumption of the engine is determined as follows:

$$g_{e.x} = g_{e.N} \cdot \left[a - b\left(\frac{n_x}{n_N}\right) + c \cdot \left(\frac{n_x}{n_N}\right)^2 \right], \text{ g /(kWh)} \tag{2.15}$$

here, *a* , *v* , *s* are coefficients that take into account engine types:

- for a carburetor engine: *a* =1.2; *v* = 1.0; *s* = 0.8;
- for a diesel engine: *a* = 1.55; *v* = 1.55; *s* = 1.0; will be equal to;

g_{eN} - specific fuel consumption at maximum power, g/(kW·s).

The relative fuel consumption is determined by the following expression:

$$g_{e.N} = \frac{10^3 \cdot 3{,}6}{Q_n \cdot \eta_e}, \text{ g /(kW/s)} \tag{2.16}$$

where Q_p is the lower calorific value of the fuel:

- for gasoline, Q_p =43.93 MJ /kg;
- for diesel fuel, Q_p =42.50 MJ /kg;

η_e -the engine's effective efficiency:

for a carburetor engine η_e =0.25-0.33,

for a diesel engine η_e =0.35-0.40,

The desired hourly fuel consumption of the engine is determined by the following expression:

$$G_{ё.x} = 10^{-3} \cdot g_{e.x} \cdot N_{e.x}, \text{ kg /hour.} \tag{2.17}$$

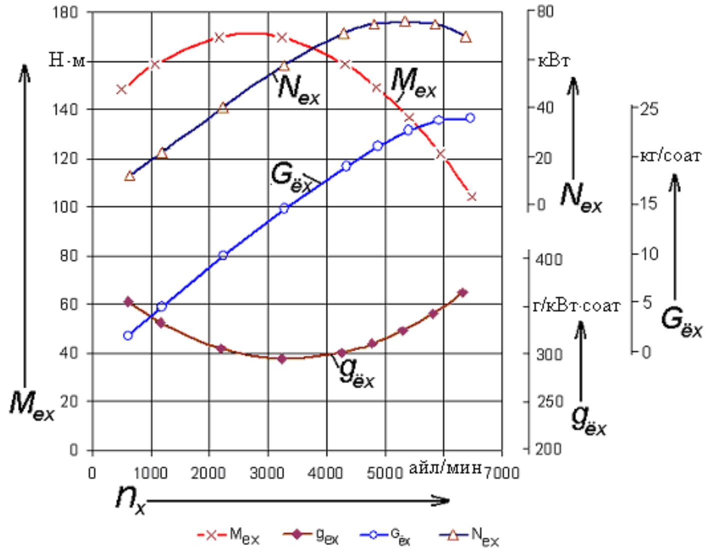
N_{ex} , M_{ex} , $g_{yo.x}$ and $G_{yo.x}$ *values* calculated by the number of revolutions of the crankshaft are filled in table 20.1.

Table 20.5

n_x rpm	Indicators of external speed description			
	$Ex_{.}$, kW	$M_{ex.}$, kW	$g_{no.x.}$, g/kWh	$G_{or\,x}$, kg/h

Based on the table, $N_{ex} = f(n)$, $M_{ex} = f(n)$, $G_{yox} = f(n)$ and $g_{yox} = f(n)$

graphs are constructed (table 2.5). This graph represents the external speed description of the engine (Fig. 2. 5).



20.5 - picture. Carburetor engine external speed characteristic graph .

1. Resistance forces acting on the vehicle

1.1 Wheel resistance force

Car wheels roll in three different conditions:

a) a wheel with an elastic tire moves on a solid road that does not deform;

b) a wheel with an elastic tire moves on a deformable track;

c) a rigid wheel moves on a deformable track.

The force of resistance to rolling depends on the force exerted by the weight of the load on the wheel, the deformation of the tire and the road, and the friction of the tire tread with the road surface.

When the vehicle moves on a hard surface road, the deformation of the wheel tire increases the rolling resistance force. The amount of this force is determined by the following expression:

On a straight road

$$P_f = (R_1 + R_2) \cdot f = G_a \cdot f \text{, N} \qquad (4.1)$$

here

R_1, R_2 – reaction forces acting on the front and rear wheels, N.

f - coefficient of resistance to rolling;

G_a is the full weight of the car, N.

The coefficient of resistance to rolling f is assumed to be the same for the front and rear wheels, except that 80 km/the coefficient of resistance to rolling is determined by f *0 at values of car speed less than 60 h, and* f at larger values :

the rolling resistance coefficient depends on the type and condition of the road, the construction of the tire, the cord layer, and the number of cord strands;

technical condition of the tire; the speed of the car; tire pressure; wheel slippage; will depend on factors such as roughness of the road.

the car 80 km/is moving at a speed higher than the hourly speed, the rolling resistance coefficient is determined using the empirical expression as follows:

$$f = f_0 \cdot \left(1 + \frac{V_{a.\max}^2}{2000}\right), \qquad (4.2)$$

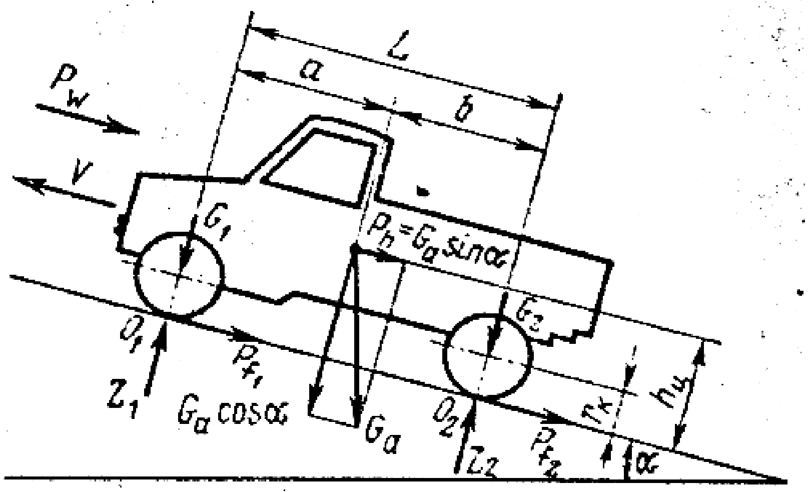
here; V_a is the speed of the car, km //h.

is a list of road types The values of are listed: $f_0(V_a < 80 км/с)$ will be

0.018-0.020 on a satisfactory paved road
0.023-0.030 on a gravel road
0.020-0.025 on a gravel road
0.025-0.035 on a dirt road
0.100-0.300 on a sandy road
0.070-0.300 on a snowy road
f are accepted in the calculations .

8. **The car's climbing resistance, rolling resistance, rolling resistance coefficient**

Highways consist of ups and downs, and there are also horizontal sections. The longitudinal slope of the road is determined by α the angle or *i* (Fig . 20. 6),



20 . Figure 6 . Forces and moments acting on a car climbing a slope.

ie $$i = tg\alpha = \frac{H}{B}$$

here, *H* is the height of the longitudinal section of the road, m.

B – road cross-section width, m.

As shown in Figure 20.6, the total weight of the car going uphill consists of components G_a, parallel to the road $G_a \cdot \sin\alpha$ and perpendicular $G_a \cdot \cos$. α The first of these is the force of resistance to the rise of the car, denoted by *R* , *that is:* $_\alpha$

$$P_\alpha = G_a \cdot Sin\alpha, \text{ N} \qquad (4.3)$$

When the car goes uphill, the force R_α resists the car's motion, and when the car goes downhill, it acts as a force pushing the car forward.

3. Air resistance, resistance coefficient, the energy required to overcome the resistance forces.

The wheel rolling resistance R_f and the car's uphill resistance R *together* $_\alpha$ form the total road resistance $R._\psi$

The total resistive force of the road is defined as:

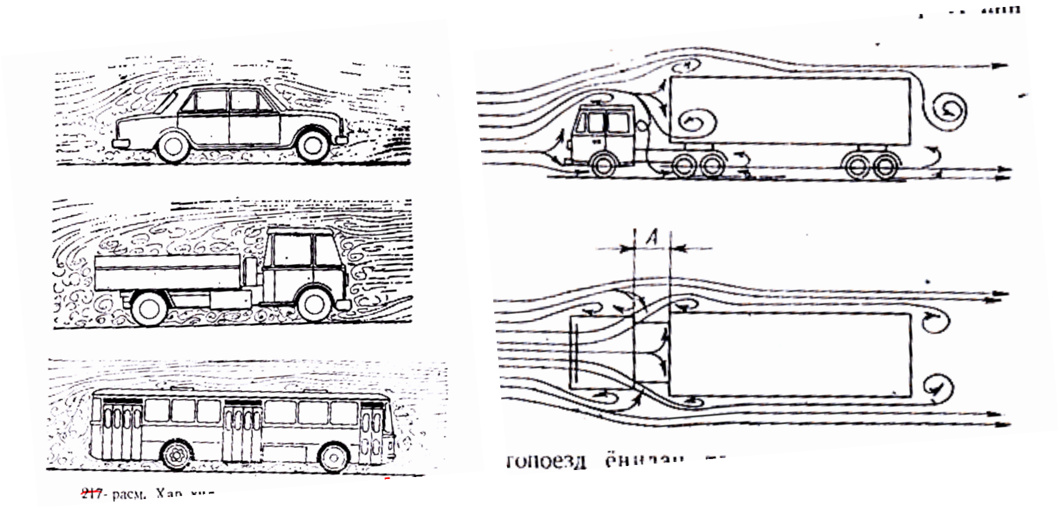
$$P_\Psi = P_f + P_\alpha = G_a \cdot (f \cdot \cos\alpha + \sin\alpha),\ \text{N} \tag{4.4}$$

If $\Psi = f \cdot \cos\alpha + \sin\alpha$ it is, and if we call it the total resistance coefficient of the road, then the resistance force of the road will be equal to:

$$P_\psi = G_a \cdot \Psi,\ \text{N} \tag{4.5}$$

3.1. Air resistance

A car encounters air resistance while driving on the road, and engine power is used to overcome it. Air acts on the front, sides and back of the car, creating a pressure force against the movement of the car (Fig. 20.7).



20.7 . Effects of air flow on different types of cars

The equal effector of these elementary forces is determined by the force of air resistance to the car $R_{w,}$ and its value is determined by the following expression:

$$P_W = K \cdot F \cdot V_a^2,\ \text{N} \tag{4.6}$$

K - air resistance coefficient;

F - surface of the car as seen from the front, m ^{2};

V_a is the speed of the car, m /s.

For trucks and buses, the surface of the vehicle is determined as follows:

$$F = B \cdot H,\ \text{m}^2 \tag{4.7}$$

for cars

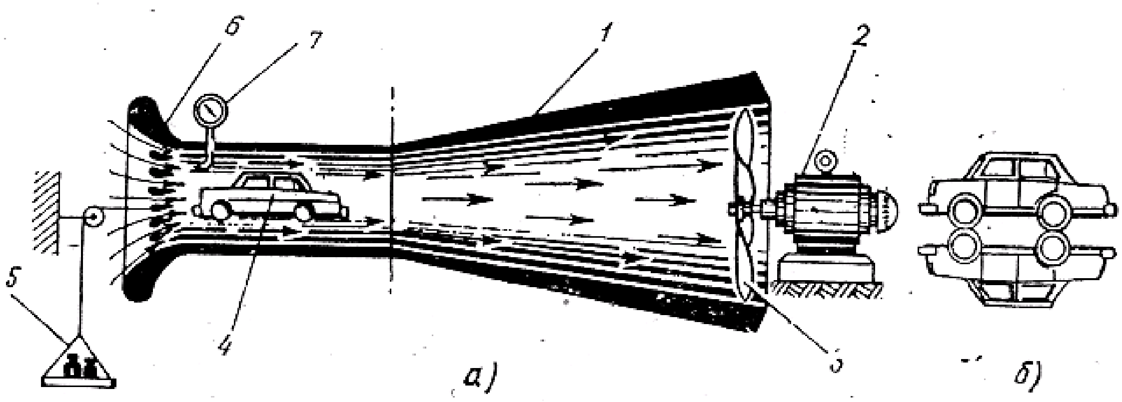
$$F = 0{,}78 \cdot B_1 \cdot H,\ \text{m}^2 \tag{4.8}$$

here; V - the distance between the front wheels of the car when viewed from the front, m;

N - the height of the car, m;

V_1 - car width, m.

Air resistance is determined using an aerodynamic tube (Fig. 20.8 , a)



20.8 . Aerodynamic pipe scheme

A car model 4 is hung inside the aerodynamic tube 1. A fan 3 with an electric motor 2 is installed inside the pipe, and a guide grid 6 corrects the air flow and prevents hydro-bloating at its entrance. loses. The air stream drawn in by the fan makes the car R_W tries to move with force, this resistance force occurs when the vehicle is moving at a speed equal to the speed of the air flow. R_W according to the indication of Libra 5 the force and the speed of the air flow are determined using the anemometer 7, and the value of the component is found if the front surface of the car is clear. A 1/5-1/10 scale model of the car is inflated in the aerodynamic tube.

A model car hanging on a pipe is affected by airflow from all sides, while in reality the air blows from the top and bottom of the car. Therefore, the value of *K* is smaller than the actual coefficient when blowing a single car in the pipe.

To eliminate this shortcoming, the experiment is conducted with two symmetrically placed car models (Fig . 20.8, b). The shape of the car greatly affects the direction of the air flow.

Aerodynamic drag has a negative effect on the vehicle's traction dynamics and fuel economy.

The coefficient of overcoming air resistance is determined by car type as follows:

for a passenger car with a closed body....0.20-0.30;
for buses..................................0.40-0.60;
for trucks.........................0.60-0.80;
for auto-trains...................................0.81-0.96;

Power to overcome the forces of resistance **.**

N_F reaching the driving wheels is used to overcome external resistance is called the power balance of the car.

It is known that the balance of forces of the car was equal to:

$P_T - P_f - P_\alpha - P_W - P_{ja} = 0$. To go from force to power, we multiply the left and right sides of the force balance equation by the velocity V_α and divide by 1000; As a result, we get the following:

$$N_T = \frac{P_T \cdot \vartheta_a}{1000};\ N_f = \frac{P_f \cdot \vartheta_a}{1000};\ N_\alpha = \frac{P_\alpha \cdot \vartheta_a}{1000};\ N_W = \frac{P_W \cdot \vartheta_a}{1000};\ N_{ja} = \frac{P_{ja} \cdot \vartheta_a}{1000}, \text{kW}$$

Based on these, the power balance equation is written as follows:

$$N_T = N_f + N_\alpha + N_W + N_{ja}, \text{ kW or} \tag{4.9}$$

$$N_e = \frac{N_T}{\eta_{ky}} = \frac{N_f}{\eta_{ky}} + \frac{N_\alpha}{\eta_{ky}} + \frac{N_W}{\eta_{ky}} + \frac{N_{ja}}{\eta_{ky}} \text{ kW} \tag{4.10}$$

Control questions.

1. Explain the towing capacity of a vehicle?
2. Why is towing capacity considered?
3. What is determined by calculating engine power?
4. of the main gear?
5. How is a geometric series defined?
6. The influence of factors encountered in operation on the drag-speed characteristic?

7. What forces act on the car?
8. Torques driving a car?
9. Explain that an engine is a source of energy?
10. Explain the description of motor external speed?
11. Experimental determination of motor external speed characteristics?
12. How to determine the number of revolutions of the toothed shaft?
13. How to determine the power of the engine crankshaft at the desired number of revolutions?
14. How to determine the engine torque for the desired number of revolutions of the crankshaft?
15. How to determine the relative fuel consumption for the desired number of revolutions of the engine crankshaft?
16. How is the hourly fuel consumption determined by the desired number of revolutions of the engine crankshaft?

2 1 -Topic: The equation of motion of the car. Methods of solving the equation. Acceleration of the car.

Plan.

1. Differential equation of motion of the car.
2. Inertia force.
3. Coefficient that takes into account the inertia force of rotating masses, methods of solving the equation
4. Traction and power balance graph.
5. . Speed of the car, rating indicators.
6. Acceleration of the car.
7. Acceleration graph and its analysis.

8. Calculation and graphic determination of the time and path taken to increase the speed.

Basic words and phrases . The differential equation of the car's motion, the inertial force, the coefficient that takes into account the inertial force of the rotating masses, the methods of solving the equation, the traction and power balance graph, the speed of the car, the evaluation indicators, the acceleration of the car, the acceleration graph and its analysis, the time taken to increase the speed and to calculate and determine graphically.

1. Differential equation of motion of the car.

1.1. The general equation of motion of a car and methods of solving it

The general equation of motion of the car is the driver R_t and the resistance P_f, P_α, P_w, P_{ja} connects the forces to each other.

If the forces acting on the car are condensed into the shadows on the road plane, the following equation is formed:

$$P_T - P_f - P_\alpha - P_W - P_{ja} = 0 \text{ or } P_T = P_f + P_\alpha + P_W + P_{ja} \quad (5.1)$$

The car moves at the following rates:

movement under the influence of gravity, overcoming resistance;

direct movement in the absence of gravity;

movement when braking force is applied.

The following dimensions determine the dynamics of the car during movement:

- maximum speed - V_{amax};
- dynamic factor of the car at maximum speed - $D_{a.vmax}$;
- total road resistance coefficient at maximum speed - φ_{vmax};
- the total resistance coefficient of the road when driving at the first speed - φ_{max} .

Due to the fact that there are no specific functional links connecting the forces and the speed included in the general equation, the following graphical methods are used to solve it:

- using the balance of forces and its graph.
- using the power balance and its graph.
- using dynamic factor and dynamic passport graphics.
- balance of forces and power of the car.

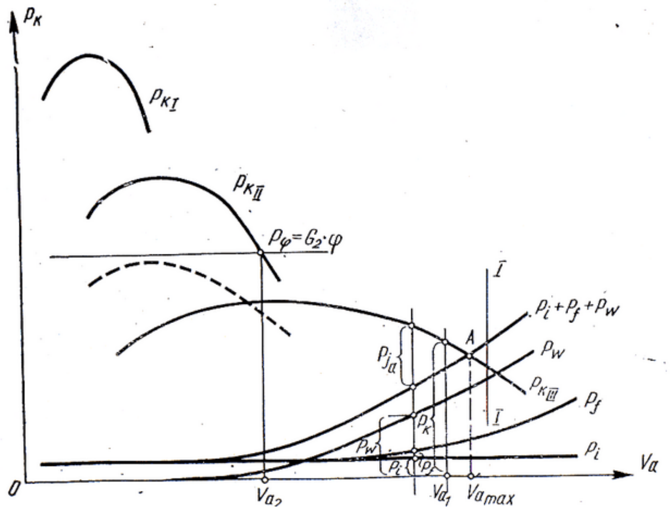
1.2. Balance of forces acting on the car .

The equation of motion of the car is defined by the following expression:

$$P_T - P_f - P_\alpha - P_W - P_{ja} = 0 \text{ or } P_T = P_f + P_\alpha + P_W + P_{ja}$$

This equation is called the car's force or traction balance equation, which can be solved graphically as shown in Figure 21.1.

The graph in the figure $P_f = f(\vartheta_a), P_\alpha = f(\vartheta_a)$shows $P_W = f(\vartheta_a)$the line of functions.



21 .Figure 1. Balance of forces equation and its solution .

When the resulting curves are added graphically, $P_f + P_\alpha + P_W$ a curve is formed.

A, where the sum of the total resistances intersects the *R* $_{T\ line}$, shows the value of the car's traction force, which is necessary for the car to overcome these resistances at a constant maximum speed.

Traction force *R* $_T$ The distance between the lines and the lines is $P_f + P_\alpha + P_W$ *R* $_{ja}$ ordinate, which is the unused part of the traction force, which is used to give acceleration to the car.

the R $_w$ force graph and the abscissa axis gives the value of *R* $_{w\ on\ the\ scale}$, the ordinate between the *R* $_w$ graph and *R* $_{f\ gives}$ *the R* $_f$ force on the scale, the ordinate between the *R* $_\alpha$line and the abscissa axis gives the value of *R* $_w$ force on the scale. With this method, the speed of the car is determined depending on the road conditions, and the cargo and passenger transportation is planned based on this speed.

2. Inertia force.

2.1. Resistance to the acceleration of the car (inertia force).

A car consists of two different masses; forward moving body, cab, load and rotating wheel, crankshaft, flywheel, pinion, shafts. Therefore, when the car is moving on the road, its inertia force *R* $_{j\ \alpha}$is affected by the advancing and rotating moving masses.

In addition to forces, the rolling of the front and rear wheels of the car $M_{f_1} : M_{f_2}$ is affected by moments of resistance and M_{ja_1}moments of inertia of the wheels. $M_{ja_1} : M_{ja_2}$

R $_{j\ \alpha}$generated by forces and moments acts on the center of gravity of the car and resists the acceleration of the car, and its direction is opposite to the direction of the car's movement. The inertial force acting on the car is defined by the following expression:

$$P_{ja} = -\frac{G_a}{g} \cdot \delta_{айл} \cdot j_a \text{, H} \tag{5.2}$$

here, g is the free fall acceleration of the body, g = 9.81, m/s ^{2};

δ_{ayl} is a coefficient that takes into account inertial forces and moments of inertia of rotating masses;

j_a acceleration of the car, m /s ^{2}.

that takes into account the rotating masses δ is determined by the following empirical expression:

$$\delta_{айл} = 1{,}04 + 0{,}04 \cdot U^2_{у \cdot к}, \tag{5.3}$$

here, U_{uq} is the transmission number of the gearbox. The acceleration of a car when overtaking a car is determined by the following expression:

$$j_a = \frac{(P_т - P_W - P\psi) \cdot g}{\delta_{айл} \cdot G_a} \text{, m/s}^2 \tag{5.4}$$

2.2. Reactive forces

When the car is stationary without moving, it is not affected by external resistance forces, only the weight of the car G_a creates reaction forces R_1 and R_2 *on the front and rear wheels (Fig. 21.2):*

We write the following from the condition of the balance of the moments generated by the forces relative to the front and rear axles of the car:

moments about the front axle:

- $R_2 \cdot L + G_a \cdot a = 0$ from this, $R_2 = \frac{G_a \cdot a}{L}$, N moments relative to the rear axle

$R_1 \cdot L - G_a \cdot в = 0$ from that, $R_1 = \frac{G_a \cdot в}{L}$, N

here, L is the distance between the front and rear wheels (vehicle base), m.

a - the distance from the front wheel axis to the center of gravity, m.

$$a = \frac{G_1 \cdot L}{G}; \tag{5.5}$$

v - the distance from the center of gravity to the axis of the rear wheel, m.

$$в = \frac{G_2 \cdot L}{G}; \tag{5.6}$$

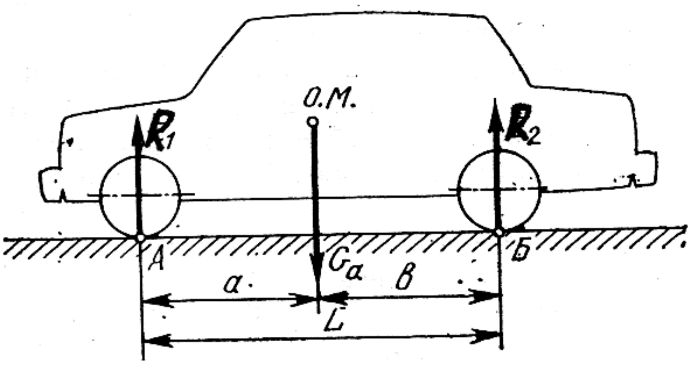


Figure 21.2. Gravity and reaction forces acting on a stationary car on a horizontal road.

When the car moves uphill under the influence of all internal and external forces and moments, the normal reactions of the road acting on the wheels R_1, R_2

change under the influence of the forces and moments acting on the car, i.e.:

$$R_1 = \frac{G_a \cdot в}{L} = \frac{G_a \cdot в \cdot cos\alpha}{L} - \frac{P_f \cdot r_F + P_W \cdot h_W - P_{ja} \cdot h_g + P_\alpha \cdot h_g - M_{jF}}{L};$$

$$R_2 = \frac{G_a \cdot a}{L} = \frac{G_a \cdot a \cdot coo\alpha}{L} + \frac{P_f \cdot r_F + P_W \cdot h_W - P_{ja} \cdot h_g + P_\alpha \cdot h_g - M_{jF}}{L}$$

here, h_w, h_g,-the height of influence of wind and inertia force, m;
M_{jF} - moments of inertia of all wheels, N.

increases with the road deviation angle α, vehicle acceleration and resistance forces .

The weights of gravity on the front and rear axles are G_1 and G_2 how many times its size compared to is determined by weight distribution coefficients as follows:

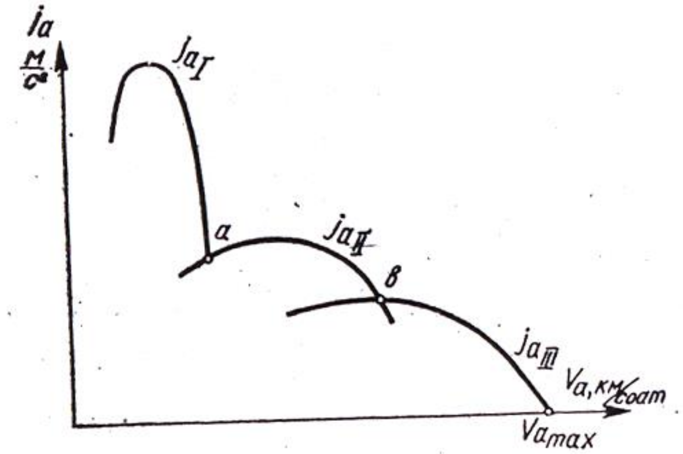
$$m_1 = \frac{R_1}{G_1}; (5.7) \quad m_2 = \frac{R_2}{G_2}. \qquad (5.8)$$

The values of these coefficients are as follows:
for the front axle...... m_1=0.55-0.7;
for the rear axle............ m_2=1.2-1.35.

3. The coefficient taking into account the inertial force of rotating masses, methods of solving the equation

Coefficient of rotating masses. For each extension, it is defined as:

$$\delta_{айл} = 1{,}04 + 0{,}04 U^2_{у.к} \qquad (5.9)$$



21 .Figure 3. Description of the acceleration of cars

where *U is the gear ratio of* *the uk* gearbox. Since the dynamic *D* factor is determined for 8-10 speed values of each gear, the same value of acceleration is also determined for each gear Fig. 21.3. Dimensions of acceleration include speed time and distance. The speed, distance and time of the car are determined using special mechanisms.

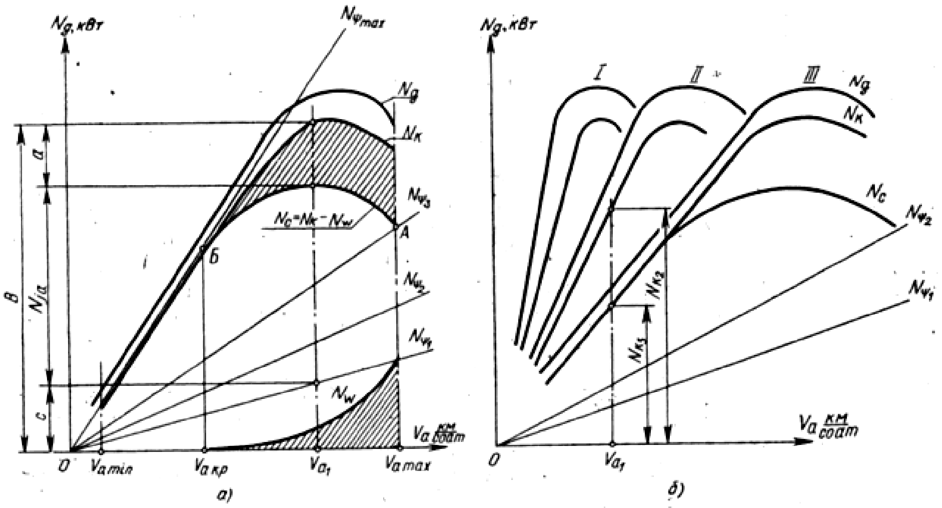
4. Traction and power balance graph.

To solve the power balance equation (4.10) graphically, we consider the car moving in a gear.

Using the graph of the external speed characteristic of the engine , we draw a graph of N_e , if the power spent to overcome the resistances in the power transmission is subtracted N_{ku} *from the* N_e *value* , that is $N_e - N_{ky} = N_T$, the power on the leading wheel N_T comes out. The powers on the right side of the equation above are on the graph

$$N_e = f(V_a)\ N_T = N_e \cdot \eta_{ky} = f(V_a),\ N_f = f(V_a),\ N_a = f(V_a),\ N_w = f(V_a)$$

lines . N_f , N_α and N_w are assumed to be constant when drawing graphs . $f = const$ Therefore, these lines consist of straight lines (Fig. 21.4).



21 .Figure 4. Power balance of the car and its solution.

In the graph, N_e is the effective power of the engine, kW, N_T is the traction power on the leading wheel of the car, kW.

We solve the power balance equation graphically in order to clearly visualize the distribution of engine power at each speed of the car.

V_α, number of revolutions n) are placed on the abscissa axis in the figure in order to relate the power N_e *of the engine* and the power spent to overcome all resistances, the speed of the optional transmission of the car with the number of revolutions of the engine crankshaft . The power value is placed on the ordinate axis.

arbitrary speed $V_{\alpha 1}$.

As can be seen from the graph, the difference between the power supplied to the leading wheel and the power used to overcome the wind force is the unused part of the power, and it is denoted by N_s .

The unused part of the power is used to increase the acceleration of the car by overcoming the resistance of the road. At the point *A where* N_ψ lines intersect with N_T , the car will have the greatest speed.

Using the graph, the power delivered to the leading wheel $N_T = N_e \cdot \eta_{ky}$, kW, and the power spent to overcome the road resistance $N_\Psi = N_f + N_\alpha + N_W$, kW, are determined.

Using the intersection points, the value of the forces in the balance of forces, the desired speed of the car V_{a1} or the desired number of revolutions of the crankshaft is determined as follows:

$$N_e - N_T = N_{ку};\ \ N_\Psi - N_a = N_W;\ \ N_T - N_W = N_c;$$

$$N_\alpha - N_f = N_э \text{ and } N_f = N_f$$

A, the speed to the right always slows down because the road snow is greater than the traction force applied to the leading wheel, i.e.:

$$N_\Psi > N_T$$

A, there is excess power that is not expended, and the power expended for traction is greater than the power expended to overcome road resistance, i.e.:

$$N_T > N_\Psi$$

This power tends to give acceleration to the car. Therefore, unused excess power (N_s) is used to drive the car.

5. Speed of the car, evaluation indicators.

When the car is moving on the street, especially on the city streets, its speed is always changing.

For example, cars used in the city move with 15-25% flat motion, 30-45% flat acceleration and 30-40% braking. Hence, the dynamics of a vehicle in variable motion is measured by the distance and time required for acceleration and velocity changes.

6 Acceleration of the car.

From the dynamic factor formula, the acceleration of the car is equal to:

$$j_a = (Д_a - \psi) g / \delta_{айл},\ \text{m/s}^2 \qquad (7.1)$$

of the dynamic factor (for each gear) in this formula are determined for both speeds , and the value of the ps coefficient is given. The coefficient of rotating masses d $_{ayl}$ is found for each gear as follows:

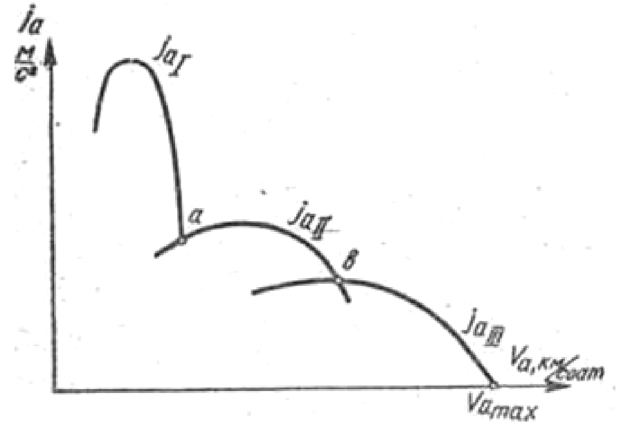
$$\delta_{айл} = 1{,}04 + 0{,}04 U^2_{у.к} \qquad (7.2)$$

U_{uk} to this formula are set to the values for the desired extension. If the gearbox installed in the car has three gears, their acceleration values are calculated separately.

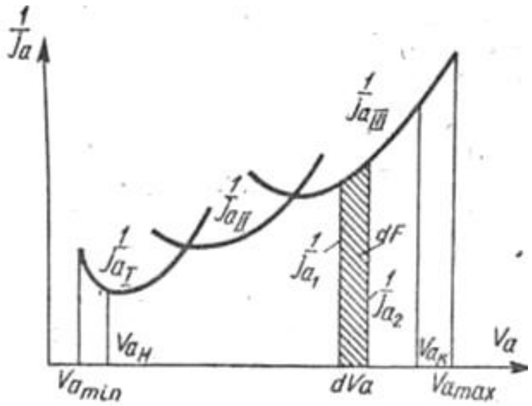
Since the dynamic factor is determined for 8...10 speed values of each gear, it is necessary to determine the acceleration value for each gear . 21.5, shown in Fig. *a* , *v* the acceleration values at the points are closest to the acceleration values for the adjacent gears , which is optimal for adding gears because the car has a maximum speed in each gear . As a result, the dynamic load on the car is reduced.

7. Acceleration graph and its analysis.

Car noise IS CHECKED IN the horizontal q name of the path . When the car is moving at a minimum speed, the driver presses the accelerator pedal and holds it until the car reaches the maximum speed. Moves from gear to gear as quickly as possible. The speed, distance and time of the vehicle are automatically recorded using mechanical devices . The distance covered by the vehicle during the period of rapid acceleration *is S* and time *t* is found.



21 . Figure 5 . Acceleration graph of the car



21 . Figure 6 . A graph of reverse acceleration values for a three-speed gearbox

The dynamic factor Dα in the expression *is determined* for each transmission and for the speeds, for which the value of the coefficient *ps* is given.

When the car moves with acceleration, it can be determined by the analytical method of the traveled distance and time.

The acceleration of the car is equal to the product of speed times time, that is:

$$j_a = \frac{dV_a}{dt} \text{ where } dt = dV_a / j_a$$

from speed V_1 to speed V_2 *is determined as follows:*

$$t = \int_{V_1}^{V_2} \frac{dV_a}{j_a} \qquad (7.3)$$

from speed *V1* to speed V2 is determined *as follows* .

$$S = \int_{t_1}^{t_2} V_a dt \qquad (7.4)$$

Solving these integrals is difficult because j_a with V_a and V_a and there are no connections between them.

As can be seen from the formula, the analytical calculation of the path and time in the movement with the shigov is much more difficult and takes a lot of time. Acceleration distance and time can be easily determined from the acceleration graph by the graphical integration method. For this, it is necessary to build a graph that is inverse to the acceleration of the car $\frac{1}{j_a} = f(V_a)$(Fig. 7.2).

Speed V_{an} from V_{ak} The time taken to increase to is equal to the sum of elementary surfaces bounded by T , and $\frac{1}{j_{a1}}$dV $\frac{1}{j_{a2}}$ a , that is, here $m_{\frac{1}{j_a}}$, m_{and} , are the scales for the parameters on the ordinate and abscissa axes; F - V_{an} and V_{ak} is the surface bounded by the line of inverse accelerations and the abscissa axis.

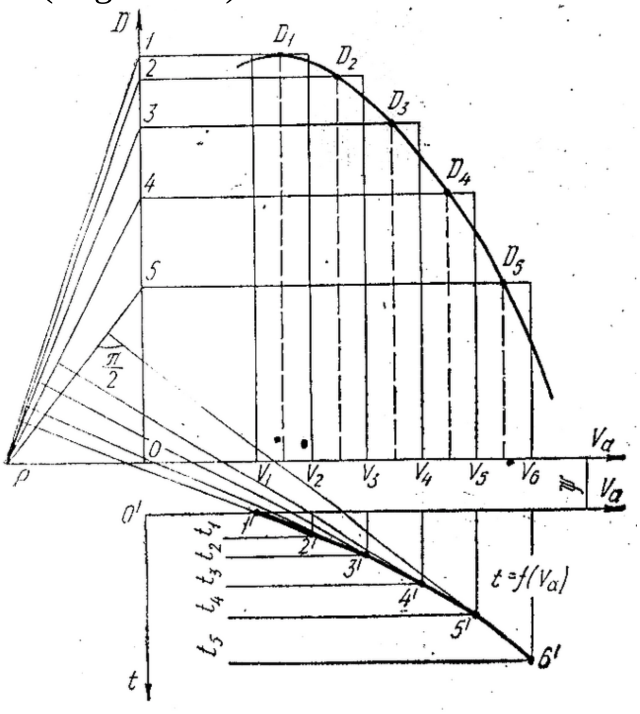
F the surface can be determined by planimetry. As a result, the value of the above formula can be determined and the function $T = f\ (\ V_a\ )$ can be drawn as shown in figure 7.2.

During the integration period of the graph in Fig. 7.2, as the speed approaches $V_{amax\ ,\ the\ acceleration}$ j_a tends to zero, as a result, $\frac{1}{j_{aIII}}$ the line approaches the ordinate corresponding to $\frac{1}{j_{aIII}} = \infty$ $V_{amax\ ,\ i.e.}$.

8. Calculation and graph of the time and path taken to increase the speed method to determine.

Therefore, these equations can be solved in an additional graphical way.

For this, it is necessary to have a graph of the dynamic factor built for one transmission of the car (Fig . 21. 7).



21 . Figure 7 . Determining acceleration time graphically.

PS below the abscissa axis . m_t to the ordinate axis we put the time in seconds on the scale.

So m_t =c/mm. Velocities $m_v = \frac{м/с}{мм}$ will be the scale of the axis.

On the left side along the abscissa axis, we mark an optional OR section.

The amount of the OR section is determined as follows.

$$OP = \frac{(m_t \cdot m_Д)}{m_v}$$

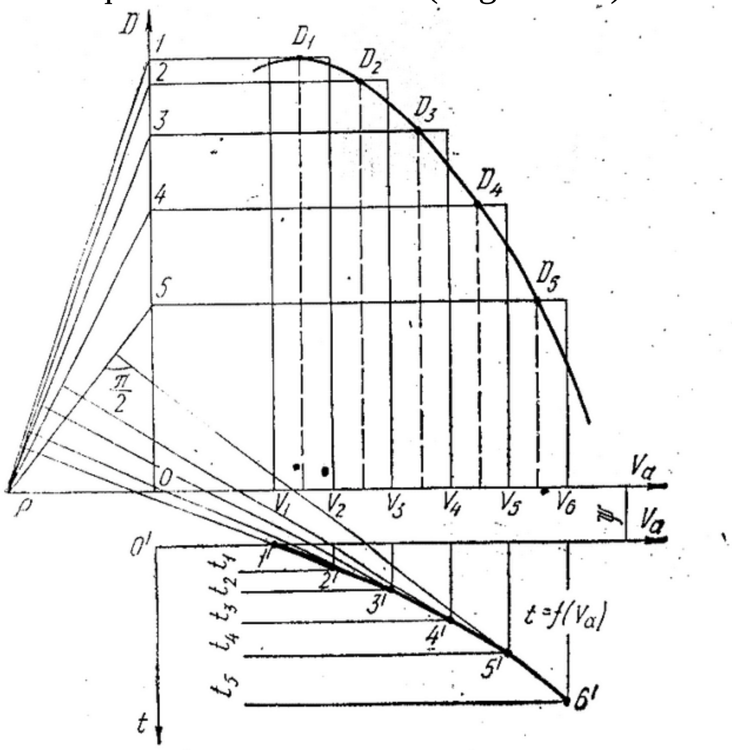
here m_D is the scale of the ordinate of the dynamic factor, (N/mm).

To determine the acceleration time, use the graph of the dynamic factor V_1-V_2; V_2-V_3; V_4-V_5; V_5-V_6, we divide into pieces. We assume that the dynamic factor will have an invariable average value within these segments, i.e. D_1, D_a, D_3-D_5. To find the time it takes for the speed of the car to change from V_1 *to* V_2, *we drop the shadow of the average dynamic factor* D_1 on the ordinate axis and connect it to *the pole* *P*. Then we pass the shadow of the speed V_1 on the lower axis 1^1 perpendicular to the section 1R. This is continued until the perpendicular intersects the 2 .point ^{1}The defined 1^1-2^1 cross section shows the change in time spent as the velocity changes from V_1 to V_2. Similarly D_2 to find the time when V_1 to V_2 *changes* We connect the shadow 2 with the pole *R* and pass it perpendicularly through the point 2^1. The transferred perpendicular is continued to 3^1 points. In this way, it is possible to determine the time spent for each speed section. The total acceleration time is determined as follows:

$$t = t_1 + t_2 + t_3 + \text{--}..t_n. \qquad (7.5)$$

The broken lines defined in the graph are the function *t= f (Va)*.

When determining the acceleration path, the description of the dynamic factor divided into parts with equal distances is used (Fig . 21. 8).



21 . Figure 8 . Determining the path of acceleration graphically.

S is placed on the ordinate of the coordinate system built for the distance *PS* below . The scale of the acceleration path is defined as follows (m/mm):

$$m_S = \frac{g}{\delta_{айл}} \frac{m_v^2}{m_Д}$$

We connect the points 1, 2, 3, 4, 5 with the average dynamic factor of each section with the coordinate head. Vehicle speed V_1 to V_2 to determine the distance covered in time sh, we pass a perpendicular from point *a* to 10, the continuation of the perpendicular continues to point *v* . *the distance* from *point a* to point *v* is S_1, which traveled until it reached the speed from V_1 *to* V_2 means 'l. To determine the distance when the speed changes from V_2 *to* V_3 , we pass a perpendicular to 20 from point *v* and continue it to point *C. The distance* from *V* to *S* represents the distance traveled by S_2 before the velocity reaches V_2 to V_3. If the distances are determined by this method for each part of the velocity, it will have a broken line representing $S=f(V_a)$.

The value of the total path traveled by acceleration is equal to the sum of the distances traveled in some parts of the speed, i.e.:

$$S= S_1 + S_2 + S_3 +-. S_n .$$

Control questions

1. What forces resist the car's motion?
2. What forces act on the driving wheel?
3. What force causes the wheel to roll?
4. What are the slope and resistance forces of the road?
5. What is the force resisting acceleration?
6. What are reaction forces, how are they defined?
7. What is the balance of power?
8. What is the balance of power?
9. How to determine the coefficient that takes into account the inertia force of rotating masses.
10. Explain how fast the car is?
11. Explain the indicators that evaluate the speed of the car?
12. Explain the acceleration of the car?
13. What is the graph of the car's acceleration?
14. How is the time taken to increase the speed determined?
15. How is the time and distance taken to increase the speed determined?
16. Explain the nature of velocity vs time graph?

2 2 - Topic: Braking feature of the car.

Plan :

1. Braking characteristics of the car, evaluation indicators.
2. Differential equation of motion during braking.
3. Maximum deceleration of the car, normal reaction forces during braking.
4. Braking distance and time, total stopping time and distance.
5. Optimal distribution of braking forces, distribution coefficient.
6. Operational factors that affect braking properties in operation.

Key words and phrases: Vehicle braking characteristics, evaluation indicators, differential equation of motion during braking , maximum deceleration of the vehicle, normal reaction forces during braking, braking distance and time, total stopping time and distance, braking forces optimal distribution, distribution coefficient, operational factors that affect braking characteristics in operation.

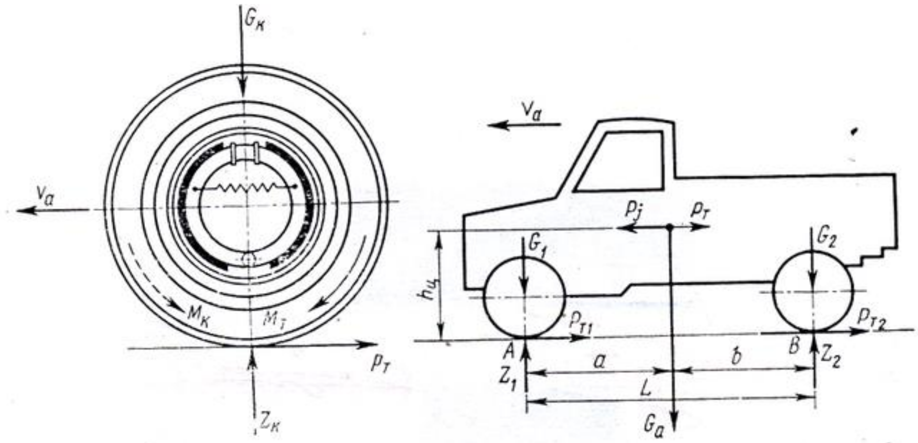
1. Braking characteristics of the car, evaluation indicators.

Braking performance indicates the vehicle's ability to slow down and brake effectively.

The characteristic of braking is the opposite of the characteristic of traction, and useful work is not performed during braking, but the driving force of the car is converted into heat energy and dissipated into the atmosphere.

All cars are equipped with brake control to reduce the speed of the car or stop it completely.

During braking, friction occurs between the brake pads and the brake drum. As a result, a friction torque is created that resists the rotation of the wheel (Fig. 22.1 a).



22 .Figure 1. a) forces acting on the wheel when braking,
b) the forces acting on the vehicle during braking

2. Differential equation of motion during braking.

The traction force between the wheel on the leading wheel of the car and the road surface is as follows:

$$P_y = P_\psi + P_{ja} + P_{торм} \tag{9.1}$$

if we put the value of acceleration force in this expression

$$P_y = P_\psi + \frac{G_a}{g}\delta_{айл} \cdot j_a + P_{торм}, \text{ we generate N} \tag{9.2}$$

We determine the acceleration from this expression:

$$j_a = \frac{g}{G_a \cdot \delta_{айл}}(P_y - P_\psi - P_{торм}) = \frac{g}{G_a \cdot б_{айл}}(P_y - \sum P), \text{ m/s}^2 \tag{9.3}$$

the sum of all the resistances $\sum P = (P_y + P_{торм})$ is equal to the displacement force, the motion of the car is plane motion; $P_y = \sum P$ if the effort $P_y \rangle \sum P$ is a force, the movement of the car will be accelerated; if the effort $P_y \langle \sum P$ if there is, the movement is decelerating.

the car braking force instead of the effort force, $P_{тор}$ the equation of motion of the car during deceleration or braking is formed;

$$j_a = \frac{g}{G_a \cdot \delta_{айл}} \cdot (P_{торм} - \sum P) \text{, m/s}^2 \quad (9.4)$$

During braking, $P_{тор}$ the direction of P_y is opposite to that of . To determine the maximum deceleration for a flat road $\sum P$, we substitute $G_a \cdot \varphi + G_a \cdot \psi + P_w$, and generate the acceleration of the car during braking:

$$j_a = \frac{g}{\delta_{айл}} \cdot (\varphi + \psi + \frac{P_w}{G_a}) \text{, m/s}^2 \quad (9.5)$$

3. Maximum deceleration of the car, normal reaction forces during braking.

Basically, the kinetic energy accumulated in the car stops (Fig. 22.1) .

The kinetic energy of a car traveling at a given speed is:

$$E_k = \frac{m_a \cdot V_a^2}{2}, \quad (9.6)$$

here, m_a – car mass, kg;

V_a – vehicle speed, m/s.

During braking, kinetic energy is converted into heat energy and dissipated to the environment. During braking, a certain work is done and this work is equal to the kinetic energy, that is:

$$\frac{m_a \cdot V_a^2}{2} = P_T \cdot S_T \quad (9.7)$$

here, P_T – the reaction force generated between the wheel and the road surface during braking, H; (Fig. 9.1 b) S_T – braking distance, m. $m_a = G_a / g$

The braking force of a speeding car to come to a complete stop must be equal to:

$$P_T = \frac{G_a \cdot V_a^2}{2 \cdot g \cdot S_T} \text{, N} \quad (9.8)$$

In order for the car to fully brake, this condition must be met, that is:

$$P_T \le P_\varphi = \varphi \cdot G_a \quad (9.9)$$

There are two types of inspection of a moving vehicle;

the friction force generated in the engine and brakes;

2) when the engine is disconnected from the power transmission, the car stops only due to the braking mechanism.

4. Braking distance and time, total stopping time and distance.

Braking time, path and graph. The main dimensions that determine the quality of car braking include car deceleration during braking j_a (m/s ^{2}), braking time t_T (s) and braking distance S_t (m). Theoretical values and practical values of these indicators can be determined.

Braking time. When the car brakes, its acceleration and speed decrease. In this case, the amount of acceleration decreases and the sign becomes negative.

The amount of acceleration is determined as follows:

$$j_a = -\frac{dV_a}{dt_T}\varphi \cdot g \text{, m/s}^2 \tag{9.10}$$

from this $dt_T = -\frac{dV_a}{\varphi \cdot g}$ we derive . Integrating this expression, we get the braking time:

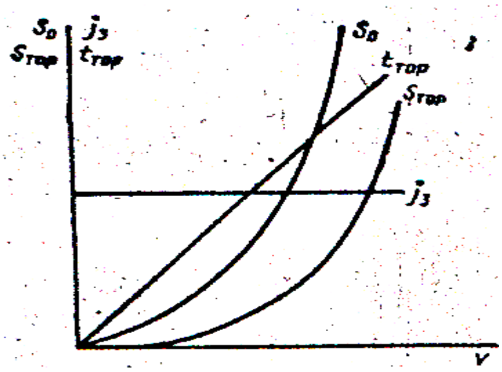
$$t_T = \int_{V_a}^{V_o} \frac{dV_a}{\varphi \cdot g} = \frac{V_a - V_o}{\varphi \cdot g} \tag{9.11}$$

where V_a, V_o – the initial and final speed of the car, m/s; φ – Coefficient of bite between tire and road surface, g – acceleration of free fall, m/s ^{2} .

Since the final speed when braking the car is equal to (9.11), the expression is written as follows: $V_o = O$

$$t_T = \frac{V_a}{\varphi \cdot g} \text{, s} \tag{9.12}$$

So the car braking time changes in direct proportion to the car's speed, (Fig. 22.2)



22 .Figure 2. Change in braking measurements

Braking track.

The path traveled by the vehicle from the time the brakes are activated until the vehicle is fully braked is called the braking distance.

It is known that since $dt_T = \frac{dS_T}{V_a}$ and $dt_T = -\frac{dV_a}{\varphi \cdot g}$ are equal, $dS_T = -\frac{V_a \cdot dV_a}{\varphi \cdot g}$ it is generated.

this expression, we form the braking path, that is:

$$S_T = \int_{V_a}^{V_o} \frac{V_a \cdot dV_a}{\varphi \cdot g} = \frac{V_a^2 - V_o^2}{2 \cdot \varphi \cdot g} \tag{4.11}$$

If $V_o = O$, $S_T = \frac{V_a^2}{2\varphi \cdot g}$, is equal to .

Therefore, the braking distance of the vehicle depends on the square of the speed, and as the speed increases, the braking distance increases rapidly. (Figure 22.2) braking time t and distance S *t determined by the theoretical method* do not take into account many factors, so their actual values in practice are more than 20-60 percent. Therefore, in order to relate the equations to each other, they are multiplied by the effective coefficient of braking, and the equations have the following form:

$$t_T = \frac{K_э \cdot V_a}{\varphi \cdot g}, \text{ s} \quad S_T = \frac{K_э \cdot V_a^2}{2 \cdot \varphi \cdot g}, \text{ m} \qquad (4.12)$$

where is $K_э$ – the effective braking coefficient.

Braking time and braking path actually consist of several sections, and separate work processes are performed in each section (Fig. 22.3)

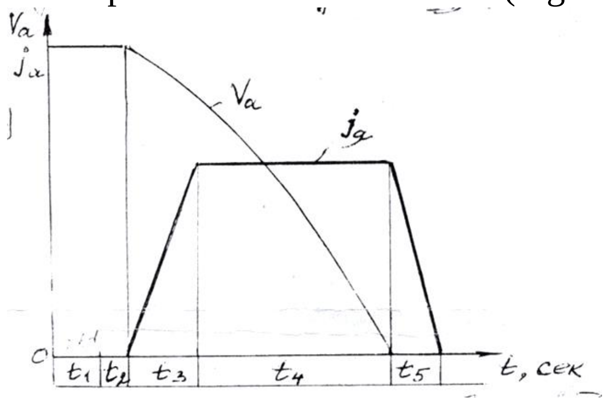


Figure 22.3. Car braking graph

Braking time and distance depends on the skill of the driver, the type and condition of the brake mechanism and operation, and the type of road surface.

Braking time includes the following:

Driver's reaction;

The operating time of the brake control.

Deceleration rise time;

Full braking time;

Deceleration period.

<u>Driver's reaction</u> t_1 the driver receives a braking signal, analyzes the signal and prepares for braking. This time depends on the skill and psychological state of the driver and is equal to 0.6-1.0 seconds.

<u>The operating time of the brake control</u> t_2 At the time of departure, the direct path of the brake pedal is selected and the brake is activated using the drive and mechanism.

The amount of this time depends on the type of handling (mechanical, air, hydraulic), for hydraulic handling t_2 = 0.03-0.05 s and for air handling t_2 =0.2-0.4 s is equal to

<u>Deceleration rise time</u> t_3 from the start of the brakes until the maximum deceleration is reached, t_3 *=0.15-0.2 s for the hydraulic brake, and* t_3 *=1 c* for the air brake .

<u>Full braking time</u> t_4 continues from the greatest deceleration until the speed of the car is reduced to the required amount. This time depends on the initial speed of the car V_a and the gear ratio, and its value is determined as follows: φ

$$t_4 = \frac{V_a}{g \cdot \varphi}, \text{ p} \tag{4.13}$$

This value is t_4 =0.2-0.3 s for a hydraulic brake; for an air brake is equal to t_4 =1.5-2.0 s.

<u>Deceleration time</u> t_5 =0.2-1.8 s, and this time is longer in air brakes.

The total braking time is defined as:

$$t_T = t_1 + t_2 + t_3 + t_4 + t_5 \tag{4.14}$$

These times are shown in Fig. 22.3 of the car's braking graph .

The braking distance S_T is equal to the sum of the distances covered in the indicated times, that is:

$$S_T = V_a \cdot (t_1 + t_2 + t_3) \tag{4.15}$$

Full braking time t_4 is determined by the expression of Professor DP Velikanov as follows:

$$S_4 = V_a \cdot (t_1 + t_2 + t_3) + \frac{K_э \cdot V_a^2}{2g \cdot \varphi}, \tag{4.16}$$

here; is the effective coefficient of braking, $K_э$ – which is equal to for a truck and $K_э = 1{,}2 ... 1{,}4$ a passenger car for a bus. $K_э = 1{,}2$

Braking distance for a passenger car S =7.2 m; S_{T} *=9.2 m* for a 2-5 ton truck and S_T =11.0 m for a truck and bus over 5 tons .

5. Optimal distribution of braking forces, distribution coefficient.

To determine the distribution of the car's braking force between the car's axles, we use the forces acting on the car with the engine disconnected from the power transmission (Fig. 22.1, b) P_t. The force of the wind P_w is not taken into account, because these forces are always involved in the braking of the car.

fulcrum of the rear wheel B:

$\sum M_B = O; \quad Z_1 \cdot L - G_a \cdot b - P_T \cdot h_M = O,$ from this

$$Z_1 = (G_a \cdot b + P_T \cdot h_M) / L \tag{9.17}$$

where h_M – is the height of the center of gravity. We construct the equation of moments of the front wheel relative to the reference point A :

$\sum M_A = O; \quad Z_2 \cdot L - G_a \cdot a + P_T \cdot h_M = O$ from this

$$Z_2 = (G_a \cdot a - P_T \cdot h_M) / L \tag{9.18}$$

It can be seen from the expressions that during braking, the reaction forces on the front wheel increase, and those on the rear wheel decrease.

It is known that braking a car $P_T = P_{T1} + P_{T2}$ is equal to force. Braking forces on the axles when the vehicle is stationary:

$P_{T_1} = \varphi \cdot G_1$; and $P_{T_2} = \varphi \cdot G_2$ is equal to . (9.19)

While the car is moving,

$P_{T_1} = \varphi \cdot Z_1$ and $P_{T_2} = \varphi \cdot Z_2$ is equal to . (9.20)

When braking a car, the reaction forces Z_1, Z_2 as the braking forces are redistributed P_{T_1}, P_{T_2} also change.

We determine the most favorable ratio of braking forces on the front and rear wheels of the car:

$$P_{T_1}, / P_{T_2} = \varphi \cdot Z_1 /(\varphi \cdot Z_2) = Z_1 / Z_2 \quad (9.21)$$

Z_1 and Z_2 we substitute the values:

$$P_{T_1} / P_{T_2} = (G_a \cdot b + P_T \cdot h_м)/(G_a \cdot \varphi - P_T \cdot h_м) .$$

In order to accelerate the braking $P_T = P_\varphi = G_a \cdot \varphi$, it must be equal to N, if we substitute the values, the following expression is formed:

$$P_{T_1} / P_{T_2} = (G_a \cdot b + G_a \cdot \varphi \cdot h_м)/(G_a \cdot a - G_a \cdot \varphi \cdot h_м) = (b + \varphi \cdot h_м)/(a - \varphi \cdot h_м) \quad (9.22)$$

When the vehicle is at rest, the reaction forces on the wheels $Z_2^1 = G_a \cdot b$ are equal to and . $Z_2^1 = G_a \cdot a$

the reaction force during braking to Z_1 the reaction force when not moving Z_1^1 is called the coefficient of change of the reaction force on the front wheel, it is denoted by *m 1 and its value is determined as follows:*

$$m_1 = Z_1 / Z_1^1 = (G_a \cdot b + P_T \cdot h_м)/(G_a \cdot b) = 1 + \varphi \cdot h_м / b, \quad (9.23)$$

Like this:

$$m_2 = Z_2 / Z_2^1 = (G \cdot a - P_T \cdot h_м)/(G_a \cdot a) = 1 - \varphi \cdot h_м / a \quad (9.24)$$

The values of these coefficients when the car brakes are:

m_1 =1.5-2 and m_2 =0.5-0.7.

6. Influencing braking properties in operation operational factors.

the car's brake control works poorly, it will lead to a road accident. It is known that the braking process occurs as a result of friction between the brake drum and the pad cover, so their surface is smoothed. This increases the gap (gap) between them and requires readjustment. Enlargement of this gap reduces braking efficiency.

In hydraulically actuated brakes, the change in clearance increases the travel of the brake pedal, resulting in longer brake life. Decreasing air or fluid pressure in the brake system increases brake application time and braking distance. Deterioration of braking performance leads to a decrease in braking torque due to the ingress of oil, water and dirt into the brake mechanism.

Braking torque depends on road and tire tread condition. Since there are micro-elevations on the road, the tire grips better with it, and φ the value of increases. If the road surface and tire tread are worn, the bite coefficient φ decreases and the car's braking performance deteriorates.

Control questions

1. Explain the braking process of a car.
2. How does the car accelerate when braking?

3. State the dimensions of the braking process.
4. How are braking forces distributed to vehicle axles?
5. How do operating factors affect the braking process?

Topic 23: Fuel economy feature of the car.

Plan:

1. Description of the fuel economy of the car.
2. Calculation of the description of fuel economy.
3. Operational factors affecting fuel economy.

Basic words and phrases: Dimensions and indicators of fuel economy of cars, factors affecting fuel economy, calculation of fuel economy description, economic description of the car, 100 kmnorms of fuel consumption of cars for distance.

1. Description of the fuel economy of the car.

One of the main features of the car is its fuel efficiency, because fuel consumption makes up 15-20 percent of the cost of the transported cargo.

The economic quality of a car is determined by the amount of fuel it consumes in given road conditions.

The unit of measure for evaluating the efficiency of a car engine is the comparative fuel g_e g /(kW·h) consumption is accepted. This size determines the economy of the engine, but not the economy of the vehicle.

of the car is determined by the amount of fuel consumed when driving a distance of 100 kilometers or 1 kmthe amount of fuel consumed when transporting 1t of cargo. The unit of measurement is l /100 km or l /ton·km.

The fuel economy of the car depends primarily on the technical condition and performance of the engine.

The amount of fuel consumed by the engine in one hour is determined as follows:

$$G_{yo} = g_e \cdot N_e / 1000 \text{ , kg /h,} \qquad (10.1)$$

where: g_e is the specific fuel consumption of the engine, g /kWh ·,

N_e - the effective power of the engine, kW.

The amount of fuel consumed by the car is determined as follows:100 km

$$Q_s = 1000 \cdot G_{yo} / (36 \cdot V_a \cdot \rho_{yo}) \text{ , l /100 km} \qquad (10.2)$$

where: V_a is the speed of the car, km //h;

ρ_{yo} *- fuel density,* cm ^{3} for gasoline fuel 0,75 g/; cm ^{3} for diesel fuel ;0,86 g/

The amount of fuel used to transport one ton of cargo over a distance of 1 kilometer is determined by the following expression:

$$Q_{\text{T-km}} = \frac{Q_s}{100 \cdot G_{юк} \gamma_c}, \text{ l /t-km} \tag{10.3}$$

where: G load - the load loaded on the car, t;

γ_s is the load class coefficient, and the values of s depending on the class and type of loads γ are as follows:

Class 1-reversible, γ_s =1.0

2nd class-bag and barrel, γ_s =0.8

3rd class-container and connected, γ_s =0.6

4th class - cargo with long dimensions, cardboard boxes, containers, wet fruit, eggs, glass containers, liquids, etc., γ_s =0.4.

2. Calculation of the description of fuel economy.

The effective power of the engine is used to overcome the road resistance, that is, when the car moves in a straight line (j_α=0), it is as follows:

$$N_e = (N_\psi + N_\omega) / \eta_{ku} \tag{10.4}$$

where: N_ψ is the power spent to overcome road resistance;

N_ω - power spent to overcome wind resistance;

η_{ku} is a general coefficient that takes into account resistances in power transmission mechanisms.

Substituting the expression (10.4) into the expression (10.1), we get the following equation:

$$G_ё = \frac{g_ё \cdot N_e}{1000} = \frac{g_ё \cdot N_e}{1000 \cdot \eta_{ку}} = \frac{g_ё \cdot (N_\Psi + N_\omega)}{1000 \cdot \eta_{ку}}, \text{ kg /h} \tag{10.5}$$

G Substituting the value of in the expression (10.2), we create the following equation:

$$Q_s = \frac{g_ё \cdot (N_\Psi + N_\omega)}{36 \cdot \rho_ё \cdot \eta_{ку} \cdot V_\alpha}, \text{ l /100 km} \tag{10.6}$$

The specific fuel consumption of the engine *is* $_{not}$ always the same, because depending on the external load, the number of revolutions of the crankshaft and the power of the engine also change, so the specific fuel consumption of the engine is determined as follows:

$$g_{or} = K_n \cdot K_N \cdot\cdot g_{orN}; \tag{10.7}$$

where: K_n is the coefficient of use of the number of revolutions of the crankshaft, its value is determined as follows:

$$K_n = n_x / n_N \qquad (10.8)$$

n_x - the desired number of revolutions of the crankshaft;

n_N - the number of revolutions of the crankshaft at maximum power;

k_N is the coefficient of engine power utilization, the value is as follows:

$$K_N = \frac{N_\Psi + N_\omega}{N_e} \qquad (10.9)$$

$G_{or\,N}$ - the specific fuel consumption at the maximum power, putting (5.7) into (5.6), 100 kmthe amount of fuel used to cover the distance is determined by the following equation:

$$Q_s = \frac{g_n \cdot g_N \cdot g_{\ddot{e}N}\left(N_\Psi + N_\omega\right)}{36 \cdot \rho_{\ddot{e}} \cdot \eta_{\kappa y} \cdot V_a}, \text{ l /100 km}; \qquad (10.10)$$

K_n and K_N *according to the* number of revolutions n and power N utilization -values of coefficients are given in table 23.1.

23 .Table 1

Engine types	*n* and *N* by degrees								
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
With carburetor , K_N	2.11	1.67	1.33	1.22	1.11	1.06	1.0	1.06	1.11
Diesel, K_N	1.56	1.38	1.25	1.12	1.09	1.06	1.0	1.06	1.25
K_N	1.15	1.09	1.04	1.02	1.01	1.0	1.01	1.02	1.04

It can be seen from the expression (10.10) that the fuel economy of the car depends on the engine speed, the speed of the car and the road conditions.

The power spent to overcome N *-path resistance is determined as follows:* $_\psi$

$$N_\Psi = \frac{P_\Psi \cdot V_a}{1000}, \text{ KBt};$$

R_ψ is the resistance of the road, it is determined as follows;

$$R_\psi = g \cdot G_a \cdot \varphi, \text{ H}$$

g =9.81 m /s ^{2} - acceleration of free fall,

G_a - full weight of the car, N.

φ- the total resistance coefficient of the road, φ=0.058.

N_w - power spent to overcome air resistance, it is determined as follows:

$$N_w = \frac{(P_w \cdot V_{a\max})}{1000}, \text{kW};$$

R_W - air resistance

$$R_W = K \cdot F \cdot (0.277 \cdot V_{amax}), \text{ kW}$$

of cars 100 kmto cover the distance are given in table 23.2 .

23. Table 2

Car replica	100 kmto the distance fuel consumption rate, l.
GAZ-53A	24
ZIL-130	29
KamAZ-5320	26
VAZ-"Zhiguli"	7.4
Tico	4.3
Damascus	8.0
Nexia	7.2

3. Operational factors affecting fuel economy.

In order to determine the low fuel consumption of a car at a certain speed under given road conditions, its economic description is drawn. This description describes the change in the economic performance of the car in relation to the speed of the car on roads with different resistance. (Fig. 23.1).

The description consists of several descriptions, and each graph refers to a specific road condition. Each road condition is represented by a resistance coefficient:

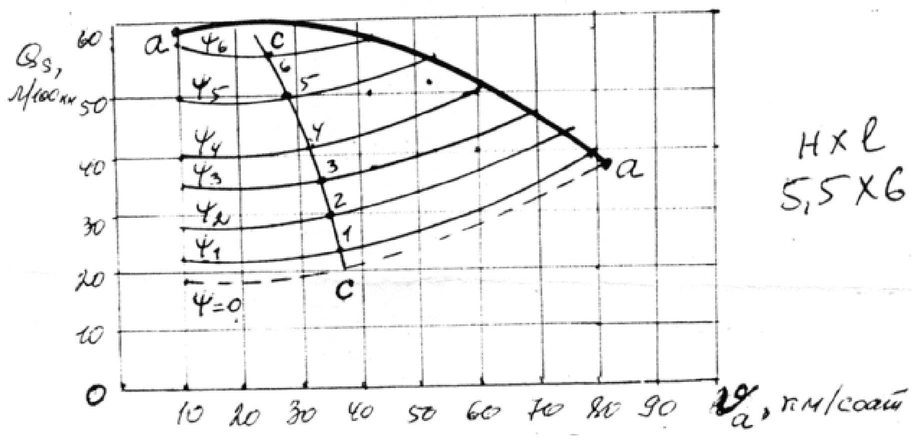


Figure 23.1, Economic description of the car .

As can be seen from the graph, for each road condition there is a point where fuel consumption is the smallest. These points indicating the smallest amount of fuel are represented by 1,2,3..6 in the figure. There is a lot of fuel on both the left and right side of these points.

On the left side, fuel consumption increases due to underutilization of the engine, while on the right side, fuel consumption increases due to increased road resistance.

For each road condition, the maximum speed of the vehicle is the speed corresponding to the points on the line aa.

So, rough road conditions reduce the top speed of the car. Fuel consumption increases as a result of incorrect adjustment of the engine supply system, ignition system and gas distribution mechanism. Economizer failure increases fuel consumption by 10-15%, one spark plug failure in a six-cylinder engine increases fuel consumption by 20-25%, and two spark plugs fail by 50-60%. As a result of incorrect installation of the production system, fuel consumption increases by 80%.

Fuel consumption increases as a result of incorrect adjustment of gears and bearings of the main transmission, incorrect adjustment of brakes and steering controls, and incorrect installation of front wheels.

When using trailers, fuel economy increases by 15-20 percent .

Fuel consumption is greatly influenced by the skill of the driver. Incorrect choice of transmission and speed will cause an increase in fuel consumption.

In addition, frequent stops and braking also have a negative effect on fuel consumption. Because the kinetic energy stored in the car is useless and you have to spend extra fuel to restore the speed.

Control questions.

1. What are the dimensions of fuel economy?
2. What factors affect savings?
3. How to describe the economic indicators of the car.
4. Why are cars regulated for fuel consumption?

Topic 24: Vehicle controllability and stability.

Plan.

1. Vehicle handling.
2. Indicators evaluating controllability, critical speed for controllability.
3. Tire lateral thrust and drag coefficient.
4. The types of turning of the car.
5. Neutral, understeer and oversteer, critical speed on toes.
6. Effect of operational characteristics on controllability.
7. Types of vehicle stability and loss of stability, evaluative dimensions.

8. Stability of the vehicle in the longitudinal plane.
9. The rollover angle of the vehicle on the front and rear axis.
10. Stability of the car in the transverse plane.
11. Critical speed for overturning and sliding in a turn.
12. Vehicle skidding, front and rear axle skidding.
13. Factors affecting vehicle stability.

Basic words and phrases. Car controllability, controllability evaluation indicators, controllability critical speed, tire side thrust and thrust coefficient, car steering and its types, neutral, low and excessive steering, critical speed for steering, influence of operating characteristics on controllability, vehicle types of stability and loss of stability, evaluative dimensions, stability of the vehicle in the longitudinal plane. roll angle of the car on the front and rear axis, stability of the car in the transverse plane. critical speed on overturning and sliding in a turn. vehicle skidding, front and rear axle skidding. factors affecting vehicle stability.

1. Vehicle controllability.

Maneuverability is a property that ensures safe movement of the vehicle at average and maximum speeds.

Controlling the steering wheel and changing the direction of the car at the will of the driver is called controllability.

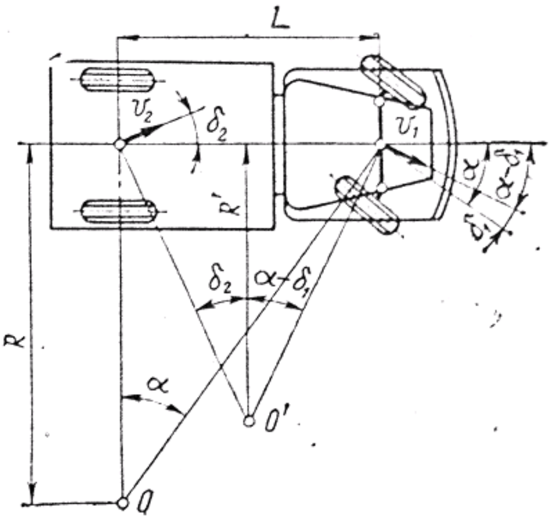
2. Indicators evaluating controllability, critical speed for controllability.

Handling dimensions include: turning radius, right and left front wheel turning angles, front and rear axle slip angles, pivot center location, vehicle base, front and rear axle dimensions.

Control parameters include: the lateral force acting on the vehicle, the reaction forces acting on the front and rear wheels, the sliding resistance coefficient, the relationship between the critical speed of the vehicle and the turning angles of the steered wheels.

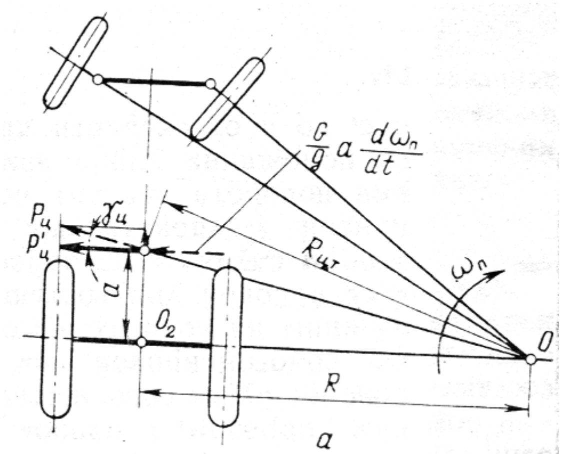
3. Tire lateral thrust and drag coefficient.

The axle of the trailing wheels is continued to determine the turning radius of the vehicle when the vehicle's wheels are in a non-skid state. We draw a line perpendicular to the plane of rotation of the front driven right wheel through the point between the front bridge, this line intersects with the line along the rear axle to form point *O*. This point will be the center of rotation of the vehicle. The distance from the turning center to the longitudinal axis of the vehicle is the turning radius *R in the case of no slippage of the wheels of the vehicle* (Fig. 24.1).



24 .Figure 1. When there is no tire sideslip
car turning.

When the vehicle with elastic tires turns, the front tires and rear tires slide at an angle d_1 *and* d_2 under the influence of the transverse component of the inertia force R_u, the wind force and the resistance forces of the road slope . The slip angles of the right and left tires are the same. As a result of tire slippage, the movement of the front and rear axles also changes (Fig. 24.2) .



24 .Fig. 2. When there is no tire sideslip
car turning.

The rear bridge moves at an angle d_2 relative to the longitudinal axis of the vehicle along the velocity vector V_2, and the front bridge moves at an angle d_1 relative to the longitudinal axis along the velocity vector α–V_1,

where: α-the average turning angle of the front wheels.

To determine the turning radius of a vehicle with elastic tires, we pass the perpendicular lines to the vectors through the points where the speed vectors are placed, and form the intersection point *O of these lines.* This point is called the instantaneous turning center of the elastic tire vehicle. The distance from the center of instantaneous turning to the longitudinal axis of the vehicle is called the instantaneous turning radius R ′of a vehicle with elastic tires .

24.1 and 24.2 that the center of instantaneous turning is shifted by a distance S from the center of turning without sliding .

⊿Using the triangle *O* ′*BA* and ⊿*O* ′*VB, we determine the radius of the instantaneous turn R and the distance* ′*S* moved :

$$L = R'tgb_2 + R'tg(\alpha - b_1)$$

from this

$$R' = L \big/ [tgb_2 + tg(\alpha - b_1)] \tag{11.1}$$

So, the turning radius of the vehicle depends on the average turning angle of the steered wheels and the sliding angle of the front and rear wheels.

turning shaft is determined by the following expression:

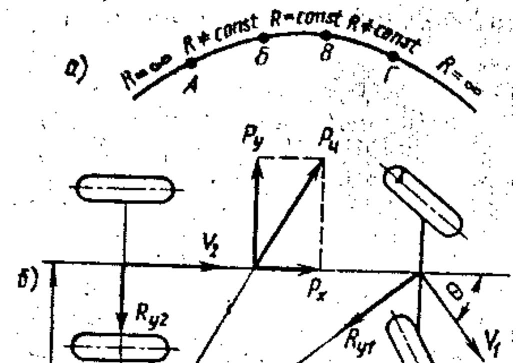
⊿*O* ′from $C = R'tgb_2 BV$,

Substituting the value of *R into* ′this expression, we get the following expression:

$$C = Ltgb_2 \big/ [tgb_2 + tg(\alpha - b_1)] \tag{11.2}$$

Therefore, the displacement of the instantaneous center depends on the turning angle of the steered front wheels and the slip angles of the front and rear wheels.

The turning process of the vehicle takes place in three periods. (Fig. 24.3): *AB* - entrance to the turn; *BV* - turn; *VG* - exit from the turn;



24 .Figure 3. Car turning. a) cycles of turning process;
b) forces acting on turning.

is followed by a curve of decreasing radius *AB followed by a straight line BV of constant radius* and a curve of variable radius *VG* moves along , then moves along a straight line of infinite radius.

The following forces act on a turning vehicle. (Fig. 24.3, b)

Centrifugal force R_{mq} ; the transverse R_u and longitudinal R_x components of the centrifugal force , the transverse resistance R_{u1} , R_{u2} forces of the road acting on the front and rear bridges.

is subjected to a centrifugal force R_{mq} perpendicular to the longitudinal axis of the car . The transverse effect of the centrifugal force acting on a straight moving car during a turn is determined by the following expression:

$$P_y = \frac{G_a V_a^2}{gR}; \tag{11.3}$$

Therefore, this force depends on the square of the speed and the turning radius and the total weight of the vehicle.

The transverse reaction forces of the road acting on the front and rear axles of a car moving straight in a turn are determined by the following expressions:

$$R_{y_1} = \frac{G_1 V_a^2}{gR}; \; R_{y_2} = \frac{G_2 V_a^2}{gR}; \tag{11.4}$$

here; G_1, G_2 - weight forces on the front and rear axles;

V_a - speed of the car; R - turning radius; g is the velocity of free fall.

<u>Wheel sideslip and vehicle handling</u>

d_1 relative to the plane of rotation under the influence of transverse force R_u, it is called side slip of the wheel.

If there is no transverse force, the wheel will move along its straight line of rotation. Under the influence of transverse force, the wheel moves at an angle d_1 relative to the plane of rotation .

The angle between the plane of rotation of the wheel and the velocity vector is called the slip angle. The value of the slip angle is determined by the following expression, depending on the lateral force and the uniformity of the side of the tire:

$$\delta_1 = \frac{P_y}{K_c}, \tag{11.5}$$

here; K_s is the coefficient of sliding resistance.

Therefore, the coefficient of sliding resistance depends on the tire size, construction, air pressure in the tire and wheel load, vehicle speed and turning radius. The value of sliding resistance K_s =60-150 kN /rad for trucks and buses ; for car tires, K_s =is equal to 15-40 kN rad./

the car is moving along x_i, side slippage of the tires is caused by factors such as transverse, slope, wind, unevenness of the road, difference in adhesion coefficients. Because at this time, the lateral *force* R acting on the car is generated. Under the influence of this force, the direction of the rear wheels is pushed to the side by an angle b_2, and the direction of the front wheels is pushed to the side by an angle d_1.

4. Car turning, its types.

<u>Control condition and factors affecting it:</u>

The following conditions must be met in order for the transport vehicle to be well managed:

it must move without sliding next to the front wheels;

the steering must make the correct connection between the turning angles of the driven wheels;

the stability of the steered wheels should be good and they should not vibrate freely;

the driving force acting from the road to the wheel and from the wheel to the driver should be small;

at the most convenient angle of rotation of the steering wheel, the front steered wheels should turn to the most convenient angle.

5. Neutral, low and excessive tortuosity, tortuosity critical speed on

in the angle, the turning radii also change, so there are the following types of turning:

Normal torsion , its indicators $d_1 = d_2$, $R' = R$ (Figs. 11.1, 11.2, 11.3);

not less torsion, its indicators $d_1 > d_2$, $R' > R$;

Excessive torsion , its indicators $d_1 > d_2$, $R' < R$;

here; R is the turning radius for an inelastic wheel, the value of which $R = \frac{L}{tg\alpha}$ is equal to:

In the case of the first type, the turning radius does not depend on the lateral slip of the tire.

In the second type of situation, under the influence of side force, the side slip angles of the front and rear tires are formed, and the direction of movement of the car changes, as a result, the car moves in a curved line, because the side slip of the rear wheels is large. , the lateral displacement of the bridge increases. As a result, the rectilinear motion becomes a curved motion and a centrifugal force is created.

In the third type, the rear wheel's sideslip angle and increased centrifugal force cause the car to turn at a smaller and smaller radius, resulting in reduced stability of the car and the possibility of overturning.

The speed of vehicles with oversteer should not exceed the critical speed. The critical speed is determined by the following expression: (Prof. VMPevzner's formula):

$$V_{кр} = 3{,}6\sqrt{\frac{gL}{\frac{G_2}{K_{c2}} - \frac{G_1}{K_{c1}}}}, \qquad (11.6)$$

here; L - car base;

G_1 , G_2 - loading of the front and rear wheels;

K_{s1} , K_{s2} - coefficients of sliding resistance of front and rear cars.

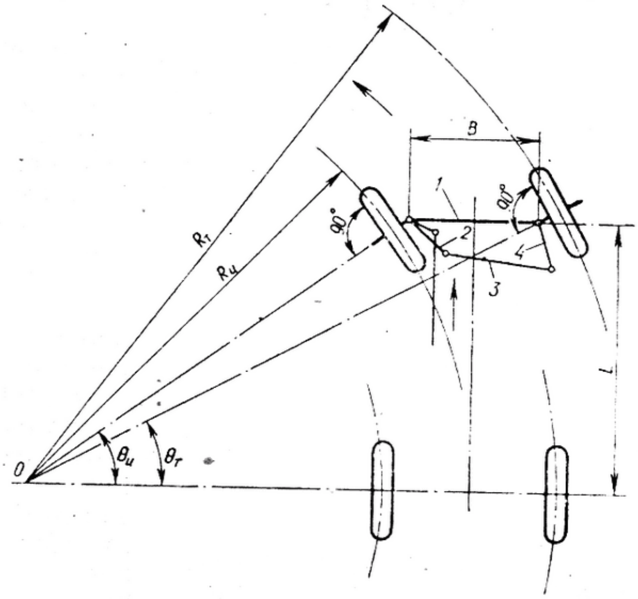
The critical speed is determined only for vehicles with oversteer.

A critical speed is not specified for vehicles with normal and understeer.

6. Effect of operating characteristics on controllability

When the car moves in a circle, the inner and outer wheels follow different paths. In order for the wheels to move without side slip, the angle of turning of the inner wheels should be more, and the outer one should be less. This task is performed by the steering trapezium. The turning angles of the left and right wheels help to understand the effect of this factor on the car's handling.

Consider the deflection of inelastic wheels. (Fig. 24.4.)



24 .Figure 4. Deflection of an inelastic vehicle wheel.

1-2-3-4 steering trapezium; R_i , R_T - turning radii of the controlled inner and outer wheels; $\theta_И, \theta_T$ – steering angles of inner and outer wheels; *O* - turning center of the car; *R* - turning radius; *V* - the distance between the shafts;

L - the base of the car.

Using two right-angled triangles, we determine the dependence of the turning angles on the turning radius of the car, the distance between the axles and the base of the car:

$$ctg\theta_T = \frac{R+b}{L}; \; ctg\theta_И = \frac{R-b}{L};$$

If the angles are shifted to one side, the following expression is formed:

$$ctg\theta_T - ctg\theta_И = \frac{2b}{L}; \qquad (11.7)$$

So, in order to turn the car, the relationship between the angles must always be maintained during the turn, and their difference is equal to the ratio of the car base to the distance between the axles.

7. Types of vehicle stability and loss of stability, evaluative dimensions.

The movement of the vehicle in a given direction on the road without overturning, without sliding, without shaking and without being pushed to the side is called stability. Stagnation is of two types: longitudinal and transverse.

Loss of vehicle stability occurs in the following cases:

- when the vehicle overturns;
- when the vehicle slides to the side;
- in the jerking movement of the leading wheels;
- when the vehicle or one of its bridges is pushed to the side;
- lateral impact force, centrifugal force, bit effector of gravity force , when affected by lateral wind forces and when hitting road obstacles.

Vehicle stability dimensions include:

- the critical speed during lateral movement when the vehicle moves in a circle (V_K);

- the critical speed at the time of the rollover when moving in a circle (V_0);

- the critical angle of the inclined road at the moment when the transverse sliding of the wheels begins (b);

- the critical angle of the inclined road at the time of overturning of the vehicle (α).

8. Stability of the vehicle in the longitudinal plane.

Longitudinal stability of the vehicle is defined as the ability of the vehicle to move on an inclined road without swaying, sliding or pushing around the rear or front axles.

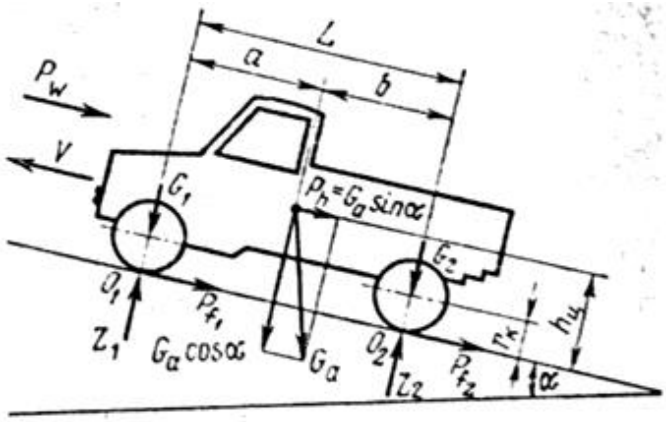
As a result of the loss of longitudinal stability of a vehicle moving with acceleration from the bottom up on a sloping road, the rear wheel can roll back around the reference point O_2 *adjacent to the road surface* (Fig. 24.5).

rolls over around the front or rear support points O_1 and O_2 . The angle of stability along which the vehicle can stand without sliding or overturning α' is called the limited angle of stability. α

Assuming that the force of the wind R_W , the force of inertia P_{ja} and the reaction Z_1 *on the front wheel are equal to zero,* the condition for the vehicle not to overturn around the point O_2 *is as follows:*

O_2 the sum of the moments of the forces relative to the reference point must be equal to zero, that is:

$$\sum M_{O2} = O; Ga \cdot Cos\alpha \cdot b - Ga \cdot Sin\alpha \cdot h_M = 0$$



24 . Figure 5 . Stability of a vehicle moving from bottom to top on a longitudinal inclined plane

from this $b \cdot Cos\alpha = h_M \cdot Sin\alpha$ we derive .

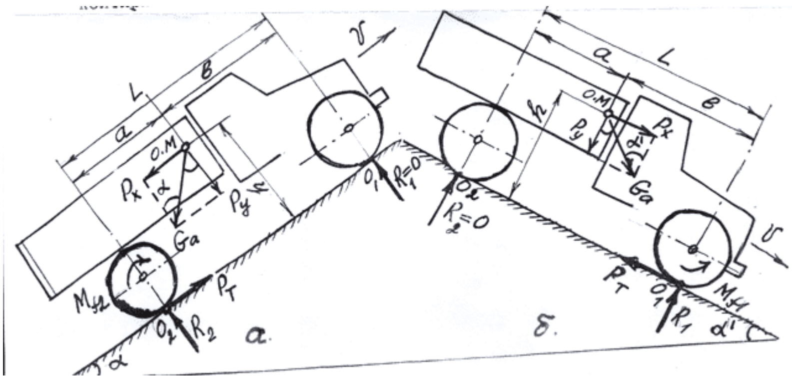
We determine the rollover angle of the vehicle using this expression:

$$tg\alpha = \frac{b}{h_M}, \tag{12.1}$$

Permissible limited values of the overturning angle for trucks and buses $[\alpha] = 35...40^0$; for passenger cars $[\alpha] = 45^0$ will be equal to

9. Overturning angle of the front and rear axis of the car.

As a result of the loss of longitudinal stability of a vehicle moving at a speed of deceleration from top to bottom on a sloping road, the vehicle may roll forward around the reference point O_1 *adjacent to the road surface of the front wheel* (Fig. 24.6). .



24 . Figure 6 . Stability of a vehicle moving from top to bottom on a longitudinal inclined plane

the wind P_W, the inertia R_{ja} and the reaction Z_2 forces on the rear wheel are equal to zero, the condition for the vehicle not to overturn around the point O_1 *is determined as follows:*

O_1 must be zero, that is:

$$\sum M_{O1} = O; Ga \cdot Cos\alpha' \cdot (L-b) - Ga \cdot Sin\alpha' \cdot h_M = 0$$

from this $Cos\alpha' \cdot (L-b) = Sin\alpha' \cdot h_M = 0$ we derive .

Using this expression, we determine the rollover angle of the vehicle around the reference point O_1:

$$tg\alpha' = \frac{L-b}{h_M} = \frac{a}{h},$$

$$tg\alpha' = \frac{a}{h}, \tag{12.2.}$$

Therefore, the longitudinal stability of the vehicle depends on its structural parameters *a* , *b* , *L.*

Permissible limited values of the overturning angle for trucks and buses $[\alpha'] = 60^0$; for cars $[\alpha'] = [\alpha] \geq 60^0$

10. Stability of the car in the transverse plane.

K is the value of the angle that allows the car moving on a transverse inclined plane to move without being pushed to the side or overturning, β represents the transverse stability of the car.

forces and reaction forces acting on a car moving on a cross slope are illustrated in Figure 24.7.

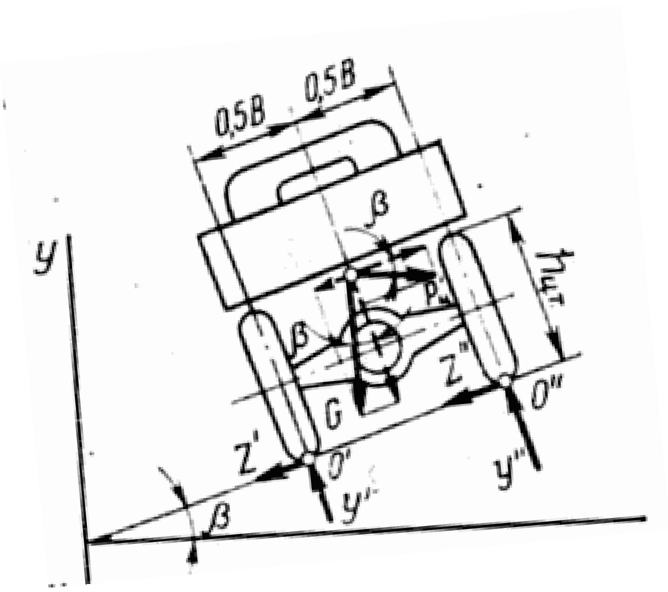


Figure 24.7. Forces acting on a car moving on a transverse inclined plane

Here, Z', Z'' – side reaction forces.

the reaction force of the road acting on the outer wheel of the car is equal to R_2 =0, and under the influence of the component of the gravity force, the car $Px = Ga \cdot Sin\beta$ can be turned transversely around the reference point 0_1.

In order for the car to move without overturning, the sum of the moments obtained from the forces relative to the reference point $\sum M_{01} = 0$ 0_1 should be equal to .

According to the equilibrium condition, we write the following equation:

$$Ga \cdot Sin\beta \cdot h_M - 0{,}5 \cdot B \cdot Ga \cdot Cos\beta = 0$$

from this, the slope angle is determined as follows:

$$tg\beta = \frac{0{,}5 \cdot B}{h_M}, \qquad (12.3.)$$

here is B – the distance between the rear wheels;

h_M – the distance from the road surface to the center of gravity of the vehicle.

The limiting value of the angle of inclination for a car moving on a transverse slope without being pushed to the side or overturning is defined as follows for the types of cars:

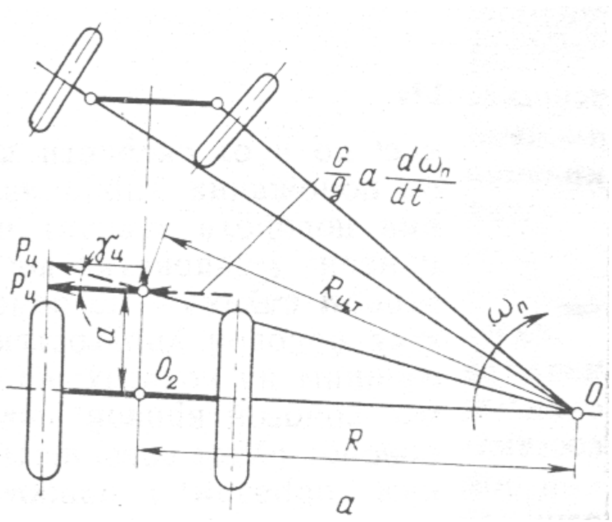
trucks and $[\beta] = 35^0$, cars $[\beta] \geq 45^0$

11. Critical speed for overturning and sliding in a turn.

Stasis when the vehicle turns along a curve can be seen in three cases:

- the vehicle turns along a curve on a straight road, the turning center is located inward;
- the vehicle turns along a curve on the slope, the turning center is located on the lower side of the slope;
- the vehicle turns along a curve on a slope, the turning center is located on the upper side of the slope.

In the first case, when the vehicle moves along a curve on a straight road with a constant radius and speed, the centrifugal force on the center of gravity of the car is R_{mq} affects. The horizontal component of this force R'_{mq} tries to turn the car outwards (Fig. 24.8).



24 . Figure 8 . Turning a vehicle around a curve on a straight road.

intersection of the vertical lines drawn through the points where the pivot is fixed to the planes of rotation of the rear and front wheels .

Centrifugal force is defined as:

$$P_{м.к} = \frac{G_a \cdot V_a{}^2}{gR}, \qquad (12.4.)$$

where: G_a – the weight of the car with cargo;

R - turning radius;

R $_{от}$ - turning radius of the center of gravity;

V $_{a}$ - speed of the car;

g - acceleration of free fall.

As the speed of the car increases, the turning radius decreases, the centrifugal force behind and causes the car to overturn around the outside wheels, which $P_\alpha > P_{мк}$ is the wheel's bite force.

A rollover of the vehicle $P_{мк} \cdot h_м = G_a \cdot \frac{B}{2}$ (12.5) begins when

here is h_M – the height of the center of gravity, m;

B – distance between rear wheels, m.

) from the expression $P_{мк} = \frac{G_a \cdot B}{2h_м}$ (12.5) and, using the equality of (12.4) and (12.6), the maximum critical speed before the start of the car rollover during a turn is determined by the following expression:

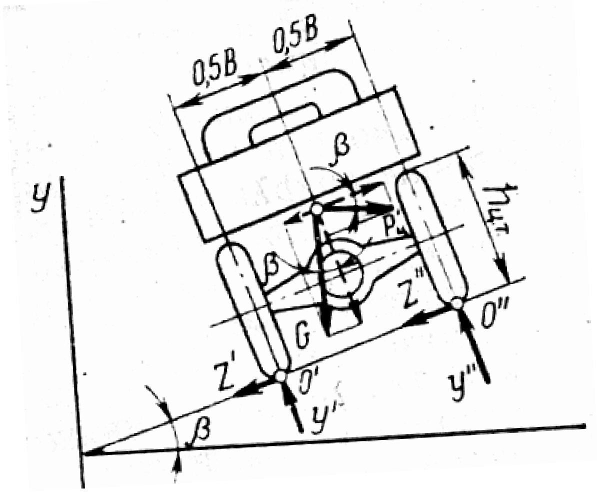
$$V_{a\,кр} = \sqrt{= g \cdot R \cdot B / 2h_м}\,, \qquad (12\ .\ 7)$$

It happens when the car slides to its side while turning . $P_{м.к} \geq P_\varphi = G_a \cdot \varphi_a$ The maximum critical speed at which the vehicle slides is defined as:

$$\mathrm{G_a} \cdot \varphi_a = G_a \cdot V^1{}_{a/кр} \,/(gR) \text{ from}$$

$$V^1{}_{a.кр} = \sqrt{gR\varphi_a}\,, \qquad (12.8)$$

In the second case, when the vehicle turns on a slope, the center of its turn is located on the lower side of the slope (Fig. 24.9).



24 . Figure 9 . Stability of the car when turning on a slope.

the force of gravity, G_a a centrifugal force $P_{м.к}$ acts on the car. This force tries to turn the car around the point O_2. At the time of the car overturning $R_1 = 0$, and $Z_1 = 0$ is equal to . The turning moment of the car is defined as follows:

$$P_{M.x} \cdot h_м - P_{\beta_x} \cdot h_м - P_{м.y} - 0{,}5 \cdot B - P_{\beta y} \cdot 0{,}5 \cdot B = 0, \tag{12.9}$$

$P_{м.к}, P_{\beta.x}, P_{мy}$ and $P_{\beta y}$ we substitute the values of the forces and write the expression as follows:

$$(P_{м.к} \cos\beta - G_a \cdot Sin\ \beta) \cdot h_м - (P_{м.к} Sin\beta + G_a \cdot \cos\beta) \cdot 0{,}5 \cdot B = 0$$

The value of centrifugal force $P_{м.к} = \dfrac{G_a}{g} \cdot \dfrac{V_a^2}{R}$ taking into account that is equal to, the stability of the car when turning along a curve on a slope is as follows:

$$\frac{G_a}{g} \cdot \frac{V_a^{\ 2}}{R} \cdot (h_M \cdot Cos\beta - 0{,}5 \cdot B \cdot Sin\beta) \leq G_a (0{,}5 \cdot B \cdot Cos\beta + h_M \cdot Sin\beta)$$

Using this equation, we determine the critical speed of the car when turning along a curve on an inclined plane:

$$V_{a.\max} \leq \sqrt{g \cdot R \cdot \frac{B + 2 \cdot h_M \cdot tg\beta}{2 \cdot h_M - B \cdot tg\beta}}, \tag{12.10}$$

If the turning center is located in the opposite direction, that is, on the slope, the maximum speed of the car while turning along the curve is equal to the following expression:

$$V_{a.\max} \leq \sqrt{g \cdot R \cdot \frac{B - 2 \cdot h_M \cdot tg\beta}{2 \cdot h_M + B \cdot tg\beta}}, \tag{12.11}$$

So, expressions 12.10 and 12.11 show what speed sh should move along the curve at the given radius and slope.

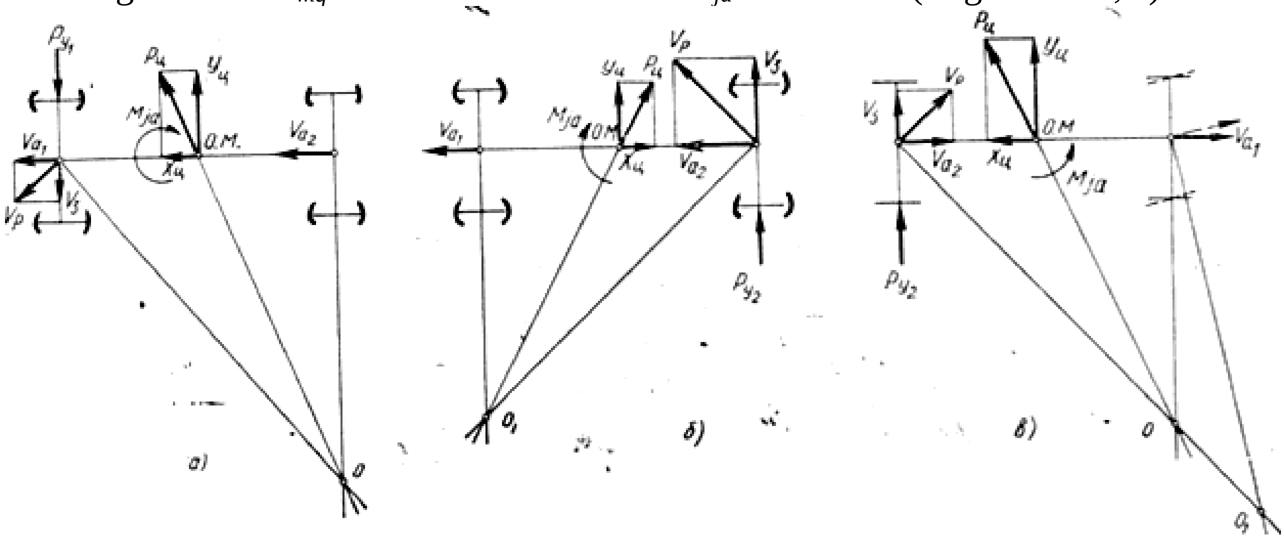
In this case, the stability of the car is dangerous, because the amount of centrifugal force during the turn $G_a \cdot Sin\beta$ is always greater. So, if the turning radius R is large $B \geq h_M$ and the center of the turn is located below the slope, the stability of the car in the turn will be stronger.

In the design of highways, the turning radius R = 300-1000m and the slope angle $\beta = 8...12^0$ are accepted on sloping roads.

12. Vehicle skidding, front and rear axle skidding.

<u>6.1. Front axle thrust.</u>

the front axle of the car is affected by the force R_{u1} *from the side, it starts to be pushed to the side with the speed* V_3. At that time V_{a1} and V_3 the equal effector of the velocity vectors moves in the direction of V_p. But the rear axle moves in the direction of the velocity vector V_{a2} and turns the car around the instant center *O*. As a result, centrifugal force. R_{mq} and moment of inertia M_{ja} are formed (Fig . 24. 10 , a).



24 . Figure 10 . a- Pushing the front axle to the side, b- pushing the rear axle to the side.

As can be seen from the figure, the side shift of the front axle is automatically extinguished, because the component of R_{mk} *is* R_{mu} and the moment M_{ja} opposes the shift of the front axle, that is, R_{u1} and R_{mu} forces are directed in opposite directions and weaken each other.

<u>6.2. When the rear axle is pushed to the side </u>(Fig. 24.10, b) R_{mk} and R_{u2} the forces are directed in one direction, increasing the roll and causing the vehicle to lose stability and create a dangerous situation. This situation is dangerous in winter. To prevent this, it is necessary to turn the front wheel to the side of the push, in which the turning radius increases by $R_{\mu k}$ power is reduced. The second way to prevent skidding is to take your foot off the brake pedal and reduce your speed.

13. Factors affecting vehicle stability.

The stability of the car ensures the safety of its movement.

of the car is more affected by the technical condition of the tire and brake mechanism. Corrosion of the tire teeth reduces the bite of the wheel with the road and increases the lateral movement, the bite coefficient decreases.

Incorrect brake adjustment creates a different braking torque on the right and left wheels, which reduces the vehicle's stability.

The transverse stability of the car can also be broken and lost as a result of incorrect placement of the load on the body. If the center of gravity of the load does not lie on the longitudinal axis of the car, the inertial force and torque on the shoulder *S* will push the front wheels to the side.

Control questions.

1. What is the controllability of the vehicle?
2. Explain control dimensions and indicators.
3. Explain the controllability condition.
4. Explain how a car turns when there is no sideslip on the tires.
5. Explain how a car turns when there is tire skid.
6. Explain the process of turning a car.
7. Forces acting on a turning vehicle.
8. Explain the types of twist.
9. Explain the limiting speed in terms of torsion.
10. Explain stagnation and its dimensions.
11. Explain stability on a longitudinal inclined plane.
12. Explain stability on a transverse inclined plane.
13. Explain the stability of a car in a turn.
14. Tell ways to increase the lateral slip and stability of car axles

2 5 - Subject. The characteristic of the car.

Plan.

1. The car's height, dimensions that evaluate the height.
2. Indicators of support of Utaghony.
3. Geometric indicators of turgidity.
4. The influence of the differential on the car's stability.

Basic words and phrases. Vehicle stability, dimensions that assess stability, indicators of support of stability, geometric indicators of stability, effect of differential on vehicle stability.

1. The car's height, dimensions that evaluate the height.

of the vehicle to move even in difficult road conditions and in places where there is no road is called its passability.

Using the means of transport shows that it is required to use it effectively even if the road conditions are bad. Difficult road conditions include difficult sections, slippery, soft and mountainous roads.

Vehicles are divided into three groups according to their characteristics:

cars with normal engines;

high displacement cars;

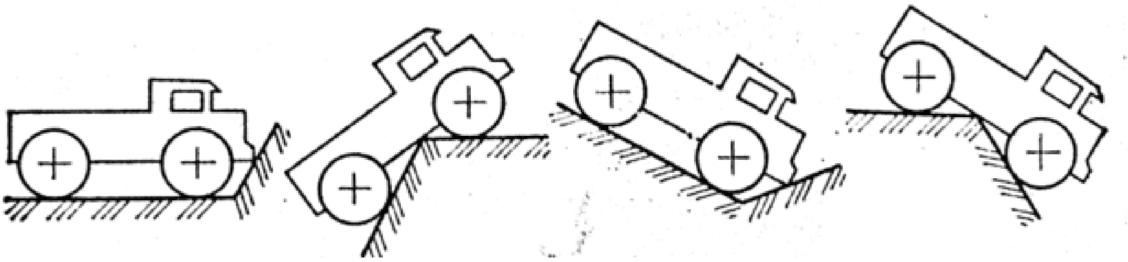
cars with the highest displacement.

Normal suspension cars have only the rear or front axle leading and are used on flat roads. This type of car has a total of 4 wheels, two of which are leading wheels. In this case, the wheel formula will be 4x2.

The front and rear axles of high suspension cars are leading, and they are used on rough roads, deserts and fields without roads. In cars of this type, all wheels are leading. In this case, the wheel formula will be 4x4, 6x6, 8x8.

The highest displacement cars include cars with a half-chain and three or more leading bridges.

The types of car's passability over road obstacles and their sizes mainly consist of geometric and support-gearing indicators (Fig. 25.1).



25 .Figure 1. Passage of the car over road obstacles.

2. Indicators of support of Utaghony.

Images of the driving and leading wheels when crossing the obstacle when the height *N* of the obstacle that the car can pass are presented (Fig. 25.2).

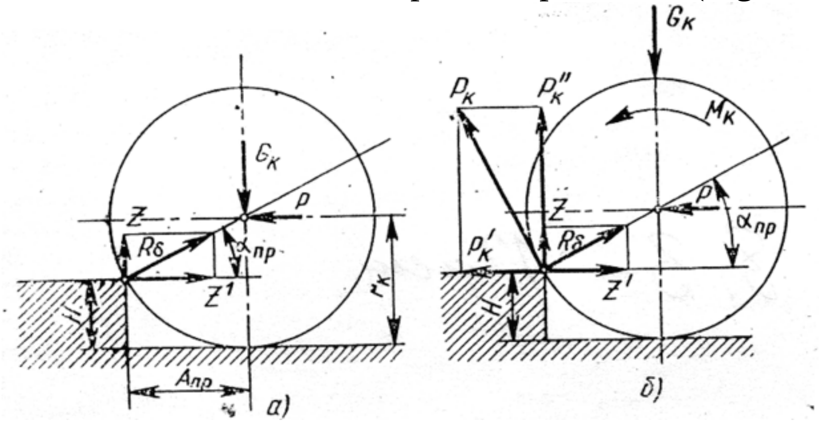


Figure 25.2. The passage of wheels over an obstacle.
a) Driven front wheel. b) leading rear wheel.

the vehicle's passability over road obstacles are as follows:

when the driving wheel leaves the ground, it is affected by the vertical force G_k, the horizontal pushing force R, the reaction force of the barrier R_v, Z^1 *and the reaction force Z of the road.*

As can be seen from the figures, the height cannot be greater than the wheel radius $N > r_k$, *but smaller* $N < r_k$

pushing force R should be large. P_k on the support of the barrier due to the torque M_k *on the wheel* effort is generated. This force $R_k{}'$ and $R_k{}''$ allocated to the founders. Here is an additional $R_k{}''$ a force is generated which, combined with the force Z, lifts the wheel up and over the obstacle. The force $R_k{}'$ *reduces the rolling resistance* Z^1 force.

The values of these forces are determined as follows:

we write the equilibrium condition of the front wheel:

$Z = G_K$ and $Z = P$

These forces acting on the wheel are defined as:

$$Z = Z^1 \cdot tg\alpha = P \cdot tg\alpha \quad C_K = P \cdot tg\alpha \text{, from } P = C_K / tg\alpha \qquad (13.1)$$

AOS from the triangle $tg\alpha = OC / AC = (r_K - H) / AC$

$$AC = \sqrt{AO^2} - OC^2 = \sqrt{r^2} - (r_K - H)^2 = \sqrt{H(2r_K} - H)$$

Substituting the value of *AS*

$tg\alpha = (r_K - H) / \sqrt{H(2r_K} - H)$ We get (13.2).

We determine the value of the force pushing the wheel by putting the value (13.2) into the expression (13.1):

$$P = G_K / tg\alpha = G_K \sqrt{H(2r_K} - H)/(r_K - H) \qquad (13.3)$$

From the expression (13.3) it is seen that when *N = r* *K , the value of* *R* is multiple. But the front drive wheel cannot go over the obstacle. *Under the influence of* torque Mk on the leading rear wheel, *there is an effort Rk force* on the support of the barrier and its horizontal *Rk '* and vertical *Rk ''* the founders are formed. *Z + P K '* under the action of the cumulative force and *Z'* the reaction force *P K '* as a result of the decrease in force, the rear leading wheel *N = r K* over the fence.

The base-biting dimensions of the transmission are as follows:

dynamic factors in traction and bite conditions;

specific traction force on the vehicle hook;

specific pressure of the tire to the road;

front and rear wheel track matching coefficient.

Chains are attached to the wheels to increase traction on slippery roads, and wide-profile tires are used on soft terrain.

The maximum dynamic factor *D a.max under the condition of traction* . the ability of the car to move without stopping, and the maximum dynamic factor $D_{a\ \varphi}$ under the condition of engagement of the wheel with the road ensures the movement of the leading wheel without jerking.

The relative traction force *r il on the rear hook of the car is determined by the ratio of* the maximum traction force *R il* on the hook to the weight of the car, that is:

$$\rho_{ил} = P_{ил} / G_a \qquad (13.4)$$

This size indicates the ability to overcome more road resistance at the expense of excess power in the engine.

The ratio of the weight acting on the tire to the contact surface of the tire on the road is called the specific pressure of the tire *R sh , that is:*

$$P_ш = \frac{G_2}{F_2} \qquad (13.5)$$

R sh =0.18-0.55 MPa on an asphalt road for trucks .

The distance between the tracks of the front wheels *is 1* The ratio of the distance between the tracks of the rear wheels to *a 2* is called the matching coefficient η m of the front and rear wheels, that is:

$$\eta_M = \frac{a_1}{a_2} \qquad (13.6)$$

the value of this coefficient η_M is $\neq 1$, the rear wheel does not follow the track of the front wheel, additional energy is spent to open a new path. Therefore, one additional wheel is installed on both sides of the rear axle.

3. Geometric indicators of turgidity.

Geometric indicators of stability are important when driving a car in off-road conditions.

The geometric indicators of the turbidity are as follows (Fig. 25.3):

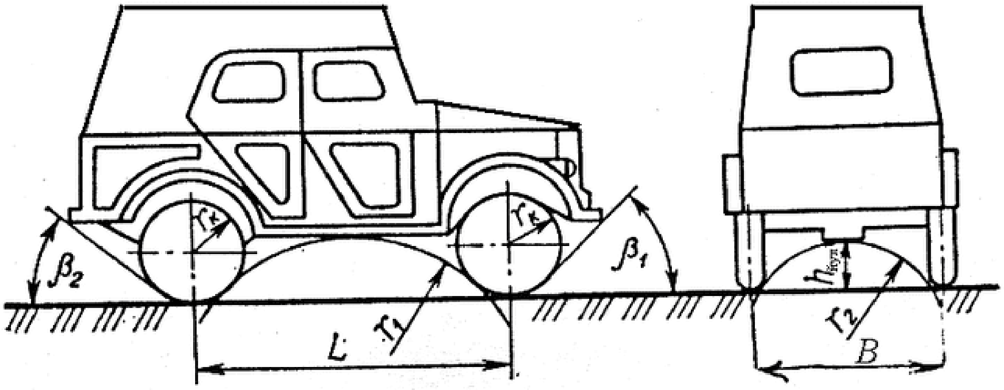


Figure 25.3. Geometric indicators of turgidity.

The front angle of the slope $\beta_{is\ 1}$, the rear angle of the slope $\beta_{is\ 2}$, the longitudinal radius of the slope is r_1 , the transverse radius of the slope is r_2 , the height of the slope $_{is}$ $h_{'l}$.

Previous $\beta_{1\ of\ Utagony}$ the angle ensures that the frontmost point of the vehicle can exit without hitting the barrier.

The rear β_2 corners of the suspension ensure that the rearmost point of the vehicle does not touch the barrier when it moves backwards.

The wheelbase dimensions of modern cars are given in the table below (Table 25.1).

25 .Table 1

Cars	h_{road} , m	β_1 , grad	β_2 , grad	r_1 , m
Light vehicles	150-220	20-30	15-20	3.2-8.3
Trucks	250-350	40-60	25-45	2.7-5.5
Buses	220-300	10-40	6-20	4-9

r_1 of the overhang ensures that the car can overcome the obstacle in the longitudinal plane without touching it. The transverse radius $r_{2\ of\ the\ crossing}$ determines the height of the obstacle that the car can pass. Ground clearance h_{road} is one of the main indicators and is the distance from the lowest point of the car to the road surface. This determines the height of the intermediate barrier, in cars with a normal clearance h_{road} =150- 220 mm, in 4x4 cars with an average clearance h_{road} =180- 270 mmand high o In cars with tires, $_{the\ distance}$ h *will be* =400- 500 mm.

4. The influence of the differential on the car's stability.

The differential, suspension and shock absorbers, the structure of the power transmission, and the distances between the front and rear wheels have a large effect on handling. Matching wheel tracks reduces drag forces.

In order for the car to work in bad road conditions, it is necessary to give a lot of power to its leading wheels. All factors that reduce engine power and increase transmission resistance: corrosion of parts, improper adjustment of the ignition system, use of low-quality fuel and oils affect the transmission ability.

The poor engagement of the wheels with the road and the increased resistance to rolling of the wheels have a great effect on the passability. Wider tires are installed on the car to overcome the reinforced road obstacles.

Control questions

1. What is permeability?
2. What are the geometric indicators of permeability?
3. Explain abutment-bite indicators of permeability.
4. How vehicle design and operating factors affect permeability.

2 6 - Topic: Characteristics of the car's smoothness.

Plan.

1. Driving smoothness of the car.
2. Meter and indicators of walking fluency
3. Vibration of a single-mass system.
4. Vehicle vibration and factors affecting it.

Basic words and phrases. Driving smoothness and dimensions of a car, vibration of a one-mass system with one degree of freedom, singularity of oscillating systems and elastic masses of a car, artificial and relative coefficients of vibration and decrement, vibration of a car, influence of operational factors on the smoothness of a car .

1. Driving smoothness of the car.

Vehicle assemblies are connected to each other by hinge joints and elastic joints, and vibrate under the influence of changing forces due to the level of the road. Vibrations affect passengers and the driver, increase component wear, increase fuel consumption, and reduce vehicle performance.

2. Meter and indicators of walking fluency

Vehicle vibration has the following dimensions: vibration amplitude (path); vibration frequency; oscillating velocity, acceleration and change of oscillating acceleration per unit time.

The speed and amplitude of vibration does not affect a person. Acceleration creates large inertial forces in the human body. As a result, impulses are formed and they affect a person.

Therefore, reducing vibration and improving the smoothness of the car at the highest level are the main operational requirements for modern cars.

3. Vibration of a single-mass system.

We examine the vibration of a one-mass system with an arbitrary one degree of freedom (Fig. 26.1).

System 1 with mass *m* is attached to spring 2 with unit length *S*. Before applying a load to the spring, it is in state I, and after applying the load *G*, the spring is deformed to static displacement under the influence of gravity $f_{cm} = \frac{G}{C}$ and is in state II.

To get the object out of balance, the spring is compressed and released, and the free-oscillating movement of the object is created. At this time (case III) the system is elastic $R_{e\ of\ the\ spring}$ force, the force of inertia R_j and the resistance force $R_{a\ of\ the\ damper}$ are affected.

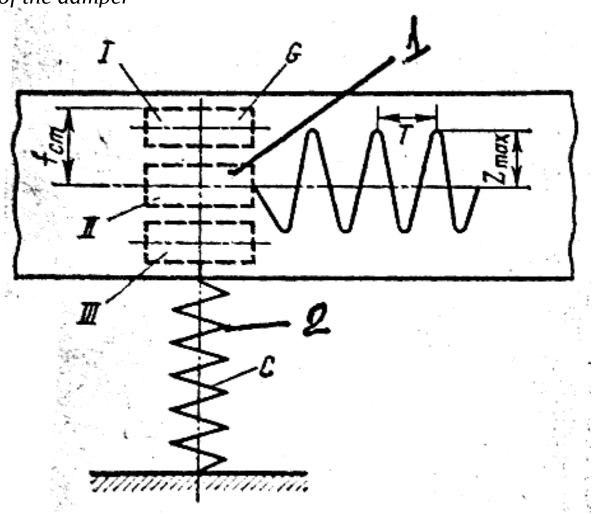


Figure 26.1. A one-mass system with one degree of freedom
vibration

If a pencil is placed on a vibrating system and the tip of the pencil is leveled on a moving paper tape, a line of sinusoidal harmonic oscillations is formed on this tape, which gives two indicators, namely, the maximum path of oscillation of the system out of state II (amplitude) Z_{max} and the oscillation period *T between the oscillation paths* can be seen.

The differential equation of harmonic oscillatory motion for this case is expressed as follows:

$$m\frac{d^2Z}{dt^2} + CZ = 0 \qquad (14.1)$$

here, *m* is the mass of the system; *S* - elasticity of the elastic spring; *Z* -vertical displacement of the system; $m\frac{d^2Z}{dt^2}$ - *m* is the acceleration of the center.

The above equation has the following solution:

$$Z = Z_{\max} \cdot Sin \cdot \sqrt{\frac{C}{m}} \cdot t\ , \qquad (14.2)$$

Since the angular frequency of free oscillation is equal to (14.2), we write the expression as follows: $\omega = \sqrt{\frac{C}{m}}$

$$Z = Z_{\max} \cdot t \cdot Sin\omega\ , \qquad (14.3)$$

$Z_{\max}$ - the largest vibration path (amplitude) $Z_{\max} = \frac{2m \cdot g}{C}$, *t* - time elapsed after the start of the vibration; *S* - the stiffness of the spring.

Using the expression (14.3), the dimensions of the harmonic free vibration are determined as follows:

swing speed:

$$v = \frac{dZ}{dt} = Z_{max} t \cdot \omega \cdot Cos\omega \text{, m/s;} \tag{14.4}$$

vibrational acceleration:

$$j = \frac{d^2Z}{dt^2} = -Z_{max} \cdot t \cdot \omega^2 \cdot Sin\omega \text{, m/s}^2\text{;} \tag{14.5}$$

rate of increase in acceleration:

$$j' = \frac{d^3Z}{dt^3} = -Z_{max} \cdot t \cdot \omega^3 \cdot Cos\omega \text{, m/s}^3\text{;} \tag{14.6}$$

oscillation period:

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{c}{m}}} \text{, s;} \tag{14.7}$$

number of oscillations per minute (frequency) of the system:

$$n = \frac{60}{T} = \frac{30}{\pi} \cdot \sqrt{\frac{c}{m}} \text{,} \tag{14.8}$$

The stiffness of the spring *S* is determined by the static displacement (deformation) of the spring, i.e

$f_{cm} = \frac{G}{C}$ from this $C = \frac{G}{f_{cm}}$ and $m = \frac{G}{g}$ if, the expression (14.8) can be written as follows:

$$n = \frac{30}{\pi} \cdot \sqrt{\frac{g}{f_{cm}}} \approx \frac{300}{\sqrt{f_{cm}}}, \ \frac{тебраниш}{минут}; \tag{14.9}$$

So, the greater the static deformation of the spring, the lower the frequency of harmonic free oscillation. Therefore, the installation of soft suspensions in the car reduces its harmonic free vibration, which means that the suspensions are always absorbing and damping vibrations and impulses.

The static deformation of the spring is as follows according to the type of car:

For cars f_{cm} = 100- 250 mm;

For trucks f_{cm} = 60- 120 mm;

For buses f_{cm} = 100- 200 mm;

4. Vehicle vibration and factors affecting it.

When a vehicle runs smoothly without vibration, its performance and average speed increase, service life increases, fuel consumption decreases, and it is less tiring for the driver and passenger. Therefore, reducing vibration and improving driving smoothness are the main operational requirements for modern cars.

The main cause of car vibration is the unevenness of the road.

Since the car is a multi-mass system, its vibration is very complex.

To study the vibration of the car, the mass of the car is divided into two groups: sprung and unsprung.

The sprung mass of the car is the mass transmitted to the elastic part of the suspension, which includes the body with its load, the cabin, the frame and the internal combustion engine attached to it, the clutch, the gearbox.

Front and rear axles and wheels with masses m_1 and m_2 *to the unsprung mass, with dimensions* S_{p1} and S_{p2} suspensions, S_{sh1} and S_{sh2} include tires with uniformity and shock absorbers with resistances K_1 and K_2 *(Fig. 26.2).*

If the crushing deformation of the tire due to the weight of the car is Z_{sh}, the crushing deformation of the suspensions is Z_p so, total crushing (deformation):

$$Z = Z_{ш} + Z_{п} = \frac{G_a}{C_п} + \frac{G_a}{C_ш}$$

At that time, the total number of suspensions will be as follows:

$$C = \frac{G_a}{Z} = \frac{C_п \cdot C_ш}{C_п + C_ш}$$

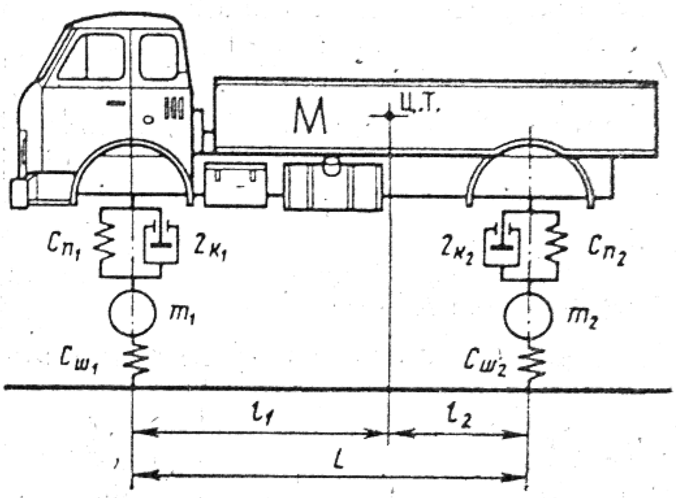


Figure 26.2. Car vibration systems and elastic unity of the masses

Since the oscillation is vertical, it obeys the following law:

$$m = \frac{d^2 Z}{dt^2} + (C_{п1} + C_{п2}) \cdot Z = 0$$

where Z is the displacement of the center of gravity from the neutral position at a given time.

Since the car's vibration is damped, the solution to the above expression is:

$$Z = Z_{\max} \cdot t \cdot Sin\sqrt{\frac{C_{п1} + C_{п2}}{m}}, \qquad (14.10)$$

here $\frac{C_{п1} + C_{п2}}{m} = \omega$; $C_{п1} + C_{п2} = C_п$ but $C_п = \frac{G_a}{Z_п}$; $m = \frac{G_a}{g}$;

here, S_p - the total uniformity of the front and rear suspensions; Z_p - total crushing of the front and rear suspensions. S_{sh} - the total width of the front and rear tires; G_a - weight of the car with cargo; t is the elapsed time after the start of oscillation.

The total stiffness of the front and rear suspensions of the car is S_p =200-.600

N/cm, the stiffness of the tire is equal to S_{sh} =2000-4500 N/cm.

m mass of a fully loaded passenger car to the sum of its unsprung masses is called the car sprung coefficient:

$$\mu_м = \frac{m}{m_1 + m_2}, \tag{14.11}$$

here, m_1, m_2 – the unsprung masses of the front and rear wheels and axles, $\mu_м$ the higher the coefficient, the better the smooth ride of the car.

Therefore, $\mu_м$ in order to increase the value of ni, it is necessary to reduce the weight of the unsprung masses. The sprung mass is increased by reducing the unsprung mass.

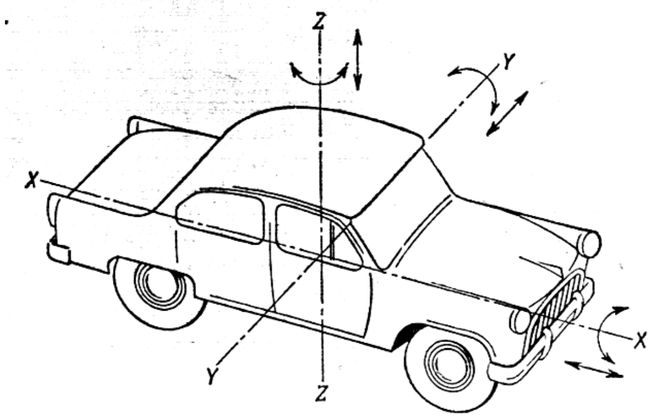
For cars $\mu_м$ = 6.5-7.5; the load will be equal to = 4-5 for cars . $\mu_м$

Reducing unsprung masses reduces thrust forces. An increase in the spring masses causes a decrease in thrust.

Trucks should always be fully loaded to increase smoothness. In this case, the mass *m* increases due to the load, and as a result, $\mu_м$ the coefficient also increases.

4.1. Car vibration

When the car is moving on the road, its body, cabin, frame and mechanisms mounted on the frame are located in space and have six degrees of freedom (three linear and three angular), which are perpendicular to each other *OX* , *OU* , *OZ* o oscillates along and around the axes (Fig. 26.3).



26 .Figure 3. Car vibration

<u>Rectilinear vibration:</u>

Oscillation hopping along the *ZZ axis;*

Reciprocating vibration along *the XX axis;*

Oscillating along the *UU axis.*

<u>Angular vibration:</u>

Swinging around the *UU axis (galopirovanie);*

oscillating around *the XX axis;*

Oscillation by impact around *the ZZ axis.*

It is considered a system with two degrees of freedom to facilitate the smoothness of the vehicle:

The first is vertical oscillation along *the ZZ* axis;

The second is angular vibration around the transverse *UU axis.* The two types of vibrations together have a great effect on the human body. Example: if the average step of a person walking is 0.75 m and the walking speed is 3-4 km/h, the upward swing of a person is (3000-4000)/(0.75·60)=67-89 times/min. Yes, if the speed is 4-5 km/h, the number of vibrations is 90-110 times/min. It will be. The vibration of a car is 60-80 times per minute, and that of a truck is 100-130 times per minute. Therefore, the vertical vibration of the car is reduced with the help of soft suspensions and shock absorbers .

The angular vibration of the car can be reduced due to the improvement of the suspension structure and the correct distribution of the vehicle mass along the longitudinal axis and due to the shock absorber.

So that the driver does not get tired, his seat should be spring-suspended, and so that the passengers do not get tired, the seats should be spring-loaded or soft.

Shock absorbers are spring, spring, hydraulic and rubber, and they are installed between the wheel and the frame or body.

The efficiency of the suspension and shock absorbers is determined by the vertical vibration damping coefficient h :

$$h = \frac{K_a}{m_K}. \tag{14.12}$$

where K_a is the coefficient of resistance of the shock absorber, N·c/m; m_k - spring loaded on the wheel, mass, N·c ^{2}/m;

the damping coefficient and the stiffness of the suspension (angular frequency of free vibration ω-) is determined by the relative damping coefficient of vertical vibration:

$$\psi = \frac{h}{\omega}, \tag{14.13}$$

for modern cars $\psi =$. The amplitude of the free oscillation is called the decrement of the decay intensity of the vertical oscillations in one period and it is defined as follows:

$$d_K = \frac{Z_1}{Z_2}; \frac{Z_1'}{Z_2'}; \frac{Z_2}{Z_3}; \frac{Z_2'}{Z_3'} -.$$

here, Z_1, $Z_{2\text{-}ampl}$ i bundles in the initial and final period of vibration ;

Z_1', Z_2' - the amplitudes of the vibration in the initial and last periods with a negative sign.

4.2. The influence of operating factors on the smoothness of the car

It is known that the vibration of the car is caused by the unevenness of the road. On rough roads, wavy bumps appear in 1-2 years and deteriorate the smoothness of the car.

If the technical condition of the running part of the car is faulty, it will affect the smoothness of its running. If oil gets between the spring sheets, the friction increases and the frequency of vibrations increases, as a result, the bodies are subjected to large impulses.

If the shock absorber fluid solidifies, the shock absorber ring becomes unusable, and if the oil leaks, the vibration damping property is lost.

When the frequency of the unevenness of the road becomes equal to the frequency of free oscillation of the car, resonance phenomenon can occur. As a result, the wheels roll without touching the road surface from time to time, the smoothness of the ride, stability and controllability of the car become difficult.

When the car is fully loaded, the weight forces on its front and rear axles increase several times under the influence of vibrations.

Control questions

1. Do you know what is the smoothness of the car and what are its dimensions?
2. Explain the vibration of a single-mass system with one degree of freedom.
3. Explain the path (amplitude) of oscillation, how is it determined?
4. How is the rate of oscillation, acceleration, rate of acceleration determined?
5. How is the period of oscillation and the number of oscillations determined?
6. Explain vibration damping and relative coefficients and decrement.
7. How does a car vibrate in space?
8. How to reduce vibration.
9. How do operating factors affect vehicle handling?

27- Subject. Environmental characteristics of the car.

Plan.

1. Definition of environmental characteristics of the car, impact on the environment.
2. Measures to reduce the negative impact of the car on the environment.
3. Use of alternative fuel types. Size neutralizers.
4. Hybrid cars. Electric cars.

Key words and phrases: Environmental features of the car , Hybrid cars , Electric cars

"Environmental protection" appeared as a result of the development of industry and automobile transport . If the plants and factories are located in one specific place and pollute only certain areas, then the cars will affect all the places reached by human feet .

The harmful effects of car transport on the environment can be seen from the following diagram.

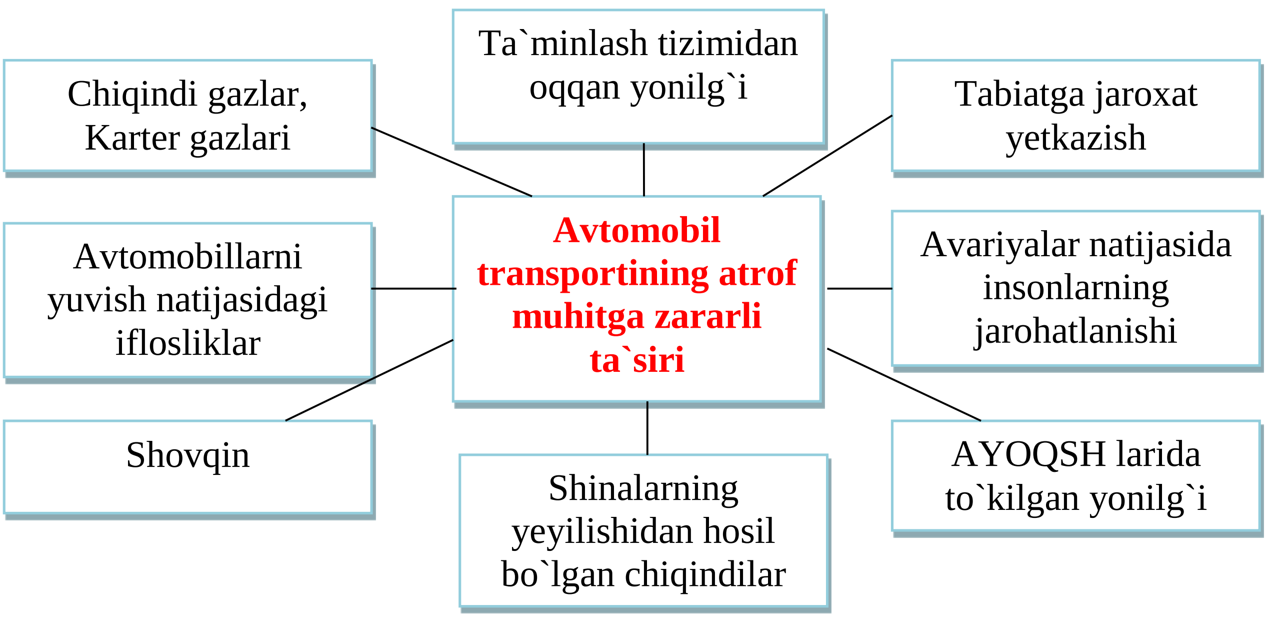


Figure 27.1. Harmful impact of automobile transport on the environment.

When any fuel burns, various combustion emissions are released. These wastes have a serious impact on human health and the environment. Factories, factories and motor transport enterprises in the city are the main sources of environmental pollution. If the plants and factories are located in one specific place and pollute their surroundings, then the cars will show their effect in all the working places. Car transport is currently considered to be a source of more pollution than plants and factories.

In the use of motor vehicles, 3 different sources of environmental damage can be seen: exhaust gases, crankcase gases, and harmful substances formed as a result of fuel evaporation (from the fuel tank, carburetor, etc., Fig. 1).

Exhaust gases make up 65-70% of the toxic substances released into the environment as a result of the car's operation, and crankcase gases make up 20%. At present, the biggest problem to be solved is to reduce the toxic emissions from the use of the car.

It was found that there are more than 200 toxic wastes in the gas produced by fuel combustion in the car engine. The most toxic of these include carbon monoxide - CO, unburned hydrocarbons - CH, nitrogen oxides - NOx .

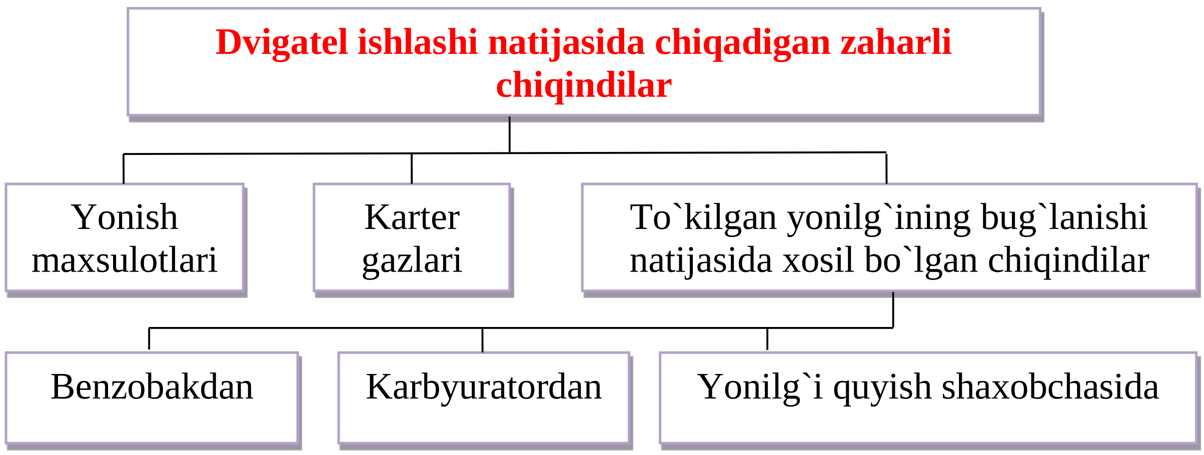


Figure 27.2. Toxic waste generated as a result of vehicle operation.

Many countries have introduced licensing standards for these wastes.

In the CIS countries, regulation of emissions from fuel combustion was introduced in 1970 based on the instructions issued by the UN Economic Commission for Europe (EEC).

Waste gases also contain harmless oxygen, carbon dioxide, nitrogen, and sulfur. However, nitrogen at high temperature and under pressure forms nitrogen oxides, which are very toxic. Due to many reasons, toxic products in waste gases are not always in the same volume. It depends on the type of engines, operating mode, level of adjustment, engine maintenance and fuel quality.

A diesel engine is less harmful than a carburetor engine. During the operation of diesel engines, harmful gases such as CO, NO_x and CH are released less, but the volume of the body containing harmful benzopyrene is larger. Carburetor engines release lead compounds, diesel engines release lead compounds, and diesel engines release barium compounds.

These bricks are formed as follows:

- as a result of adding ethyl alcohol to increase the anti-detonation properties of gasoline (ethyl alcohol contains lead);
- to reduce the burning of diesel fuel, a substance prepared with the presence of a special anti-smoke barium substance is added.

Engine **operating conditions play a major role in whether exhaust gases** are harmful or harmless. The largest emission of CO is produced in the mode of operation of the engine only, in which the engine runs on an enriched fuel mixture. At the same time, as a result of improper installation of the combustion system in carburetor engines, the voltage (spark) is transferred to the spark plug earlier or later than normal, which leads to incomplete combustion of the fuel mixture. A change in the distance of the switch contacts from the norm also causes a decrease in the voltage in the candles and a weakening of the spark, which also leads to incomplete combustion of the combustible mixture, as a result, an increase in the amount of CO in the combustion products.

of diesel engines , as well as the irregularity of the spray angle (if the angle is low, the speed of fuel spray increases and the fuel partially sits on the piston, if the angle is large, it burns `i does not reach everywhere in the combustion chamber) leads to deterioration of the combustible mixture and incomplete combustion of fuel. Even in these cases, the amount of harmful substances in exhaust gases increases.

As a result of the operation of carburetor and diesel engines, indicators of the amount of exhaust gases in the combustion products are shown in table 27.1.

Table 27.1.

Substances in waste gases	The composition of waste gases, %	
	Gasoline engines	Diesel engines
Nitrogen	74-77	76-78
Oxygen	0.3-8.0	2-18
Water	3.0-5.5	0.5-4.0
Carbon-2 oxide	5-12	1-10
Carbon monoxide	1-10	0.02-0.50
Nitrous oxide	0-0.8	0.001-0.400
Hydrocarbons	0.20-0.30	0.1-0.10
Sulfur gas	0-.002	0-.03
Body, g/m^3	0-.04	0.1-1.5
Benzoprine, g/m^3	0.0002	0.00001

Protection of the atmosphere. Life on Earth will continue until the outer shell of our planet, the layer that protects the universe from the terrible effects of the atmosphere, is exhausted. The atmosphere is the air layer of the earth. Its height is difficult to say precisely, because the air in its upper layers is extremely thin. ¾ of all air is its lower layer troposphere (its average height is 11- 12 km, that is, 9 kmat the poles, 17 kmup to . at the equator). The next layer is the stratosphere (up to 80 90 km), and the remaining ¼ is all air. The highest layer is the ionosphere and exosphere (3000 kmup to 1500- .), in which there are molecules of some gases. Their density is several million times smaller than the air above the earth's crust.

for some molecules of gases on Earth 3000 km, they are found at an altitude of 10-20 thousand km. Thus, the thickness of the life-sustaining atmosphere of our planet 1,5 kmis very small compared to the scale of the earth (it is ¼ of the radius of the earth). According to the scale of the universe (the distance between the sun and the earth), it is 1/100000 of it.

The density of the atmosphere decreases from bottom to top, that is, it becomes rarefied. Its density is 0.001 g/cm $^{3 \text{ even on the surface of the sea}}$, or 1000 times less than the density of water. Therefore, according to scientists, it does not provide the concept of a means of protection. Nevertheless, the "suspended" air sustains life on Earth and protects the universe from harmful threats. Only meteorites with a mass of several hundred tons can penetrate this "textile" shell. Such events are rare, only in exceptional cases. The composition of the atmosphere is important for living things. It is composed of 78% nitrogen, 21% oxygen, 0.9% argon, and 0.03% carbon dioxide and other gases in very small amounts. In addition to these, the atmosphere contains water vapor (4%), mixtures of several different natural mechanical particles. The composition of atmospheric air can change due to various reasons (season, years, oceans, mountains, etc.).

Sources of air pollution. Natural air pollution occurs as a result of activity of more than 500 volcanoes and dust storms on our planet. In some cases, storms blow away the topsoil. Sand and dust cloud the air. It enters the respiratory tracts of humans and animals, damages the mucous membrane of their eyes, pollutes the fur of animals. There are a lot of germs in the air, and among them there are many pathogens. In some districts, various gazandas are growing massively. Gazandas are widespread in North America, Siberia, the tundra, taiga regions of the Far East, and the banks of the Danube River.

According to their origin, the most dangerous sources of atmospheric pollution are anthropogenic. Industrial and municipal wastes are especially harmful. Their annual amount is very high. Every year, the atmosphere is 150 mln. Tons of sulfur oxides, 60 million tons of nitrogen, 300,000 tons of lead and other wastes are released. As a result of human activity, the atmosphere is polluted. For example, in 1987, 22 billion tons of carbon dioxide released. 23% in the USA, 19% in the CIS, 13.5% in Western Europe, 8.7% in China, and 28% in other countries. The main part of CO_2 gas is due to burning 45% of coal, 40% of oil and 15% of gas.

Atmospheric pollution is conditionally divided into mechanical and chemical pollution. Mechanical pollution is waste from cement plants, coal burning nodules, burning of oil, wear of rubber wheels, etc. Chemical pollution Dusty, gaseous, chemically reactive substances. The first place in chemical pollution is sulfur gas. Cars emit carbon dioxide (CO) and nitrogen dioxide (NO_2). They have a bad effect on human health. Mechanical contamination of the atmosphere with radioactive substances reduces the transmission of sunlight, that is, increases the albedo, which reflects light.

Air pollution and its negative impact on the environment. Pollution of the atmosphere with various toxic gases causes people and animals to suffer from various diseases. In order to avoid the "imperceptible" effect of air pollution, certain thresholds are established. These parameters are determined by the maximum possible concentration of toxic substances. The highest possible concentration of pollution has a direct negative impact on people's health, productivity, and mood.

Issues of air purification. For a long time, the atmosphere itself was considered the only way to clean the air from impurities. Then comes the issue of air pollution prevention. The most simple of them is to install the factory shafts high . Now, special smoke detectors have been installed and they are working well. Emissions from transportation continue to be a problem around the world.

In general, protection of the atmosphere on earth is taking a drastic turn. Among the measures of atmospheric air purification, the construction of dust and gas catching facilities, the use of waste-free technology, and the electrification of railway transport are having a good effect. Every year, our state allocates a large amount of funds for the protection of the atmosphere. Cleaners installed in the right places trap various impurities in the air. Currently, airborne dust is captured using electromechanical ultrasound. Chemical devices that reduce the toxic properties of gases, used and sieve traps (filters) and others are used.

In some industries, treatment plants are working well. For example, Vakhsh is being completely separated from nitrogen. The implementation of waste-free technology captures harmful compounds that are released into the air during the production of the main product. Scientists are working on neutralization of toxic gases emitted by motor vehicles.

Currently, state control is established over 114 different chemicals and 25 different air polluting compounds. Control over them is carried out by special organizations in factories. EMC has been installed in other countries as well. But the bad thing is that they are different.

The Law "On Protection of the Atmosphere" was adopted in Uzbekistan, its task is to protect the air from pollution, to reduce the harm of harmful chemical, physical, biological and other substances to the population, plants and animals.

Improving the structure of car and tractor engines, increasing the number of gas-powered cars is very important today.

4. Use of alternative fuel types. Size neutralizers

The rapid increase in consumption and price of petroleum fuels and their diminishing sources pose the problem of searching for other types of fuel substitutes. By making changes to the engine construction, alcohols, ammonia, biogas, hydrogen, etc. are used instead of fuel. It is clear that the overall energy efficiency of diesel engines is 15% for oil fuel , 11% for oil shale and 9% for coal fuel, and 13, 10 and 8% for spark ignition engines. is equal to

In recent years, more attempts have been made to use methanol (methyl alcohol) and ethanol (ethyl alcohol) instead of petroleum fuels. Because the working mixture formed with methanol at the same temperature and pressure has the same combustion temperature as the gasoline mixture, besides, the methanol-air mixture is denser and the useful work coefficient is much higher . Pure methanol has an octane number of 92 (according to the research method), which can increase the engine compression ratio to 14 and increase the effective power of the engine by up to 20 percent.

Table 27.2 Compressed gases used in cars

Indicators	Value of indicators for gases		
	Natural gas	Methanation	B is lost
Combustion heat, KJ/m ^{3} , at least	2900	27000	22000
Amount of components : flammable c o m p o nents, % his o bida - methane	80-97	Not less than 65	50
- w o d o r o d	-	-	Not less than 12
Useless mixtures, at most: - *carbon dioxide , ⁄g m ^{3}*	0.02	0.02	0.02
- *cyan, g/m ^{3}*	0.05	0.05	0.05
Oxygen is expressed in % by volume	1.0	1.0	1.0
Tar and dust, g/m ^{3}	0.001	0.001	0.001
Water vapor in the gas stored under pressure in the cylinder, g/m ^{3} - *in the summer*	7.0	7.0	7.0
- *in winter*	0.5	0.5	0.5

Oktan s o ni	94-105	80	80
Gasoline equivalent (1 m^3 the amount of gasoline equal to the heat of gas combustion, in kg	0.71-0.83	0.62-0.70	0.89-0.91

Methyl and ethyl alcohols, despite their high octane numbers, have low cetane numbers, so they are suitable for use in spark-ignition engines. However, under certain conditions, they can be used in diesel engines by adding diesel fuel.

One of the factors limiting the widespread use of alcohols as fuel is their corrosive activity, which has a negative effect on the details of the fuel supply system; alcohols have a rapid effect on lead; they block fuel filters and carburetor nozzles; most gasket materials swell under the influence of alcohol; due to the low combustion heat, the size of the fuel tanks should be doubled for them. In order to eliminate these shortcomings, active work is carried out abroad, especially in the USA, Brazil, Germany, and Sweden.

Table 27.3. Some physical characteristics of alternative fuels

Indicators	Meta n o l	Ethan o l	Ammonia	Hydra o zin	Water
Chemical formula	SN_3ON	S_2N_5ON	NN_3	C_2H_4	H_2
DENSITY, KG/L	0.8	0.8	0.68	1,008	0.09
heat of combustion, MJ/kg; MJ/l	19.97; 5.98	26.80; 21.44	18.62; 12.67	16.70; 15.83	121.0; 10.89
Har o rat, ^{0}S: boiling tooth	64.7 -98	78.3 - 115	-33 -78	113.5 -2	-253 -259
Saturated vapor pressure, KPa	12.67	5.87	800	2.67	-
Stexe o metric coefficient	6.51	9.06	6.15	4.36	34.8

Next in years foreign in hand oil fuel instead of it is a plant oil (sunflower , soybean , cotton and etc.) to use trying A plant m o yini heat release q o ability much heavy , but their burden it 's so cute because of engine work becomes difficult (fuel to start resistance increases , burns nas o sini work product drops , spray and mixture h o sil to do processes it 's bad). All this causes the formation of soot on the surfaces of the parts without complete combustion of the fuel and increases the relative consumption of fuel.

Using hydrogen as a fuel is the most promising. In this case, the engine's energetic and environmental indicators are dramatically improved. The high heat of combustion of hydrogen is 120 MJ/kg, etc
much higher than the mass heat of fuels: gasoline is 45 MJ/kg, and diesel fuel is 42.7 MJ/kg. However, due to the low density of hydrogen, its simple energy characteristics are low compared to petroleum fuels. The ability to release heat of the hydrogen-air mixture is 15 percent lower than the gasoline-air mixture and 10 percent lower than the alcohol-air mixture.

Hydrogen is a promising fuel for engines, because it has an inexhaustible base of raw materials, a very high heat of combustion (its heat of combustion is 118045 kJ/kg), as a result of combustion, toxic substances (except nitrogen)) and does not deteriorate the properties of the oil.

The high diffusion coefficient of hydrogen makes it possible to create a homogeneous mixture even when it is transferred to the fuel cylinder in any way, to distribute it evenly to the cylinders in all engine operating modes. When hydrogen burns, it does not produce soot, soot and coke, which is acceptable from the point of view of corrosion of engine parts and service life. However, due to the low density of hydrogen, its volumetric energy capacity is relatively low. Combustion of a hydrogen fuel mixture is 6 times faster than the combustion rate of a gasoline-air mixture. A working mixture of hydrogen and air in a ratio of 1:10 is relatively effective. Hydrogen is distinguished by the lower ignition limit of the hydrogen mixture (the ratio of hydrogen and air is 1:25) and the very low ignition energy (12-14 times less than gasoline). These properties of hydrogen cause spark formation in the conduits for introducing the working mixture, premature ignition of the working mixture in the cylinders, intense combustion process, and detonation. As a result of these conditions, the work process in the carburettor engine is disturbed. In addition, the issue of storing and placing hydrogen in a car is one of the problems that must be solved. For example, if the mass of the fuel tank is 13 to store the amount of fuel (gasoline or diesel fuel) sufficient to travel a certain spare distance 15 kg, then it is enough to travel that distance. The mass of the container system for storing the intended compressed hydrogen should be 1300- .1400 kg

Due to these reasons, hydrogen is considered as a replacement material for oil-derived liquid fuel in the long term. Currently, work is being carried out on the use of hydrogen as an additive to reduce the consumption of liquid fuel.

In a number of foreign countries (Germany, the Czech Republic, Slovakia, the Netherlands, Romania, etc.), active work is being carried out on the use of biogas (obtained from the anaerobic decomposition of agricultural waste biomass - without the introduction of air).

It should also be noted that the need to use alternative types of fuel in mobile equipment is determined by the demand of time, economic criteria, and these vary depending on the amount of energy sources.

Fuels obtained from shale and bitumen. They can be considered as local types, because their properties largely depend on the characteristics of the place where they are obtained and the technology used in the production of these fuels. The index of synthetic motor fuel obtained from shale is given in table 2.14.

Fuels obtained from coal. Among the acceptable energy resources, coal is a real material for fuel development. The combustion heat of coal is 2.8 times higher than the combined combustion heat of oil and gas. It has been known for more than 70 years to obtain liquid fuel by reprocessing coal by hydrogenation method. But this technology, which was developed at the beginning of the 20th century, is currently considered useless. Unlike oil, coal contains more (up to 20%) oxygen, sulfur and nitrogen, mineral substances (ash). Coal processing involves hydrogen saturation, separation of nitrogen, sulfur, oxygen, and ash, and the structure of hydrocarbons is changed until their molecular weight is the same as that of conventional liquid fuels. Obtaining liquid fuel from coal is a very complicated process, but there is a solution for this. Currently, the technology of obtaining liquid fuel from coal up to 85% has been developed.

Table 27.4. The main properties of synthetic motor fuels obtained from shale tar

Indicators no	Gasoline	Diesel fuel		
		1-D	2-D	4-D
of fraction :				
10 percent evaporation temperature, °C	54.4	204.4	*227.8*	232.2
20 percent evaporation temperature, °C	64.4	209.4	234.4	242.2
50 percent evaporation temperature, °C	101.7	216.7	251.1	263.9
90 percent evaporation temperature, °C	163.3	242.8	280.6	318.3
Each temperature at the end of boiling , °C	196.1	269.4	290.0	331.1
K o ldiq, f o iz	1.0	2.0	1.0	1.0
Octane number :				
the research method	82	-	-	-
m o t o r method	91	-	-	-
Amount of real resins, mg/100 ml	2.8	-	-	-
Amount of sulfur , percent	0.003	0.010	0.020	0.020
A small amount	-	0.0141	0.0166	0.0202
Flash rate , °C	-	86.7	100	129.4
temperature , ° C	-	-17.8	-17.8	-6.7
Density, kg/m ^{3}	-	816	826	829.9
Coking, 10 percent of the residue according to Conradson	-	0.14	0.16	0.36
Ash, f o iz	-	0.001	0.001	0.001
Kinematic speed , mm 2 / ^{s} , 37.8 ^{0} C	-	1.66	2.40	2.96
TSetan s o ni	-	48	54	56

Passionate to fuels pourable as o siy from requirements one za - fade away more , work to issue wide j o riy to do possibility , transp o rt of the device economy and technology indicators m o s Come on and h . k .

Benzene is an aromatic hydrocarbon obtained by processing coal. It has high anti-detonation qualities and therefore is added to gasoline as an additive to increase the octane number. Due to the high boiling and melting temperatures, it is rarely used in its pure form, because it can worsen the start-up of the IYOD.

Methanol (methyl alcohol) is a fuel that can be used instead of petroleum fuels. It can be obtained in large quantities from low-quality coal and wood at low costs. It has high anti-detonation properties and is very suitable for spark-ignition IODs. In this case, it becomes possible to increase the level of compression and, consequently, the efficiency of heat use. But it is a poisonous substance. Currently, methanol is used as an additive (10-20 percent) to petroleum-derived fuels, which in turn reduces gasoline consumption without changing the design and settings of the IYOD. Table 27.5 shows the main properties of gasoline obtained from coal.

Gasoline obtained from coal may have a relatively high content of gases used when the car is moving, that is:

Fuel	Air pollution depending on the distance traveled by the car, g/km			
	S O	NS	NO $_X$	Aldehydes
Gasoline	7,272	0.994	1,678	0.188

The amount of SO and NS in coal-derived gasoline is higher than that of standard gasoline, which requires the improvement of technologies for obtaining synthetic fuels.

Fuels obtained from plants. Ethanol (ethyl alcohol) - mainly obtained from plants. It has high anti-detonation properties like methanol and is more suitable for spark-ignition IODs. Low molecular weight alcohols - methanol and ethanol, in the future the use of hydrogen as a fuel is not considered a real fuel. They can be added to fuels or used separately . Alcohol reserves are inexhaustible, methane can be obtained from coal, natural gas, lime, household waste, forestry waste and other materials. The completeness of combustion of methanol is higher than that of gasoline, it burns completely. In methanol, the power of the engine increases by 10-15 percent compared to gasoline. Ethanol gas is obtained from sugar cane and other plants.

The disadvantages of alcohols include low heat of combustion (2 times lower than gasoline), volatility, tendency to corrode details . Methanol is more toxic than gasoline and accumulates in the human body.

Ethers are a large group of hydrocarbon compounds obtained from coal, wood and plants. Depending on the raw materials and the technology of preparation, it is possible to obtain esters with mutually compatible properties for use in both carbureted IODs and diesels. It has a number of advantages over alcohols, but it is more expensive to produce. Ethers can be considered as promising fuels used instead of petroleum fuels.

Hydrogen fuels. When using hydrogen as a fuel, it is necessary to solve a number of problems: storing hydrogen and placing it in a car. Cylinders resistant to pressure of 15...40 MPa occupy a very large volume and have a large mass. For example, a GAZ-24 car 4 kgneeds an average amount of hydrogen per day. The mass of the hydrogen storage cylinder 80 kgis 0,5 kgthe amount of hydrogen it can hold. So, there should be 8 such cylinders, and their total mass 640 kgis at least.

Hydrogen burns very quickly, as a result of which engine parts can be strained. In addition, hydrogen is a very explosive substance.

Table 27.5. The main properties of gasoline obtained from coal

Indicators no	*Indicators*
Composition: B u tan	6
Rif o rmat	30
Alkylate	20
Ligr o in	44
Density at 15.5°C, kg/l	0.775
Resin content according to ASTM, g/ml	-
Br o ms o ni	14
Fraction composition, °C:	
Every time the boiling starts	32.2
10 percent evaporation rate	65.6
50 percent evaporation rate	127.8
90 percent evaporation rate	183.9
Every hour at the end of the boil	215.0
Octane number :	
in the research method : clean fuel	95.6
When adding 0.5 mlTEQ/kg antidetonator	98.5
3.0 mlTEQ/kg when adding an antidet onator	102.6
in the motor method: clean oil	86.2
When adding 0.5 mlTEQ/kg antidetonator	89.0
When adding 3.0 mlTEQ/kg antidetonator	93.2

Gas condensation . Gas taken from mines gas fuels in the composition of hydrocarbons very heavy fractions most of the time there is they will be gas b o when the wire increases and every time o s o n when it decreases it's fun . Gas capacitors that the so-called this fractions derived from oil standard liquid fuels instead , here fuels rare when or economy to many people according to use can

extracted from Central Asian gas fields 1 m^3.

Of course, it is advisable to use gas condensates without changing the IYODs. The use of gas condensates should not reduce the technical and economic indicators of the engine compared to liquid fuels. An important aspect of gas condensates is the low cost of production, the characteristics of their properties and the stability of their composition during storage. Central Asia is the largest supplier of these fuels and supplies not only its own requirements, but also the Urals, Kazakhstan and Central regions. The composition of gas condensates obtained from various mines includes light gas condensates that meet the requirements of spark-burning IOD and heavy gas condensates that are difficult to use in diesel engines. We will consider some features of these two types of gas condensates belonging to the Central Asian region. Common features for both categories are that gas condensates do not contain infinite compounds and are composed of aromatic, naphthenic, and paraffinic hydrocarbons.

Light gas condensates are obtained from Mubarak, Gazli, Uchkir and other fields. They begin to boil at a lower temperature than gasoline, which in turn increases the tendency to the formation of steam plugs in the IYOD supply system.

However, special studies show that the temperature at which steam plugs are formed in the supply system of modern power plants is slightly higher than the normal value that occurs when the machines work in the conditions of the Central Asian region.

Gas condensates have low anti-detonation properties, and their octane number is in the range of 54-58. By adding one TEQ , the octane number of gas condensates can be equal to that of medium-quality gasoline. By mixing gas condensates with high-octane gasoline, their resistance to detonation can be increased to the level required by modern IODs. In this case, the use of gas condensates reduces the demand for pure gasoline by 50-60%.

Gas condensates Since its viscosity is close to that of gasoline, it is necessary to change the design of the IYOD supply system. Special experiments have shown that light gas condensates are stable enough and losses during their storage (due to evaporation) are not high. Table 2.16 presents some coefficients of gas condensation rates .

Heavy gas condensates are obtained from Shahpakht, Achak, Shatlik, Karim, Islam, Kara-Chop, Ravot, Gugurtli and other gas fields. Experiments show that they contain more clay fractions than diesel fuel . This aspect should improve the starting properties of diesel and lead to acceleration of evaporation in the combustion chamber in the period before spontaneous ignition. At the same time, the amount of tar residues, heavy fractions that form smoke in fake and used gases is significantly less in these gas condensates than in standard fuel, and it has a positive effect on diesel properties. The cetane number of most gas condensates is in the range of 40-65, that is, equal to or slightly higher than that of diesel fuel. This aspect ensures a much smoother operation of IYoD during normal adjustments.

The density and viscosity of gas condensates is usually less than that of diesel fuel, which can lead to a slight decrease in the amount of fuel supplied during the cycle and a decrease in injection pressure in a fuel system designed for diesel fuel. If the performance of diesel is significantly worse than the performance of standard fuels, the viscosity of gas condensate can be increased by adding special thickeners, for example, polyisobutylene or diesel fuel. As a result, the demand for standard fuel will decrease by 40-50%.

Sulfur is the most harmful substance in the composition of gas condensates obtained from gas fields. In some cases, their amount reaches up to 3%, and this limits the use of gas condensates as fuel for power plants. The use of special technology is required to reduce the sulfur content of gas condensates, which makes the production of gas condensates more expensive. However, the cost of gas condensate produced in the Central Asian region is several times cheaper than that of standard fuels used in power plants . Because gas condensates are used in regions near gas fields, the cost of transportation is lower than that of standard fuels.

Table 27.6. Properties of gas condensers

Indicators no	Gas condensers			Summer L diesel fuel according to DAST 302-82
	I	II	III	
TSetan s o ni	43	53	52	at least 45
Fraction composition, °C boiling point 50% boiling point temperature at the end of boiling	 103 151 292	 111 201 350	 140 208 345	 Below 280 Below 360
Kinematic viscosity at 20°C, mm ^{2}/s	1.2	1.7	2.1	3.0...6.0
Amount of sulfur , % with common mercaptans	0.02 0.0001	0.02 0.0001	0.02 0.0001	maximum 0.2% maximum 0.01%

5. Hybrid cars. Electric cars.

The history of the first electric cars goes back even further than cars powered by an internal combustion engine. According to the electronic encyclopedia Wikipedia , the first electric vehicle in the form of a trailer was invented in 1841.

Two with seats , four wheeled initial of electric cars front wheels to those behind than relatively bigger was They are powered by lead-acid batteries based on the 36-cell Bari system. Such batteries required charging every 64 kilometers. At that time, electric cars had a power of 4 horsepower and traveled at a speed of up to 37.4 kilometers per hour.

On May 1, 1899, La Jamais Contentethe electric car for the first time increased the speed over 100 km/h on land, reaching a record speed of 105,882 km/h. American engineer Walter Baker was able to increase this indicator to 130 kilometers per hour. For the first time, an electric car manufactured by the Borland Electric company covered the distance of 167 kilometers from Chicago to Milwaukee on a single charge. Its average speed was 55 kilometers per hour.

Initially gasoline and electricity current moving of cars average speed one different was However, the biggest drawback of electric cars was the complexity of the charging process. At that time, since there were no devices that convert alternating current into direct current, the charging process was carried out with the help of an electric motor. An alternating current motor drives a shaft connected to the electric car's battery. In 1906, although a relatively simple-looking device was created to convert alternating current to direct current, the charging problem was not sufficiently solved.

In the first quarter of the 20th century, cars were driven mainly by electricity and steam. In 1910, 70,000 electric taxis operated in New York City alone . Also, the number of electric trucks and electric omnibuses (electric buses) was the majority.

to the 1960s come motor vehicles with depends respectively to the body came ecological problems and fuel products of the price sharp increased leaving of electric cars improved appearances create on take going things more accelerating sent

In the 1990s, when the atmosphere of the US state of California was mentioned as the most polluted area, the California Air Resources Committee decided that starting from 1998, 2% of all cars, and 10% from 2003, should consist of electric cars that do not emit harmful gases into the atmosphere. done That's it on purpose General Motors company since 1996 starting from EV 1 electric cars wide in scope work release starting from sent In 1997, more than 5,500 such electric cars were sold in California.

destroyed by manufacturers , but a sharp rise in oil prices revived interest in electric cars by 2007. .

Today, electric cars are widely used not only as personal vehicles, but also for transportation of goods in railway stations, production workshops and large trade networks, and for entertainment purposes in attractions.

New discoveries, new records

In the eyes of many, electric cars are slow-moving vehicles that require frequent charging and are, on top of that, very expensive. In fact, the average speed of electric cars is not far behind that of cars with internal combustion engines. For example, on May 22-23, 2010, the Dai'atsu Mira EV car produced by the Japanese electric car enthusiasts club traveled 1003,184 kilometers with a single charge. On August 24 of this year, the "Venturi Jamais Contente" electric car equipped with a lithium-ion battery reached a speed of 495 kilometers per hour in a distance of 1 kilometer in Utah, USA. Its maximum speed was 515 kilometers per hour. On October 27, the Lekker Mobil electric car covered the 605-kilometer distance from Munich to Berlin with all options, including the heating system, on a single charge. This electric car is equipped with a 55kW engine and 115kWh batteries produced by the company "DBM Energy" and has an average speed of 90 kilometers per hour, and in some places it reaches 130 kilometers per hour. According to experts of DBM Energy, with such batteries, electric car owners can drive continuously for up to 32 hours and cover a total distance of 500,000 kilometers.

"Sunmobiles" and "windmobiles"

In practice of electric cars The sun batteries and the wind energy based on moving types too work released However, such cars were not very popular due to low efficiency (10-15 percent), lack of daily energy storage. Also, the movement of "solar cars" is limited at night and on days when the weather is unfavorable, and the high cost of solar batteries also creates big problems in this regard.

Even so, the Venturi Astrolab model produced by Venturi Electronics has become quite popular among car enthusiasts . This model also differs from other types in that it moves on the basis of wind energy.

In 2012, the SolarWorld GT electric car, produced by Italian experts, made a trip around the world using solar power.

The 11.42 hp, 4.2 kW two-wheel drive Loebbemotor car also managed to draw attention to itself. Due to its light weight (overall 260 kg), aerodynamic appearance, it recorded a record speed among "solar cars". Its top speed increased to 120 kilometers per hour. This car weighs 21 kilograms and is equipped with a lithium-ion battery with a capacity of 4.9 kWh.

Also , the same at the time hybrid - " solar cars " too there is they are one of time to himself too The sun energy , too legs with pedals rotate account moves .

Advantages and disadvantages

Electric cars are more economical than other vehicles. For example, the Ford Ranger electric car consumes 0.25 kWh of energy per kilometer, while the Toyota RAV4 EV needs 0.19 kWh.

Today, the efficiency of electric motors is 88-95 percent. For internal combustion engines, this figure is only 22-42 percent. Another advantage of electric cars is that they emit less noise. However, it is recognized by many that the noiseless movement of electric cars can cause traffic accidents due to the fact that they are imperceptible to pedestrians. That is why some manufacturers are installing artificial noise emission devices on electric cars after the speed exceeds 30 kilometers per hour.

Electric cars again one superior side is that they have environment a pollutant oil products , motor oils and they are for necessary has been elephants , antifreeze demand not done . It is also emphasized that the technical inspection is simple, there is a low risk of fire and explosion during traffic accidents. Electric cars can be charged via conventional power grids, but it takes longer than dedicated high-power equipment.

To electric cars about the most big problem while their batteries with depends being remains Basically, the problem of their production and disposal has not yet been positively resolved. This is because such batteries use chemicals that are harmful to the environment, including lead, lithium, and various acids.

The problem of creating power structures for mass production of electric cars is also waiting for its solution. Mass charging of electric cars at home is unlikely to cause stress and disruptions in the electricity supply systems. Also, the charging process takes more time.

Most electric cars travel a short distance on a single charge. 24 kWh batteries can cover a distance of 160 kilometers. Air-conditioning and heating systems, the number of passengers and the volume of cargo replaced by electric cars, the increase in the speed of the car to 90-100 kilometers reduce this distance to 2 times.

Also , from electric cars applicable lithium batteries cost tall if it is leaded batteries volume size and heavy weight with problematically remains

Today's market

At the moment, large automobile concerns such as Nissan, BMW, Mitsubishi, and Chevrolet are showing great interest in the production of electric cars. Toyota RAV4 EV, ZENN, ZAP Xebra, General Motors EV1, Chevrolet Volt, Volvo C30 BEV, Tesla Roadster, Modec, Reva NXR, Renault series ZE, Nissan LEAF, Tazzari ZERO electric cars can be counted as the most sold models.

In 2011, the Japanese company Mitsubishi took the lead in the electric car market. This company's Mitsubishi i MiEV electric car sold more than 15,000 units in Europe and Japan in September 2011.

Research conducted by the specialists of the IDTechEx company showed that in 2005, the global sales of electric cars, including hybrid cars (both electric and two combustion engine cars), reached 31.1 billion dollars. By 2015, sales of electric cars will increase 7 times and reach 227 billion dollars. According to the estimates of PriceWaterhouseCoopers, in 2015, the production volume of electric cars will reach 500,000 units per year. In this regard, decisions have been made in countries such as Germany, Japan, China, and South Korea aimed at the rapid development of the electric car industry. it is determined how many years of tax benefits will be introduced and a large amount of government funds will be allocated for the further development of the industry.

Control questions.

1. Advantages and disadvantages of gaseous fuel.

2. Types of gaseous fuels by origin, their composition and properties. 3. What types of gaseous fuels are divided according to the heat of combustion?

4. Natural gas, its composition, properties, use.

5. Compressed gas, its composition, properties, use.

6. Electric cars.

7. "Sunmobiles" and "windmobiles"

LABORATORY TRAINING MATERIALS

LABORATORY TRAINING MATERIALS.

1-LABORATORY WORK

Topic: General structure of the car.

I. Purpose of work:

1.1. Acquaintance with the creation of cars, their development stages, general structure and technical indicators;
1.2. Study of the general structure of the car and engine. Getting to know the performance indicators of engines.

II. Content of work:

2.1 Learning the types of cars ;
2.2 the general appearance of the car and the location of the names of the car ;
2.3 Acquaintance with types of engines;
2.4 Study of engine operating processes and key k' indicators .

III. Equipment and recommended manuals and instructions :

3.1 Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2 Layouts of one and four - cylinder and V-shaped eight-cylinder engines;
3.3 Nexia, Damas, car engines;
3.4 on the general structure of carbureted and diesel engines (b - stroke and cross - stroke engines);

IV. Order of work:

4.1 It is necessary to read and master those in the Q house :

- Familiarity with the history of the creation of automobiles and automotive industries ;
- Learning the types of cars and getting to know their main models;
- Getting to know the general structure of the car and the functions of its main parts;
- get acquainted with the functions, types and use of internal combustion engines;
- get acquainted with the structure of a single-cylinder engine;
- familiarization with engine mechanisms and systems;
- familiarization with the working processes of carburetor and diesel engines;

- familiarization with working cycles of two- and four-stroke engines;
- put serial numbers on engine cylinders;
- familiarization with the working order of pistons in engine cylinders;
- study the structure of a multi-cylinder engine.

V. The procedure for drawing up the H report :

5.1 2.1 or 2.2, models of cars are determined according to the option;
5.2 Brief information is written about the history of the creation of the car and the automotive industry;
5.3 Draw a diagram of the general structure of the car (Fig. 1.1), identify its main parts, write information about their functions and types of cars;
5.4 the function, types, types and structure of the engine as well as working processes;
5.5 Draw a diagram of the structure of a single-cylinder engine (Fig. 1.2) and mark its main parts with numbers, and write the names of the parts;
5.6 Draw the structural scheme of in-line and V-shaped multi-cylinder engines and assign the order numbers of the cylinders;
5.7 The main technical indicators of cars are written in tables 2. 3- 2.4-2.5 ;

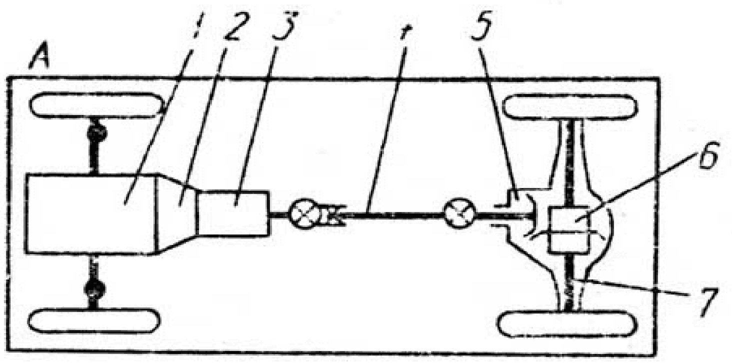


Figure 1.1. Drawing of the general structure of the car .

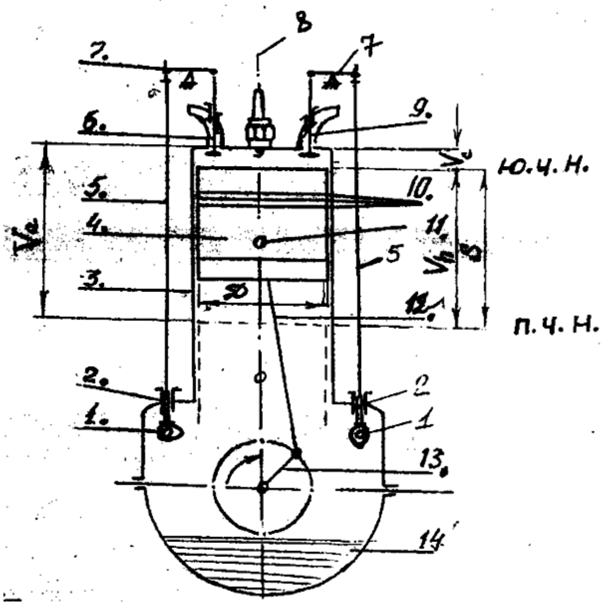


Figure 1.2. Schematic diagram of a single-cylinder engine.
1. camshaft, 2. push rod, 3. cylinder, 4. piston, 5. connecting rod, 6. intake valve, 7. throttle valve, 8. spark plug or injector, 9. exhaust valve, 10. compression and oil drain holes. 11-piston finger, 12-rod, 13-crankshaft, 14-carter. Vh-cylinder working volume, S-piston path, V_s -compression chamber volume. Ю.Ch.N-upper end point, P.Ch.N-lower end point, D-piston diameter, V_a - full volume of cylinder .

Working order of cylinders

1. Table 1

Crankshaft half when spinning	TS CYLINDERS			
	1	2	3	4
I takt 0^0-180^0	Work path	***Release***	Compression	Input
II-takt 180^0-360^0	***Release***	Input	Work path	Compression
III-takt 360^0-540^0	Input	Compression	Release	Work path
IV-takt 540^0-720^0	Compression	Work path	Input	Release

The sequence of the working path determines the working order numbers of the cylinders, in table 1.1 , the working order numbers of the cylinders for VAZ and Moskvich car engines are 1-3-4-2. For similar GAZ-24 "Volga", UAZ-3151 car engines, the working order of the cylinders is 1-2-4-3;

For six-cylinder in-line ZIL-157KD, GAZ-5204 car engines, the order of operation of cylinders is 1-5-3-6-2-4;

1-4-2-5-3-6 for six-cylinder two-row V-shaped YaMZ-236 engine;

For eight-cylinder two-row V-shaped ZIL-130, GAZ-5312, KamAZ-5320 car engines will be 1-5-4-2-6-3-7-8.

Note: Determine the names of the parts according to the above drawing for one car according to the given option .

The main technical indicators of the car

2. Table 3

No	Indicators name	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
	car model						
1	Carrying capacity (number of people, with cargo), kg						
2	Car net weight, kg						
3	Maximum speed in high gear, kmG's						
4	Engine copy						
5	Fuel consumption, 100 kmG'l						
6	Car dimensions:						
	A) full length						
	B) the greatest width						
	C) the greatest height						
	G) base						
	D) between the front wheels (track)						
7	Wheel formula						
8	When and where the car was developed, year						

NOTE: Write down the order of operation of the cylinders of the car models (6) given in the table 2.1 , 2.2 according to the number i in the laboratory work . Based on this, fill in table 2. 4 for each car with the order of operation of the cylinders of the given car engine according to the option .

Divide into tacts according to the working order of the cylinders

2. Table 4

Crankshaft half when spinning	TS CYLINDERS							
	1	2	3	4	5	6	7	8
I-tact								
II-tact								
III-tact								
IV								

The main technical indicators of internal combustion engines

2. Table 5.

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
	car model						
1	engine brand						

2	number and location of cylinders						
3	cylinder diameter, mm						
4	piston path, mm						
5	working volume of the engine, l						
6	Compression level						
7	maximum power, kW						
8	maximum torque, N · m						
9	the number of revolutions of the crankshaft, aylG'min						
10	operation of the cylinders						

Note: *2. Table 5. Vehicle models are obtained according to the options given in the laboratory work.*

VI . Laboratory work according to the following to questions good mouth will be answered.

6.1 In which automobile factories were the cars produced according to the option, in which year?
6.2 Name the main parts of a car?
6.3 Explain the functions of the parts of the car?
6.4 Explain the functions of car parts?
6.5 Identify the types of cars listed in the table?
6.6 Where is a special car used?
6.7 cars ?
6.8 What is the function of the engine?
6.9 Tell the main mechanisms and systems of the engine?
6.10 Explain Yu.Ch.N and P.Ch.N?
6.11 What is piston path?
6.12 Explain the working, combustion chamber and full volumes of cylinders?
6.13 What is the compression ratio, what are their values in carburetor and diesel engines?
6.14 What processes are carried out inside the cylinder?
6.15 Explain tact and cycle?
6.16 Explain the working order of cylinders?
6.17 What indicators are included in the technical indicators of the engine?
6.18 What are the differences in the structure and operation of carburetor and diesel engines?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.

5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

2 - LABORATORY WORK

Topic: **General structure of the engine.**

II. Purpose of work:

1.3. To study the classification, general structure and main parameters of the car engine . ;

III. Content of work:

2.5 Learning the types of cars ;
2.6 the general appearance of the car and the location of the names of the car ;
2.7 Acquaintance with types of engines;
2.8 Study of engine operating processes and key k' indicators .

1. The function of the engine, the main dimensions.

An engine is a machine that converts the chemical heat generated by the combustion of the working mixture into mechanical energy and uses energy to move the vehicle. According to the structure of the internal combustion engine: there are piston, electric, gas turbine, jet, rotor-piston, flywheel, steam, orbital and stirling engines.

Modern vehicles are mainly equipped with piston internal combustion engines. Piston internal combustion engines installed in cars are divided into the following types:

- depending on the type of fuel used: light liquid fuel - carburetor engines running on gasoline or compressed liquid gas, diesel engines running on heavy liquid fuel.

- depending on the method of formation of the combustible mixture, carburetor engines with mixture formation outside the cylinder and diesel engines with mixture formation inside the cylinder.

- with carburettor engines, which are ignited by an electric spark of the working mixture, and diesel engines, which spontaneously ignite by touching fuel particles sprayed into clean air heated by compression.

Depending on the method of production: four-stroke and two-stroke engines. According to the structural structure: 1,2,3,4,5,6,8,12 pistons and depending on their location (vertical row, horizontal row or V-shaped), according to the location of the gas distribution mechanism - the valves are above or located below and according to the location of the camshaft - the camshaft is located inside the block or on the block cover.

The general structure of the internal combustion engine, functions of mechanisms and systems. Reciprocating internal combustion engines are composed of the following mechanisms and systems: crankshaft-rod mechanism, gas distribution mechanism, and cooling, lubrication, fuel supply, ignition (in a carburetor engine) and propulsion systems.

The crank mechanism receives the pressure of the gas produced by the combustion of the working combustible mixture inside the cylinder, and converts the straight forward and backward movement of the piston inside the cylinder into the rotational movement of the crankshaft. The engine consists of a cylinder (13) and a crankcase (6) whose lower part is closed with a base (20) (Fig. 2.1).

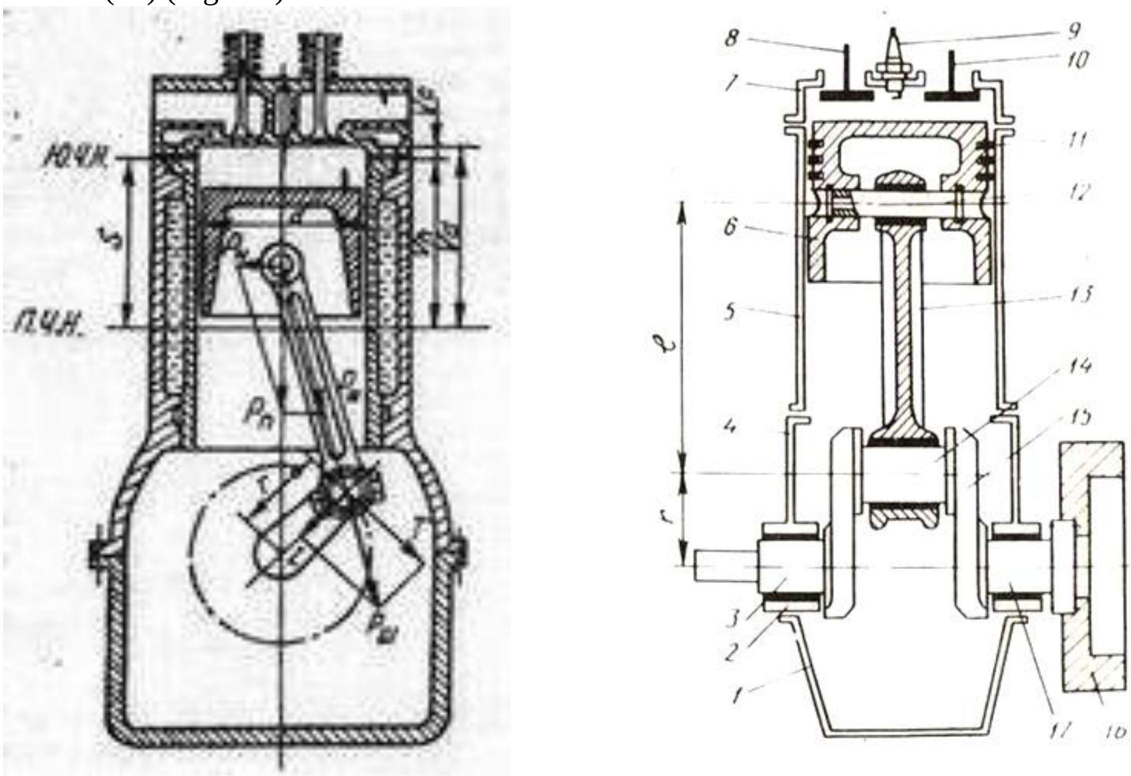


Figure 2.1. The structure of the piston internal combustion engine.
A- transverse view, B-longitudinal view.

a) Inside the cylinder there are compressor (compressor) piston rings (11), the cup-shaped piston (6) with its top facing up moves. The piston pin (12) is connected to the crank shaft (15), which rotates on the support bearings located in the crankcase. The crankshaft consists of support necks (17), jaws (15) and connecting rod neck (14). The cylinder, piston, connecting rod and crankshaft together make up the crankshaft mechanism.

b) This mechanism converts the advance-return movement of the piston into the rotational movement of the crankshaft.

The cylinder (5) is covered with a cylinder head (7) from the upper side. In this head, intake and exhaust valves (8, 9) are installed, the opening and closing of which corresponds to the movement of the piston and the rotation of the crankshaft.

Gas distribution mechanism . The burner serves to carry out the entry of the working mixture or air into the cylinder and the expulsion of the used gases. This mechanism includes gas distribution shaft, shaft drive gear, pushers, valves, valve springs, rocker arm, rocker arm shaft, rods.

The fuel supply system cleans gasoline and air, prepares a combustible mixture from them, transfers it to the engine cylinders and expels the used gases to the environment.

Cooling system. It distributes the heat released from the hot parts of the engine to the outside environment and ensures its most comfortable thermal operation. The engine is liquid or air cooled.

The lubrication system injects oil at high pressure between the engine's rubbing parts, reduces their wear, partially cools the surfaces of the rubbing parts, washes dirt and wear particles from the rubbing surfaces, and cleans the oil.

The ignition system creates an electric spark and sends it to the cylinders in order to ignite the carbureted engine.

The drive system serves to drive the engine.

The main rates and indicators of the internal combustion engine. The position (point) inside the cylinder where the piston rod is farthest from the crankshaft axis is called the upper end point (U.CH.N). The lowest position (point) inside the cylinder closest to the crankshaft axis of the piston top is called the lower end point (P.CH.N). The distance traveled by the piston from one end point to the other end point is called the stroke of the piston (*S).*

r) between the support neck of the crankshaft and the axis of the connecting rod is called the radius of curvature.

is equal to twice the radius of curvature $S = 2R$.

The volume created when the piston moves from the upper end point to the lower end point ($V_{шч}$) is called the working volume of the cylinder. With a sheepish expression
is determined.

$$V_{shch} = pD^2 S/4 \text{ , m}^3$$

where: *D* is the cylinder diameter, m

S - piston path, m

When the piston is at the upper end point, the volume created above it (V_s) is called the volume of the compression or combustion compartment.

V_a) formed on it is called the full volume of the cylinder.

The working volume of the cylinder and the volume of the combustion compartment are added together to represent the full volume (V_a) of the cylinder.

$$V_a = V_c + V_{shch}$$

The ratio of the volume of the cylinder to the volume of the combustion chamber is called the compression ratio. It is defined by the following expression.

$$\varepsilon = \frac{V_a}{V_c} = \frac{V_h + V_c}{V_c} = \frac{V_h}{V_c} + 1$$

Compression level value:

Carburetor engines up to 6.5-10;

It is equal to 14-21 in diesel engines.

Compression ratio piston P.CH.N. from Yu.Ch.N. shows how many times the volume of the working mixture inside the cylinder decreases due to compression.

In multi-cylinder engines, the sum of the working volumes of the cylinders is called engine displacement (V_l) *:*

$$V_l = V_{shch} \cdot i \text{ } 1000, \text{ l}$$

where: *i* - number of cylinders; The coefficient that converts 1000-m ^{3} to liters.

Table 2.1

Technical indicators of the car engine

Indicators	Car replicas							
	GAZ-53A	Zil-130	KamAZ-5320	VAZ-2106	UzOtayol M-50	Tico	Damascus	Nexia
Engine	SM3-53 V-shaped	Zil-130 V-shaped	Kamaz 740 V-shaped	VAZ-2106	IVECO 8040.25	F8C	F8CB	SONC
Cylinder diameter, mm	92	100	120	79	104	68.5	68.5	
Number of cylinders	8	8	8	4	4	3	3	4
Piston rod, mm	80	95	120	80	115	72	72	

Working volume of the cylinder, liter	4.25	6.0	10.85	1.57	3.90	0.89	0.89	1.49
Compression level	6.7	6.5	17	8.5	17	9.3	9.3	8.6
Operation procedure of cylinders	15426-378	15426-378	15426-378	1342	1342	132	132	1342
Maximum capacity, kW	84.6	110.6	154.4	58.8	85	30,14	27.9	66.1
Number of revolutions, rpm	3200	3200	2600	5400	2700	5500	5000	5400
Maximum torque, kW	284.4	402	637.4	121.6	353	60	64	123
Number of revolutions, rpm	2000-2200	1800-2000	1400-1700	3000	1400	2500	3000	3400

The disc-shaped flywheel (16) maintains the continuous movement of the piston at the extreme points.

The sum of the input, compression, expansion and output processes is called the duty cycle.

A part of the work cycle is called a tact.

If the working cycle of the engine occurs in four strokes of the piston, such an engine is called a four-stroke engine, if it occurs in two strokes of the piston, the engine is called a two-stroke engine.

2. The general structure of four and two-stroke piston engines .

2.1 Operating cycles of four-stroke engines.

The duty cycle of a four-stroke carbureted engine. The working cycle of the engine consists of four strokes (Fig. 2.2).

The first beat is input. This stroke is necessary to fill the cylinder with a combustible mixture. When the piston moves from YUCHN to PCHN, a rarefaction (aeration) occurs in the cylinder up to 0.07-0.08 MPa, under its influence, the combustible mixture enters the cylinder through the opened inlet valve. The combustible mixture in the cylinder is mixed with the used gas from the working cycle to form a working combustible mixture. When the piston reaches from YUCHN to PCHN, the cylinder is filled with the fuel mixture, the intake valve is closed. At the end of the stroke, a working mixture with a pressure of 0.7-0.9 kg/cm ^{2} and a temperature of 70-110 ^{0} C is formed.

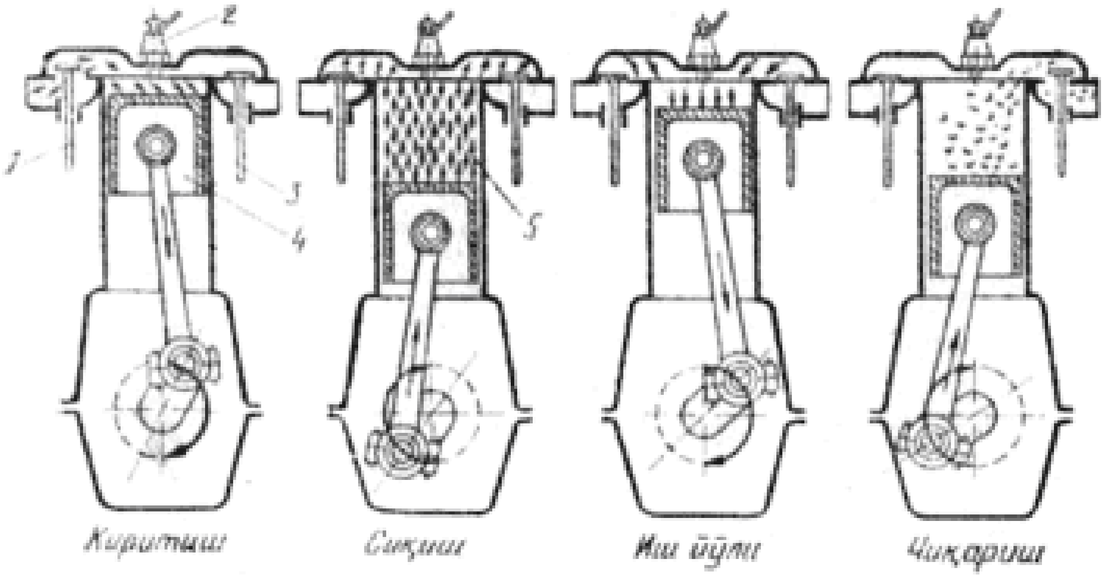


Figure 2.2. The duty cycle of a single-cylinder carbureted engine.
1-intake valve, 2-spark plug (spark plug), 3-exhaust valve,
4th piston, 5th connecting rod, 6th crankshaft

The second beat is compression . As a result of reducing the volume of the tact working mixture, it increases its internal energy and prepares it for combustion. When the piston moves from PCHN to YUCHN, the working mixture is compressed. At this time, the inlet and outlet valves are closed. At the end of the compression stroke, the pressure of the working mixture will be 12-17 kg/cm ^{2} and the temperature will be 300-400 ^{0} C.

At the end of the compression cycle, an electric spark with a high voltage appears between the electrodes of the spark plug, which ignites the working mixture compressed in the cylinder.

The third tact is the way of work . Or the combustion and expansion tact. In this cycle, the thermal energy generated by the combustion of the working mixture is converted into useful mechanical energy. In this case, the inlet and outlet valves are closed. At the beginning of the stroke, the mixture burns and releases a lot of heat. At this time, the pressure of the burned gases rises to 35-50 kg/cm ^{2} and the temperature rises to 2000-2400 ^{0C} . Under the influence of this pressure, the piston moves from YUCHN to PCHN, in which the stroke of the working path is performed.

The fourth beat is release . In this tact, the cylinder is cleaned of used gases. When the exhaust valve is opened, the piston moves from PCHN to YUCHN, pushing the burned gases out of the cylinder and out into the environment. At the end of this stroke, the pressure of the gases remaining in the cylinder is 1.1-1.2 kg/cm ^{2} and the temperature is around 500-830 ^{0} cm.

The duty cycle of a four-stroke diesel engine. In a diesel engine, clean air is injected into the cylinder and fuel is injected into the compressed air using an injector. (Figure 2.3)

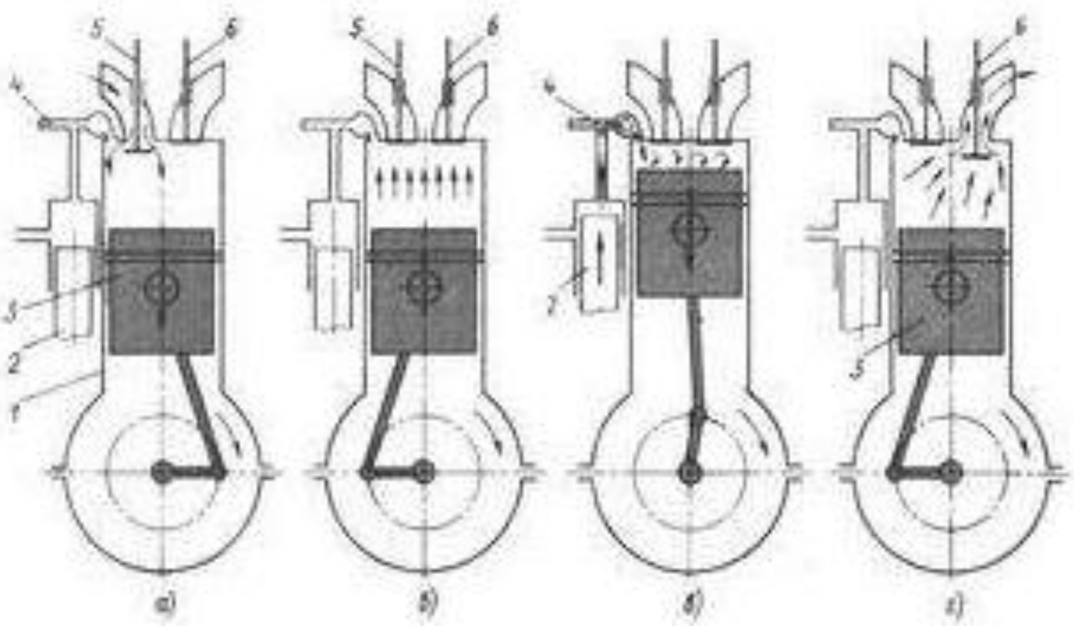


Figure 2.3. The duty cycle of a four-stroke diesel engine
1-intake valve, 2-injector, 3-exhaust valve, 4-piston,
5-high pressure fuel pump (YuBYoN)

The first measure is introduction. When the piston moves from YUCHN to PCHN, fresh air cleaned of dust is sucked into the cylinder by the inlet valve, at the end of the stroke, the pressure of the air in the cylinder is 0.8-0.9 kg/cm ^{2} and the temperature is 50-70 ^{0} C.

The second beat is compression. Both valves are closed. As the piston moves from PCHN to YUCHN, the air in the cylinder is compressed. At the end of the compression stroke, the air pressure rises to 30-40 kg/cm ^{2} and the temperature rises to 500-730 ^{0C} . At this time, fuel is injected into the cylinder through the nozzle under the pressure of 200 kg/second with the help of a high-pressure fuel pump. The sprayed fuel mixes with superheated air and ignites spontaneously.

The third beat is expansion. Both valves are closed. At the end of the compression stroke, the ignition of the ignited fuel takes a little longer. At this time, the pressure in the cylinder is 50-80 kg/cm ^{2} , the temperature is around 1630-1930 ^{0C} . Under the influence of high pressure, the piston moves from YUCHN to PCHN, turning the crankshaft through the connecting rod at an angle of 180 ^{0} C. When the piston approaches the PCHN, as a result of gas expansion, their pressure in the cylinder decreases by 30-40 kg/cm ^{2} , and their temperature decreases by 630-930 ^{0} C.

The fourth beat is release. In this stroke, the exhaust valve is in the open position. The piston moves from PCHN to YuCHN and expels the used gases to the outside through the exhaust valve.

At the end of this stroke, the pressure of gases remaining in the cylinder is 1.1-1.2 kg/cm ^{2} and the temperature is 430-630 ^{0} C.

2.2. The duty cycle of a two-stroke engine. The duty cycle of a two-stroke engine occurs as a result of two strokes of the piston or one rotation of the crankshaft. (Figure 2.4). In such engines, the working mixture is prepared outside or inside the cylinder. Based on this, engines can be carbureted or diesel. These engines use a fuel mixture or air flow to expel spent gases and clean the cylinders.

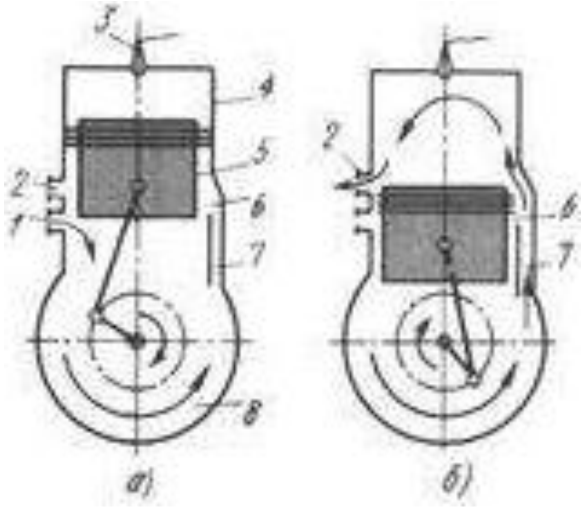


Figure 2.4. The duty cycle of a two-stroke engine.
Cylinder head 1: Cylinder 2:
3-cylinder inlet: 4-compressed combustible mixture or air injection pump: 5- crankcase: 6-crankshaft: 7-exhaust hole (window): 8-rod: 9-piston: 10-cylinder head will have an ignition or nozzle.

When the piston moves inside the cylinder, it uses its walls to open or close the inlet or outlet ports.

In the first stroke, when the piston moves from PCHN to YuCHN, the intake and exhaust ports are open. With the help of a pump, a fuel mixture or air is introduced into the cylinder through the intake port, which expels the gases remaining in the cylinder and fills the space above the piston: the upward moving piston closes the ports. From this time, the combustible mixture or air begins to compress. When the piston reaches TOP, the "burning" mixture in the engine (carburetor) or air (diesel) is supplied to the compression chamber by means of an electric spark or injector, resulting in the mixture being ignited. When the piston moves from PCHN to YuCHN, the cylinder is purged of the remaining gases and filled with a new charge, and the valves close and the compression process begins.

In the second stroke, the piston moves from YUCHN to PCHN. At the end of the compression process, the combustion of the combustible mixture creates high pressure and high temperature. Under the influence of gas pressure, the piston moves towards PCHN. Then the expansion process takes place and heat energy turns into mechanical energy. At this moment, as soon as the piston opens the exhaust window with its walls, the used gases with a large pressure begin to flow out. Then the inlet ports are opened and a combustible mixture or air is pumped into the cylinder with the help of a pump. They mix with the used gases and push them out through the exhaust ports. Engines of this type are mainly installed on motorcycles.

3. Multi-cylinder engines and their operation

V -shaped eight-cylinder engine. One of the cylinders of KamAZ-5320 car engines is located at an angle of *90* ^{0} relative to the other (Fig. 2.5). The strokes of the same name in such engine cylinders are repeated at every 720 ^{0} :8 =90 $^{0 \text{ angle of the crankshaft}}$. That is why the curve of the crankshaft is in the form of a "crest" and they are located at an angle of 90 $^{0 \text{ to each other}}$. The connecting rods of the first and fifth cylinders are attached to the first elbow, the connecting rods of the second and sixth cylinders are attached to the second, the connecting rods of the third and seventh cylinders are attached to the third, and the connecting rods of the fourth and eighth cylinders are attached to the fourth. In an eight-cylinder four-stroke engine, eight working paths occur in two revolutions of the crankshaft. When the crankshaft is turned to 90 ^{0} , the working path is in two cylinders, which ensures its smooth rotation at one rate. The order of operation of eight-cylinder engines is selected as 1-5-4-2-6-3-7-8 Table 2.2).

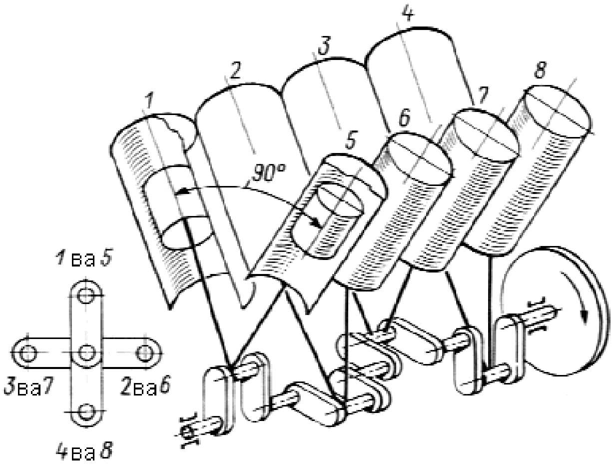


Figure 2.5. A diagram of a four-stroke eight-cylinder *V* -shaped engine with a crankshaft mechanism.

Table 2.2

four-stroke *V* -shaped eight-cylinder engine with a working order of 1-5-4-2-6-3-7-8

Crankshaft rotation	Crankshaft turning angles	TS cylinders							
		1	2	3	4	5	6	7	8
First circle	0-90 ^{0}	Job the way	Enter.	EXIT	Compression	Sq.oxr	Input	Release	Ish.y.ox
	90-180 ^{0}		Compression	Input		Job the way			Release
	180-270 ^{0}	Release			Job the way		Compression	Input	
	270-360 ^{0}		Job the way	Compression		Release			Input
Second circle	360-450 ^{0}	Input			Release		Job the way	Compression	
	450-540 ^{0}		Release	Job the way		Input			Compression
	540-630 ^{0}	Compression			Input		Release	Job the way	

The main technical indicators of the car

2. Table 3

No	Indicators name	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
	car model						
1	Carrying capacity (number of people, with cargo), kg						
2	Car net weight, kg						
3	Maximum speed in high gear, kmG's						
4	Engine copy						
5	Fuel consumption, 100 kmG'l						
6	Car dimensions:						
	A) full length						
	B) the greatest width						
	C) the greatest height						
	G) base						
	D) between the front wheels						

	(track)						
7	Wheel formula						
8	When and where the car was developed, year						

NOTE: Write down the order of operation of the cylinders of the car models (6) given in the table 2.1 , 2.2 according to the number i in the laboratory work . Based on this, fill in table 2. 4 for each car with the order of operation of the cylinders of the given car engine according to the option .

Divide into tacts according to the working order of the cylinders

2. Table 4

Crankshaft half when spinning	TS CYLINDERS							
	1	2	3	4	5	6	7	8
I-tact								
II-tact								
III-tact								
IV								

The main technical indicators of internal combustion engines

2. Table 5.

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
	car model						
1	engine brand						
2	number and location of cylinders						
3	cylinder diameter, mm						
4	piston path, mm						
5	working volume of the engine, l						
6	Compression level						
7	maximum power, kW						
8	maximum torque, N · m						
9	the number of revolutions of the crankshaft, aylG'min						
10	operation of the cylinders						

Note: *2. Table 5. Vehicle models are obtained according to the options given in the laboratory work.*

VI . Laboratory work according to the following to questions good mouth will be answered.

6.1 In which automobile factories were the cars produced according to the option, in which year?

6.19 Name the main parts of a car?

6.20 Explain the functions of the parts of the car?

6.21 Explain the functions of car parts?
6.22 Identify the types of cars listed in the table?
6.23 Where is a special car used?
6.24 cars ?
6.25 What is the function of the engine?
6.26 Tell the main mechanisms and systems of the engine?
6.27 Explain Yu.Ch.N and P.Ch.N?
6.28 What is piston path?
6.29 Explain the working, combustion chamber and full volumes of cylinders?
6.30 What is the compression ratio, what are their values in carburetor and diesel engines?
6.31 What processes are carried out inside the cylinder?
6.32 Explain tact and cycle?
6.33 Explain the working order of cylinders?
6.34 What indicators are included in the technical indicators of the engine?
6.35 What are the differences in the structure and operation of carburetor and diesel engines?

References:

6. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
7. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
8. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
9. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
10. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

3 - LABORATORY WORK

Topic: Crankshaft mechanism.

I. Purpose of work :

1.1 Study of the general structure of crank-rod mechanisms.

II. Content of work :

2.1. Getting to know the types of KShM;
2.2. Acquaintance with work processes;

III. Equipment and recommended tutorials :

1. Video materials, poster drawings of cars manufactured at UzAvtoMotors SNG.
2. Layouts of one- and four-cylinder and V-eight-cylinder engines;
3. Nexia, Damas, car engines;
4. A set of color posters on the structure of KShM and GTM of gasoline and

diesel engines (longitudinal and transverse shear engines).

IV. Order of work :

It is necessary to read and fully master the following:

- Getting to know the task, types and general structure of KShM;
- Acquaintance with the structure of the piston, piston rings, piston finger, connecting rod, crankshaft, inserts and flywheel;

V. Procedure for drawing up the report :

5.1. write brief information about the mission, types, structure and working processes of KShM;
5.2. show the names of the main parts of the structural schemes of KShM (Fig. 2.1);
5.3. 2. Fill in the table 1 by taking the main indicators of KShM and the models of the cars according to the given options .

2. Table 1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
1.	Car model						
2.	Engine model						
3.	KShM						
4.	The number and location of cylinders						
5.	Piston diameter and path, mm						
6.	Compression level						
7.	Crankshaft:						
8.	The number of connecting rods						
9.	The number of the base joint						
10.	Block material						
11.	Piston material						
12.	Crankshaft material						

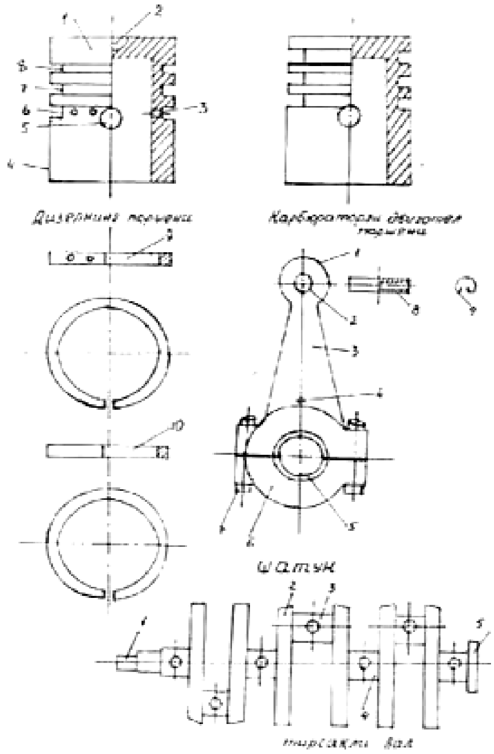


Figure 2.1. - Structural forms of KShM parts

V. To the following questions about laboratory work verbal response is given.

5.1. Explain the role, types and structure of KShM?
5.2. What types of cylinders are there and how are they installed in the block?
5.3 What is the function of piston and rings, what material are they made of and what is their structure?
5.4. What is the difference between pistons in carbureted and diesel engines?
5.5. What are the parts of the connecting rod?
5.6. Tell the function and general structure of the crankshaft?
5.7. How is the crankshaft constructed in in-line and V-shaped engines?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

4 - LABORATORY WORK

Topic: Gas distribution mechanism.

I. Purpose of work :

1.1 Study of the general structure of gas distribution mechanisms.

II. Content of work :

2.1. Familiarity with GTM types;
2.2. Acquaintance with work processes;

III. Equipment and recommended tutorials :

3.1. Layouts of one- and four-cylinder and V-eight-cylinder engines;
3.2. Nexia, Damas, car engines;
3.3. A set of color posters on the construction of GTMs of carburetor and diesel engines (longitudinal and transverse shear engines).

IV. Order of work :

It is necessary to read and fully master the following:

- Getting to know the function, types and general structure of GTMs;
- Acquaintance with the structure of the distribution shaft, push rod, rod, crank arm and valves;
- Acquaintance with the symbol on the camshaft gear;
- Familiarity with the phase of gas distribution.

V. Procedure for drawing up the report :

5.1. write brief information about the function, types, structure and working processes of GTM;
5.2. To show the structural schemes of GTM (Fig. 2.2 [a]) and the diagram of the gas distribution circuit (Fig. 2.2 [b]) and the names of its main parts;
5.3. 2. Fill in the table 1 by taking the main indicators of GTM and the models of the cars according to the given options .

2. Table 1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				onboard	self-destructive		
1	GTM						
2	Number of slots of the inlet valve, mm						
3	Exhaust valve clearance, mm						
4	Location of valves						
5	Crankshaft location						

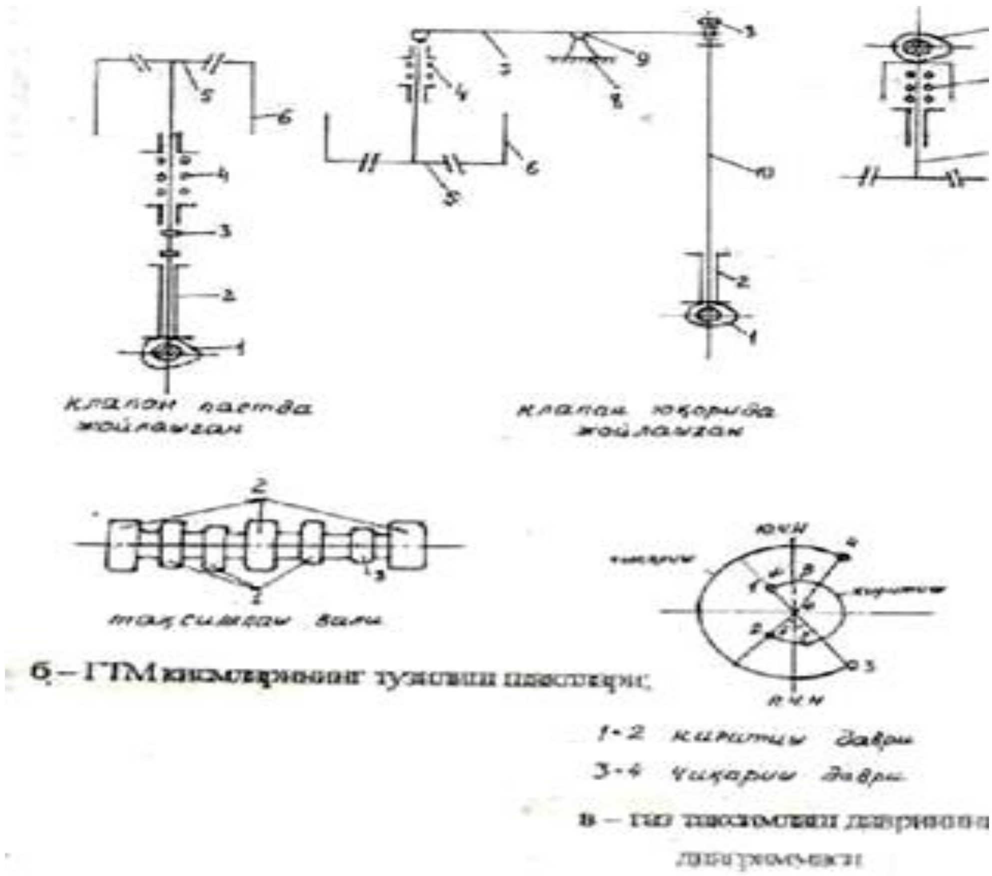


Figure 2.2. Shapes of GTM parts and gas distribution circuit diagram.
a - structural forms of GTM parts; b - diagram of the gas distribution circuit

VI. To the following questions about laboratory work verbal response is given.

Explain the function, types and structure of GTM?

- Tell the difference between above and below GTM?
- What is the function of the valve, its types and what material is it made of?
- Explain the function of the symbol on the distribution gear?
- How are valves adjusted?
- Explain gas distribution circuit diagram?

References:

6. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
7. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
8. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
9. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
10. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

5 - 6- LABORATORY WORK
Subject: Cooling, lubrication systems.

I. Purpose of work :

1.1 Study of the general structure of cooling and lubrication systems.

II. Content of work :

2.1. Acquaintance with the function and operation of cooling and lubrication systems;

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. The main parts of the lubrication and cooling system;
3.3. Covitish , lubrication and methodical instructions for the performance of laboratory work on the study of fuel supply systems. N. 20 19 y.

IV. Order of work :

4.1. It is necessary to read and fully master the following:

- Acquaintance with the function, types, general structure and operation of cooling, lubrication and fuel supply systems;
- Getting to know the structure, operation and installation of the liquid radiator, liquid pump and thermostat in the engine;
- Getting to know the types of oil pump, oil radiator, coarse and fine oil cleaners and their installation in the engine;
- Getting to know the types of oil and cooling fluids and their characteristics ;

V. Procedure for drawing up the report :

5.1. Draw the structural forms of the cooling system (Fig. 3.1) and the thermostat (Fig. 3.2) and lubrication system (Fig. 3.3) and the centrifuge (Fig. 3.4) and indicate the name of the main parts;
5.2. Write a brief description of the function, types, structure and working processes of cooling and lubrication systems;
5.3. Write a brief description of the function, types and operation of the thermostat;
5.4 Fill in the main indicators of cooling and lubrication systems in table 3. 1 based on the models of cars according to the given option .

Indicators of cooling and lubrication systems

Table 3.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
	car model						

	Type of cooling system						
	Radiator type						
	Thermostat type						
	Thermostat valve opening temperature, t^0						
	Type of coolant						
	Type of lubrication system						
	Oil capacity, l						
	Pressure lubricated parts						
	Oil pressure MPa (kgG'cm ^{2})						
	Oil pump type						
	Type of mild detergent						

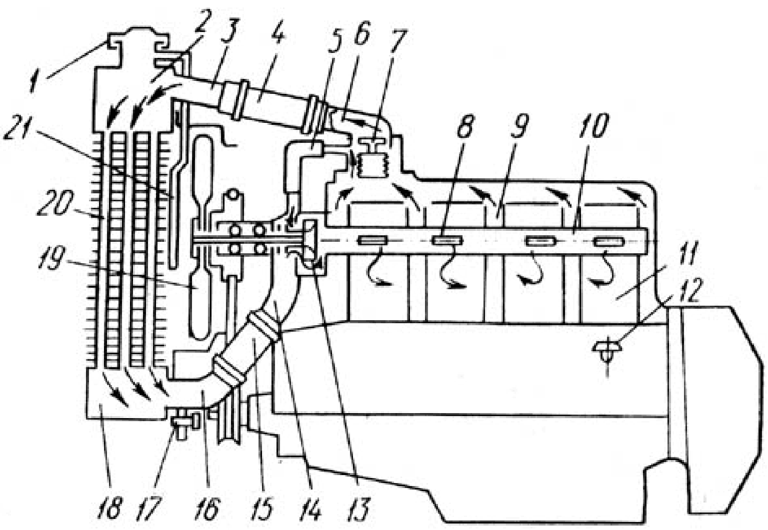


Figure 3.1. An illustration of the operation of a liquid cooling network.

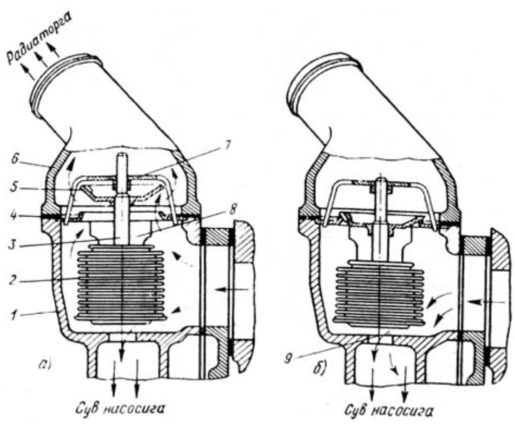


Figure 3.2. An illustration of the operation of a thermostat with a liquid filler.

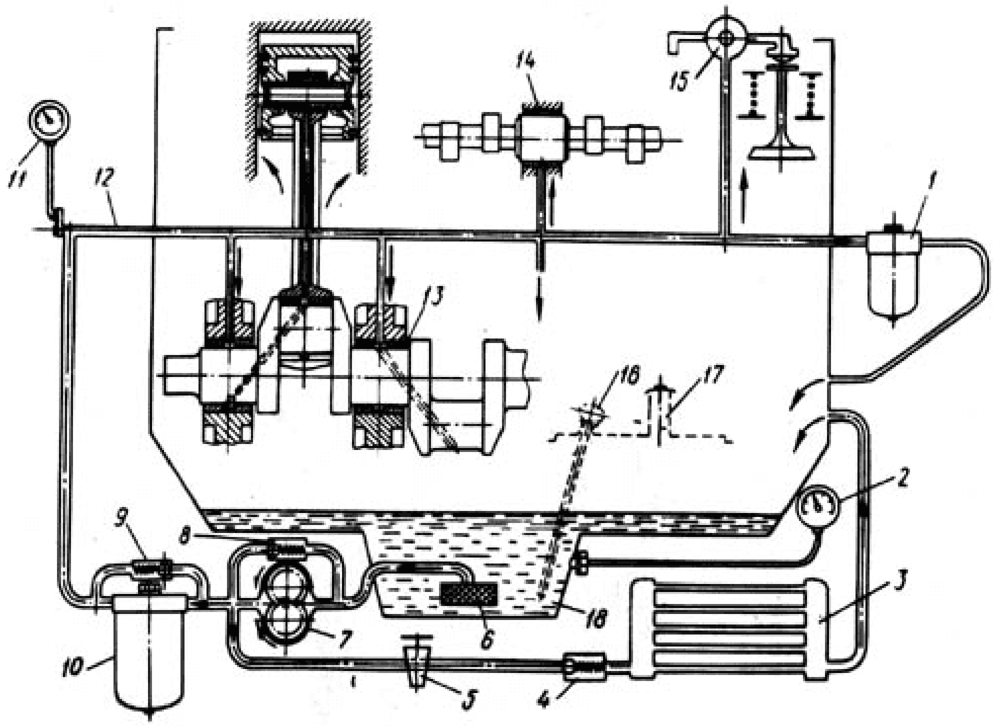


Figure 3.3. A simplified diagram of the lubrication network.

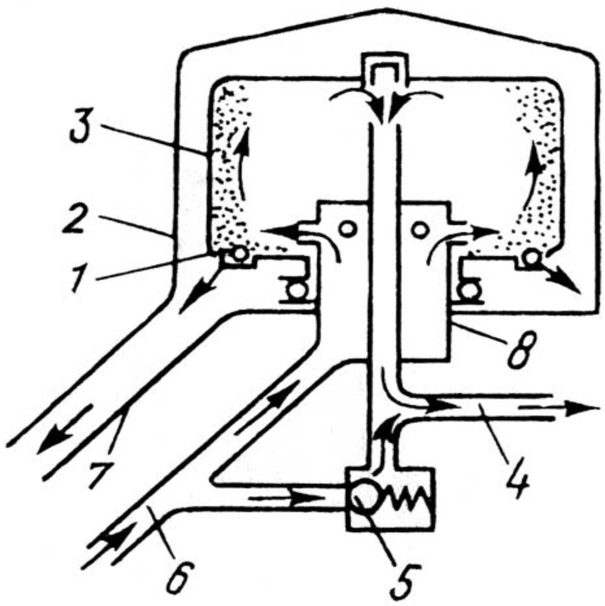


Figure 3.4. A simplified drawing of a centrifuge.

VI. To the following questions about laboratory work verbal response is given.

6.1. Tell the function, operation and types of cooling and lubrication systems?
6.1. of cooling and lubrication systems ?
6.2. What is the cooling system used for and what are the requirements for the coolant?
6.3. How does the fluid move in the system? How is the air cooling system constructed?
6.4. How is the oil cleaned in the system, how is the connecting rod and core

necks of the crankshaft lubricated?
6.5. How to lubricate piston cylinder and piston pin and distribution shaft, pusher valves?
6.6. Why is the engine crankcase ventilated?

References:

11. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
12. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
13. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
14. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
15. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

7 -LABORATORY WORK
Topic: Gasoline engine supply system .

I. Purpose of work :

1.2 Acquaintance with the function, structure, operation and location of the supply system of the carburettor engine.
1.3 Getting acquainted with the function, structure, operation and location of the injection engine supply system.
1.4 Getting acquainted with the function, structure, operation and location of the supply system of a gas-powered engine.

II. Content of work :

2.1. Acquaintance with the structure and location of the parts of the supply system of the carburettor engine;
2.2. Acquaintance with the structure and arrangement of parts of the supply system of the injection engine;
2.3. Acquaintance with the structure and location of gas engine supply system parts.

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. The main parts of the supply system;
3.3. A car with a GAZ device.

IV. Order of work :

4.1. It is necessary to read and fully master the following:
- Acquaintance with the general structure and operation of fuel supply systems;

- To study the structure of a simple carburetor and the formation of a combustible mixture in it;
- Study of the structure of the gas-air mixer and the formation of a combustible mixture in it.
- Study the function, structure and operation of two-stage gas reducer;
- fuel supply systems.

V. Procedure for drawing up the report :

- Write a brief description of the function, structure and operation of fuel supply systems;
- Draw a simplified diagram of the supply system of a carbureted engine, show the names of parts and fuel lines (Fig. 3.5);
- Draw a simplified diagram of the supply network of the gasoline engine supply system, write the names of the parts and show the fuel supply line.
- Draw a diagram of the gas cylinder supply system of a car engine running on a high-pressure gas cylinder, show the names of its parts and the gas path (Fig. 3.7);
- Write information about the structure, names and operation of the air-gas mixer of a gas engine (Fig. 3.8);
- Write information about the types and properties of used gasoline and gases;
- Fill in the main indicators of fuel supply systems in table 3.2.

The main technical indicators of fuel supply systems.

Table 3.2

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
	car model						
	B enzyme d agal cleaning filter type						
	Fine to coarse filter type						
	Carburetor model and chamber number						
	Gasoline type						
	Gasoline capacity, l						
	100 kmgasoline consumption, l						
	Gas type						
	Number of gas cylinders						
	Volume of gas in one cylinder, m ^{3}						
	100 kmgas consumption, m ^{3}						
	Fuel pump pressure						
	Number of high pressure						

	plungers						
	Number and type of coarse filter						
	Number and type of fine filter						
	Volume of the fuel tank, l						
	Number and type of nozzles						
	Fuel injection pressure at the injector, mPa						

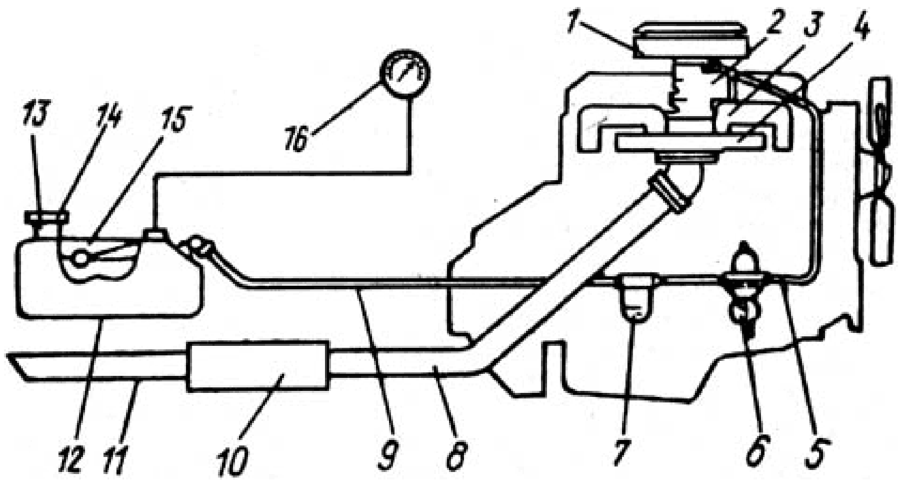


Figure 3.5. Diagram of the location system of the devices of the supply network of the carburettor engine.

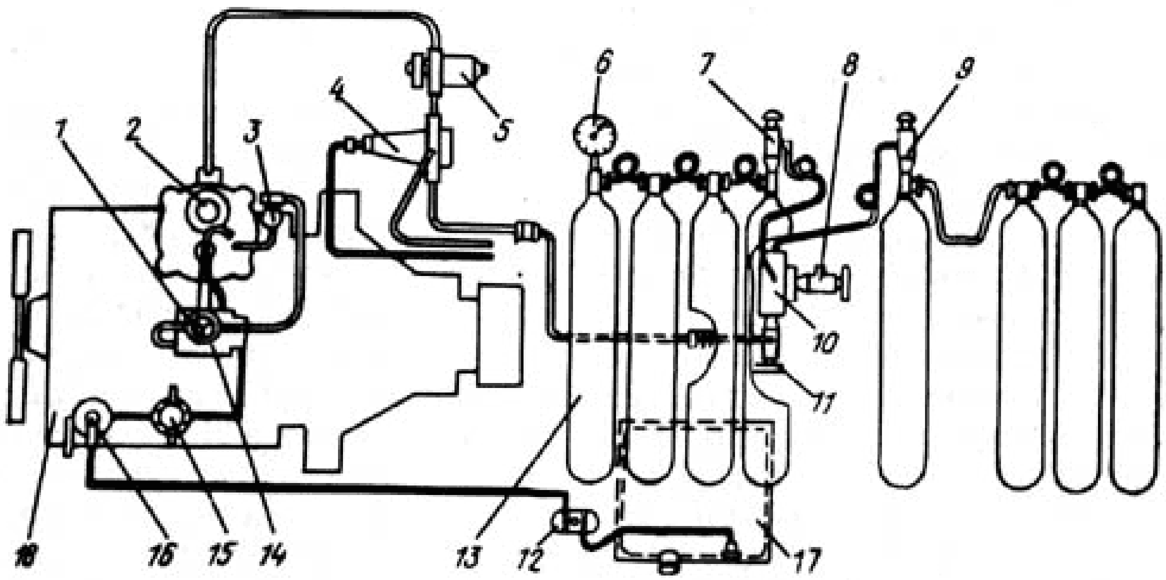


Figure 3.7. ZIL-43610 car engine working on a high-pressure gas cylinder generalized drawing of gas cylinder supply equipment.

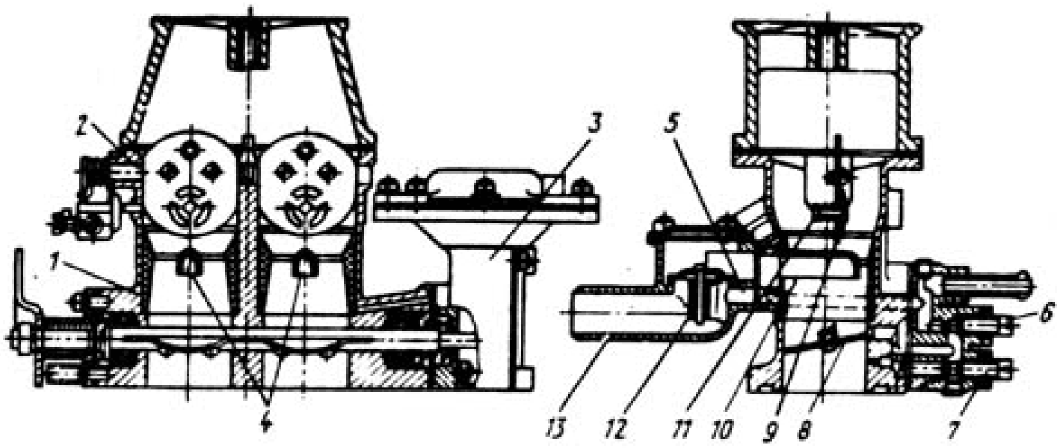


Figure 3.8. SG-250 gas mixer.

VI. To the following questions about laboratory work verbal response is given.

- Explain the function, structure and operation of fuel supply systems ?
- Explain the function and operation of carburetor idle, economizer, float chamber, acceleration pump, air and throttle valves?
- What are the engine operating conditions, what is the fuel composition for the operating conditions?
- Explain the function, structure and operation of high pressure fuel pump?
- Explain the operation of the gas cylinder supply system of a car engine running on a high pressure gas cylinder?
- What types of gasoline and gases are used in car engines?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

8 - LABORATORY WORK

Topic: Diesel engine supply system

I. Purpose of work :

1.5 Getting to know the function, structure, operation and location of the diesel engine supply system.

II. Content of work :

2.1. Acquaintance with the structure and location of diesel engine supply system parts;

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. Parts of diesel engine supply systems;

IV. Order of work :

It is necessary to read and fully master the following:

- Acquaintance with the function, structure and operation of the high-pressure fuel pump (equipment);
- Learning the function, types, structure and operation of the nozzle;

V. Procedure for drawing up the report :

➢ Write the names of the parts of the simplified drawing of the supply network of the diesel engine and show the fuel inlet (Fig. 3.6);
➢ Draw a diagram of the gas cylinder supply system of a car engine running on a high-pressure gas cylinder, show the names of its parts and the gas path;

The main technical indicators of fuel supply systems.

Table 3.2

<table>
<tr><td rowspan="3">No</td><td rowspan="3">Indicators</td><td colspan="6">The main technical indicators of the car</td></tr>
<tr><td colspan="2">A light car</td><td colspan="2">Truck</td><td>Bus</td><td>Special car</td></tr>
<tr><td></td><td></td><td>Boarded</td><td>self-destructive</td><td></td><td></td></tr>
<tr><td colspan="2">car model</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Number and type of coarse filter</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Number and type of fine filter</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Volume of the fuel tank, l</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Number and type of nozzles</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Fuel injection pressure at the injector, mPa</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

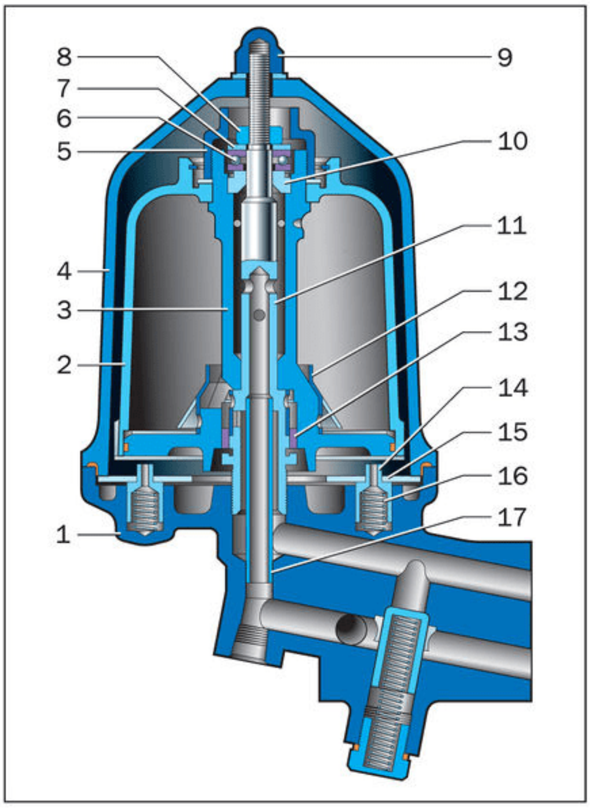


Figure 3.4. A simplified drawing of a centrifuge.

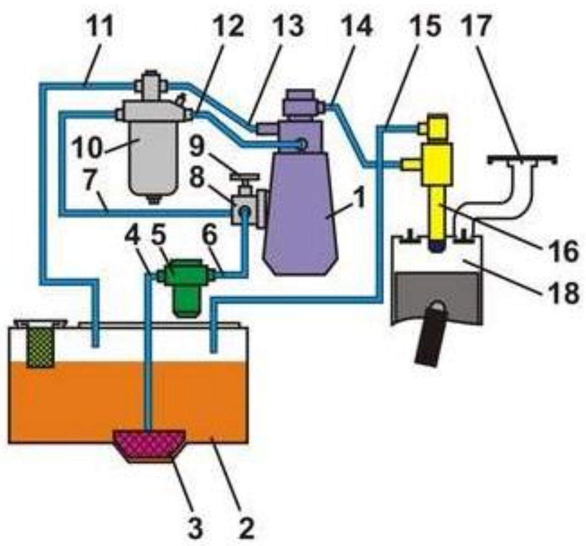


Figure 3.6. Maintenance system of diesel engine .

VI. To the following questions about laboratory work verbal response is given.

6.1. Explain the function, structure and operation of fuel supply systems ?
6.7. What are the engine operating conditions, what is the fuel composition for the operating conditions?

6.8. Explain the function, structure and operation of high pressure fuel pump?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

9 - LABORATORY WORK

Subject: Transmission. Connection plug

I. Purpose of work :

1.1 Acquaintance with the function, types, structure and operation of the clutch ;

II. Content of work :

2.1. Getting acquainted with the automatic installation and fastening of the coupling ;

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. Clutch models;
3.3. Clutch color posters;

IV. Order of work :

It is necessary to read and fully master the following:

- the clutches of Tiko, Damas, Nexia, ZIL-130 and KamAZ-5320 cars study constructions;
- See the installation and engagement of the clutch and gearbox in the car;
- Studying the structure, operation and adjustment of the friction clutch ;
- the hydraulic clutch ;

V. Procedure for drawing up the report :

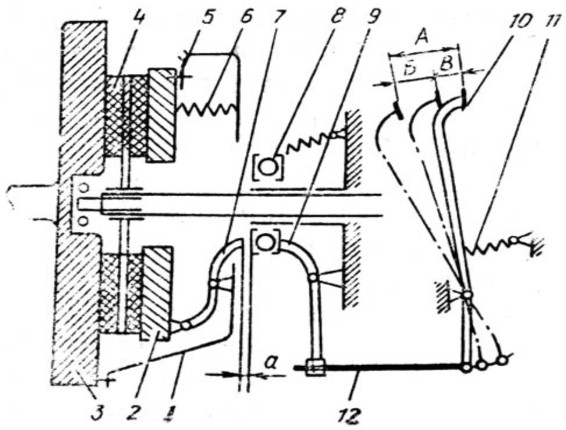
5.1. Write a brief description of the function, structure and adjustment of the clutch;
5.2. Draw a pictorial drawing of a single-disc friction clutch (Fig. 4. 1);

5.3. Draw a schematic diagram of the hydraulic coupling (4 . 2 - picture);
5.4. 4. Fill in table 1 of the main indicators of the friction clutch .

The main technical parameters of the friction clutch

Table 4.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarde d	self-destructive		
car model							
Number of leading discs							
Number of drives							
The type of connection							
The presence of a clutch booster							
A gap between the discs							
The gap between the separating lever and the compression bearing, mm							
The full path of the pedal, mm							
Work path, mm							
Freeway, mm							
Work path, mm							



4 . Figure 1 . Illustrative drawing of a single-disc friction casting clutch.

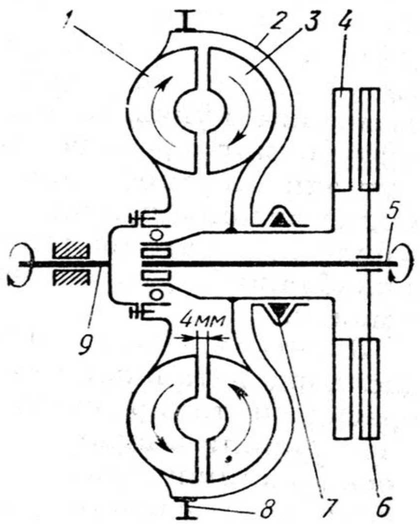


Figure 4.2. Illustrative diagram of hydraulic coupling and clutch coupling in series.

VI. To the following questions about laboratory work verbal response is given.

6.1. What are the components of a friction clutch and how does it work?
6.2.Name the types of clutch and explain the function, types, structure of the clutch?
6.3.What cars are equipped with single and double disc friction clutches?
6.4.How to connect, disconnect and adjust the friction clutch?
6.5.How is the hydraulic coupling constructed, how does it work, what are its advantages?
6.6. What are the main characteristics of the clutch?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. " Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

10 - LABORATORY WORK

Subject: Extensions and distribution boxes .

I. Purpose of work :

1. Getting to know the function, types, structure and operation of the gearbox .

II. Content of work :

2.1. Acquaintance with the installation and fastening of the gearbox to the car.

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. Models of gearboxes ;
3.3. Color posters of the gearbox ;

IV. Order of work :

4.1. It is necessary to read and fully master the following:

- Based on the indicated literature and methodical instruction, study the clutches of light and heavy-duty vehicles and the constructions of the transmission box ;
- To study the order of installation, fastening of the gearbox in the car and transmission of movement from the clutch to the main gear ;
- Acquaintance with extension switching schemes;
- Getting to know the methods of determining the number of transmissions for transmissions I-II-III-IV;
- To study the reason why it is impossible to add two gears at once;
- Learning the adjustment of the transmission box;

V. Procedure for drawing up the report :

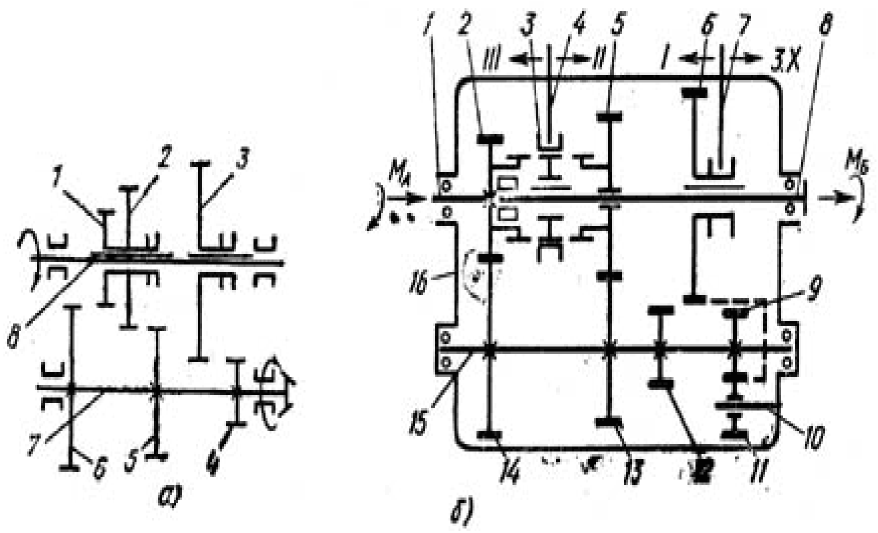
➢ Write a brief description of the function structure and operation procedure of the manual gearbox of Tiko, Damas, Nexia, Zil-130 and KamAZ cars;
➢ Draw a pictorial drawing of a step-by-step mechanical gearbox (Fig . 4. 3);
➢ Write a brief description of the function, structure and operation of a stepless gearbox;
➢ Draw a simplified pictorial diagram of a stepless gearbox hydrotransformer (Fig. 4 . 4);
➢ Fill in the main indicators of the gearbox to table 4.2.

the gearbox .

Table 4.2

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
car model							
Gearbox type							
Number of steps (forward)							
Number of synchronizers							
Which transmission is							

added using a synchronizer						
Number of extensions						
I-speed						
II-speed						
III-speed						
IV-speed						
At V-speed						
Gearbox type						
Number of steps (forward)						
Number of synchronizers						
Which transmission is added using a synchronizer						
Number of extensions						
I-speed						
II-speed						
III-speed						
IV-speed						
At V-speed						



4 . Figure 3 . Illustrative drawing of the gearbox.

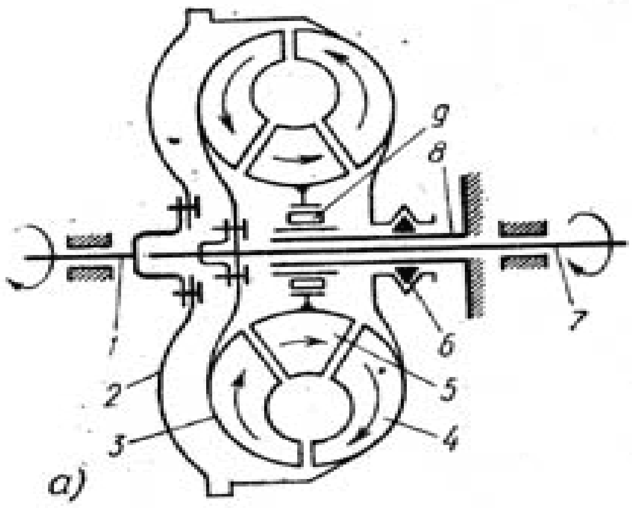


Figure 4.4. Hydrotransformer in stepless transmission pictorial drawing and main details.

VI. To the following questions about laboratory work verbal response is given.

- Tell the function and types of gearbox?
- What are the parts of a step gearbox and how does it work?
- What is the transmission number and what does it depend on?
- remove extensions ?
- State the function, structure and operation of synchronizer?
- how a stepless gearbox is constructed , how it works and its advantages ?
- What is the condition of the gear lever in Nexia cars?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

1 1 - LABORATORY WORK

Topic: Cardan transmission, main transmission, differential and half-axles .

I. Purpose of work :

1.1. Acquaintance with the function, types, structure and operation of cardan transmission;
1.2. Acquaintance with the function, types, structure and operation of the main transmission;
1.3. Acquaintance with the function, structure and operation of the differential ;
1.3. Getting to know the function, types, structure and operation of semi-axes .

II. Content of work :

2.1. Studying the installation and fastening of the cardan transmission to the car ;
2.2. Acquaintance with the installation and fastening of the main transmission and differential in the car;
2. 3 . Acquaintance with the installation and fastening of axles;
2. 4 . Acquaintance with the transmission of torque from the cardan transmission from the main transmission to the differential and half-axles.

III. Equipment and recommended tutorials :

3.1. Video materials, poster drawings of cars produced in UzAvtoMotors SNG company ;
3.2. Models of cardan transmission ;
3.3. . Color posters of the main drive, differential and half-axles ;

IV. Order of work :

4.1. It is necessary to read and fully master the following:

- Based on the indicated literature and methodological instructions, study the function, structure and connection of cardan transmission , main transmission, differential, and semi-axles of cars and trucks ;
- Familiarization with the order of installation, fixing of cardan transmission , main transmission, differential, and half-axles in the car and transmission of movement from cardan transmission to differential ;
- Getting to know the method of adjusting the main gear of one and two steps;
- Getting to know the hypoid main gear adjustment method;
- Getting to know the structure and operation of the differential;
- Familiarization with the structure, operation and no-load of axles.

V. Procedure for drawing up the report :

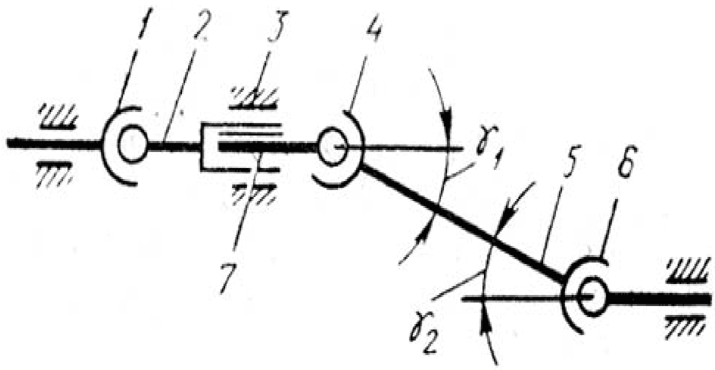
5.1. Write information about the function, structure, types and operation of cardan transmission;
5.2 . Draw a simplified diagram of the cardan transmission (Fig . 5. 1);
5.3. Write a brief description of the function, types, structure and operation of the

main gear;
5.4. Draw a pictorial diagram of types of single main gear (Fig. 5.2) and types of double main gear (Fig. 5.3);
5.5. Write a brief description of the function, types, structure and operation of the differential;
5. 6 . Draw pictorial drawings of inter-wheel and inter-axle differentials (Fig . 5. 4);
5. 7 . Write information about the structure and operation of the head gear and differential of the Tiko car;
5. 8 . Write information about the function, structure and operation of semi-axes;
5. 9 . Draw a pictorial diagram of the installation of half-axles on the rear bridge (Fig . 5. 5);
5. 10 . Fill in table 5.1 with the main indicators of the cardan transmission , the primary transmission , and the differential .

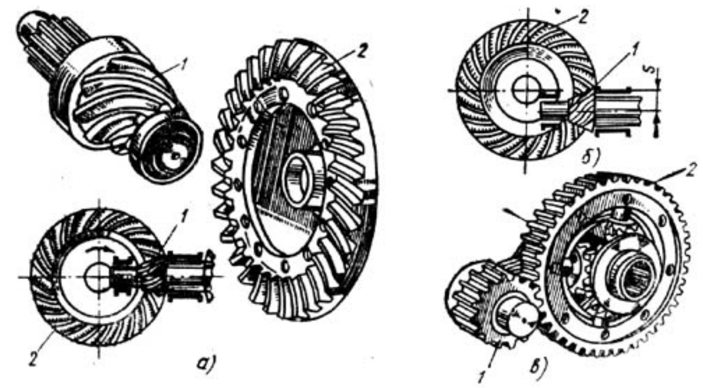
Main technical parameters of cardan transmission, main transmission, differential

Table 5.1

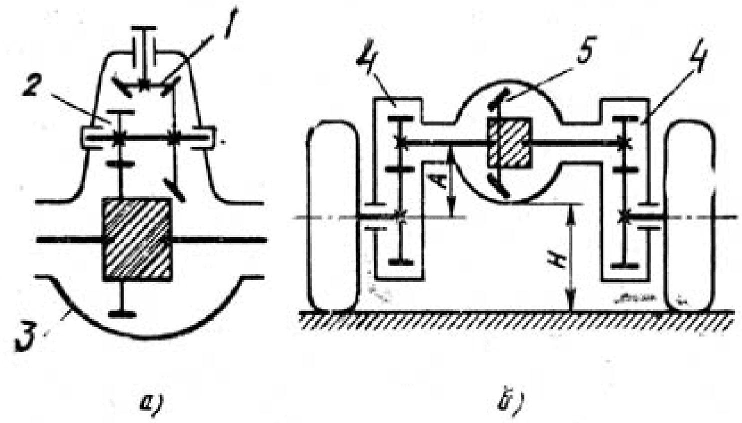
No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
car model							
A type of reverse drive cardan transmission							
Cardan number							
Whether there is an intermediate support in the cardan transmission							
Type of main gear							
Transmission number of the main gear							
Differential type							
Number of satellites							



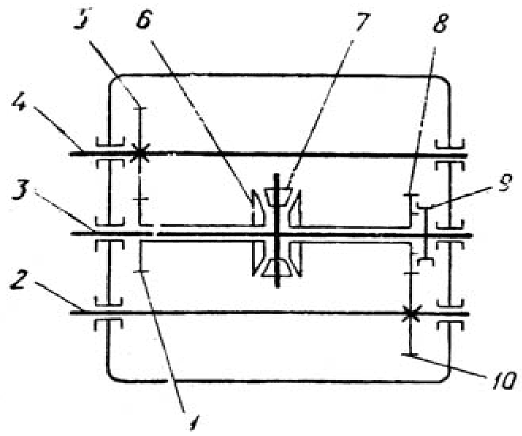
5.1 . A simplified pictorial drawing of the cardan transmission.



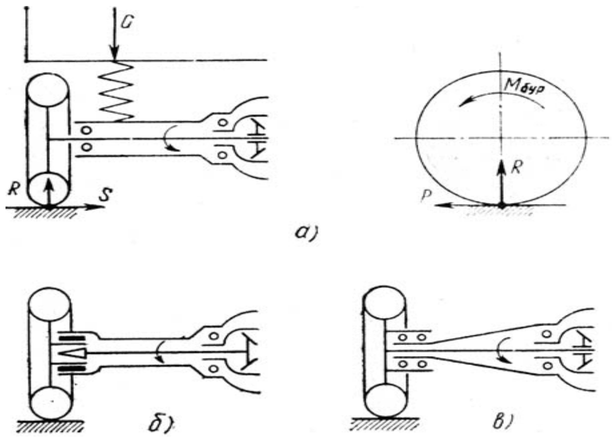
5.2 . An illustration of the types of single main gear.



5 . Figure 3 . Scheme of types of double main transmission.



5 . 4th director. The scheme of the inter-axle differential.



5 . Figure 5 . A picture of the installation of half-axles on the rear axle.

VI. To the following questions about laboratory work verbal response is given.

6.1. What are the types of cardan transmission?
6.2. Tell the function and types of main gear?
6. 3 . What are the parts of a single main gear and how does it work?
6. 4 . Tell the function, structure and operation of differential?
6. 5 . How is the inter-wheel and inter-axle differential constructed and how does it work?
6. 6 . Tell the advantages of Tico car head gear?
6. 7 . Tell the function, structure and operation of the hemispheres?

References :

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

1 2 - LABORATORY WORK

Topic: The running part of the car .

I. Purpose of work.

1.1 Acquaintance with the types of running parts of the car;
1.2 the function of the running parts of the car ;
1.3. Acquaintance with the structure of the running parts of the car ;
1.4. Acquaintance with the operation of the running parts of the car ;
1.5. Acquaintance with the installation of the running parts of the car in the car.

II. The content of the work .

2.1. Learning the types of car running parts;
2.2. Studying the function of the running parts of the car;
2.3. Studying the structure of the running parts of the car;
2.4. Studying the operation of the running parts of the car;
2.5. To study the installation of car parts in a car.

III. Equipment and recommended tutorials.

3.1 ZIL-130 truck with running parts installed;
3.2 Running parts of cars and trucks;
3.3 A set of color posters of walking parts;

IV. Order of work.

4.1 It is necessary to read and fully master the following:

- Learning the types and installation of frames of running parts of the car;
- Learning the types and installation of car body parts;
- To study the operation of leading bridges that can be divided into two parts;
- To study the operation of drawbridges;
- Function and operation and application of suspensions;
- Amortizer function structure and operation method;

V. Procedure for drawing up the report.

5.1. Write information about the function of the driving mechanisms of the car.
5.2. Write a brief description of the structure and operation of the driving mechanisms of the car;
5.3. From the walking mechanisms, draw the types of frame construction (Fig. 6.1), car suspension drawings (Fig. 6.2), write the names of its parts;
5.4. Draw drawings of the main types of suspension from walking mechanisms (Fig. 6.3) as well as pneumatic and hydropneumatic suspensions, write the names of their parts;
5.5. Write information about the function, structure and operation of the transverse stability stabilizer;
5.6. Fill in the main indicators of walking mechanisms in table 6.1;

Main technical indicators of walking parts.

Table 6.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
car model							
R ama types							

The number of body compartments						
Types of suspensions						
Types of dampers						

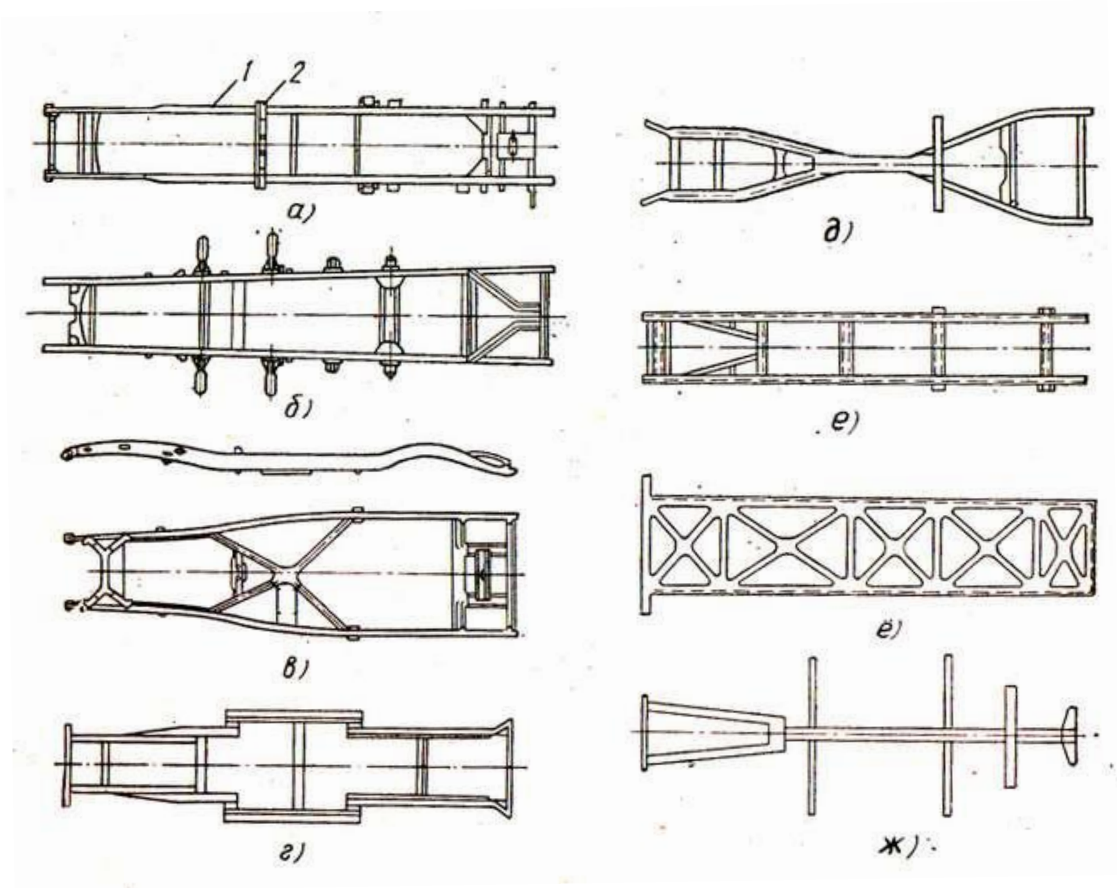


Figure 6.1 . Types of frame construction.

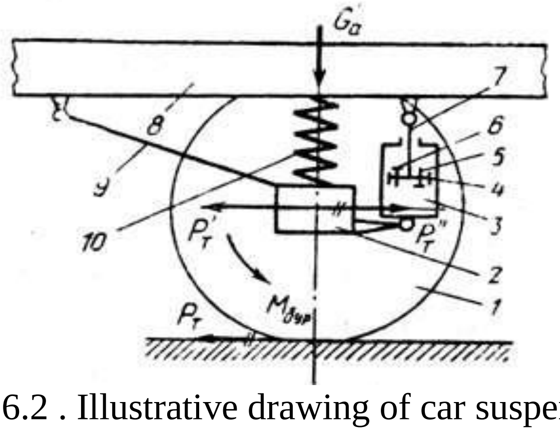


Figure 6.2 . Illustrative drawing of car suspension.

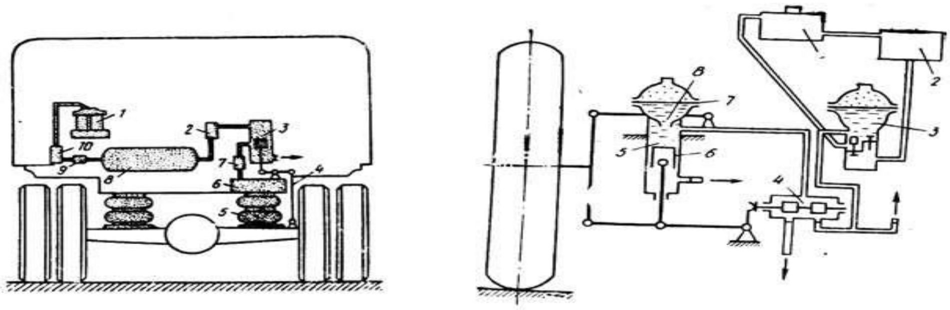


Figure 6.3 . Illustrative drawing of pneumatic and hydropneumatic suspension.

VI. The following questions regarding laboratory work are answered orally.

6.1. Explain the structure of car frames?
6.2. List the types of frames used in automobiles?
6.3. Explain the structure of car suspension?
6.4. Explain the operation and function of car suspension?
6.5. Explain the structure, function and operation of air suspension?
6.6. Explain the structure, function and operation of hydropneumatic suspensions?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

1 3 - LABORATORY WORK

Topic: Car steering wheel .

I. Purpose of work.

1.1. Getting to know the types of car steering;
1.2. Acquaintance with the function of the car steering wheel;
1.3. Getting to know the structure of the car's steering wheel;
1.4. Acquaintance with the operation of the car 's steering wheel ;
1.5. Acquaintance with the installation of the car's steering wheel in the car.

II. The content of the work.

2.1. Learning the types of car steering;
2.2. Learning the function of the steering wheel of the car;
2.3. Studying the structure of the car's steering wheel;
2.4. Studying the operation of the car's steering wheel;
2.5. To study the installation of the car steering wheel in the car.

III. Equipment and recommended tutorials.

3.1. Nexia car with steering wheel;
3.2. Steering boards of cars and trucks;
3.3 . A set of color posters of R ul departments;

IV. Order of work.

4.1 It is necessary to read and fully master the following:

- the function of steering controls of cars ;
- Studying the structure and operation of steering systems of cars ;
- Function and location of steering mechanisms ;
- Types and location of steering mechanisms;
- of the steering wheel ;
- Function and placement of power steering amplifiers;
- Power steering parts and operation.

V. Procedure for drawing up the report.

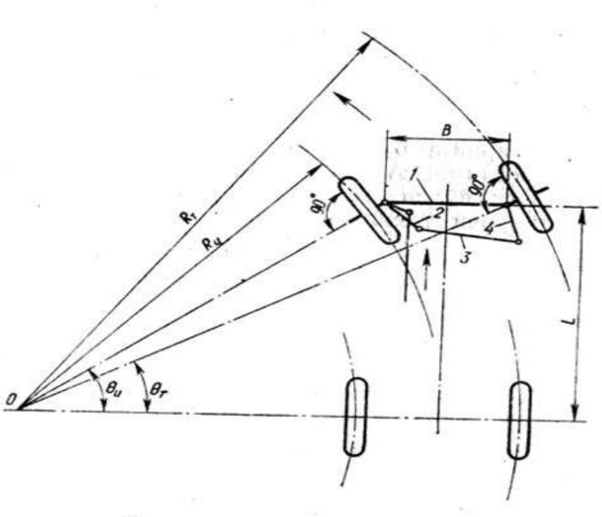
5.1 Write a brief description of the function of the car's steering wheel;
5.2 Write a brief description of the structure and operation of car steering systems;
5.3 Draw a diagram of the turning system of the car (Fig. 7.1) and the steering control (Fig. 7.2), write the names of its parts;
5.4 Write information about the function, structure, operation and types of the steering mechanism;
5.5 Write information about the hydraulic boosters, where the steering mechanism is placed separately;
5.6 Write information about easing the turning of steering wheels and draw a simplified drawing of the turning system;
5.7 Fill in the main indicators of the steering control in table 7.1.

The main technical indicators of the steering control

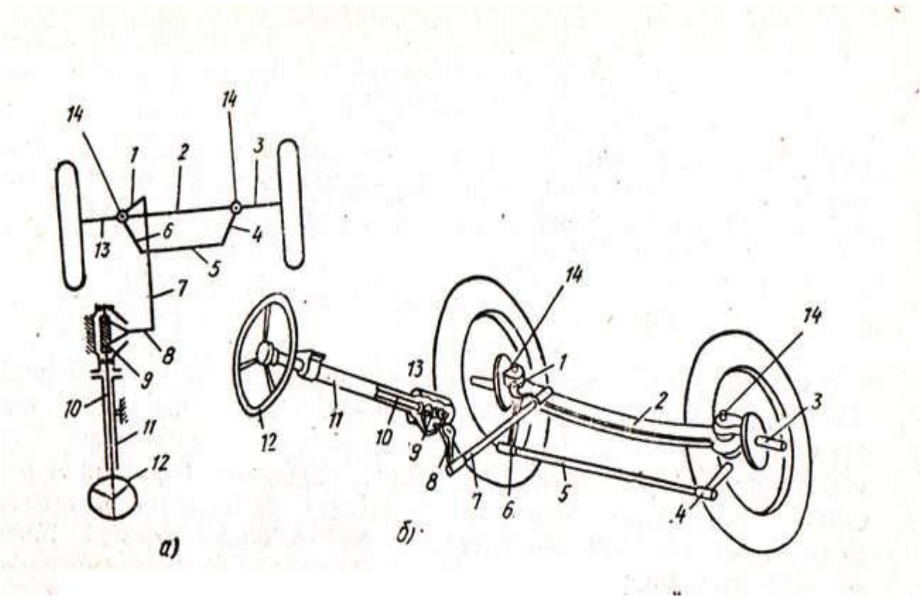
Table 7.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
Car model							

The highest turning angle of the outer wheels, mm						
Types of steering						
Types of steering mechanism						
Luft of steering wheel mm						



7.1 . A pictorial drawing of the turning system of the car and the steering trapezoid.



7 . Figure 2 . Steering: a-diagram, b-general image.

VI. The following questions regarding laboratory work are answered orally.

6.1 Explain the structure of the steering mechanism of the car ?

6.2 Explain the function of the steering wheel of a car ?

6.3 List the types of steering mechanisms installed in a car ?
6.4 What is the function of the steering wheel ?
6.5 Explain the function of power steering?
6.6 What is the role of the steering wheel?
6.7 Draw the scheme of the turning system?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

1 4 - LABORATORY WORK

Topic: Brake control of the car .

I. Purpose of work.

Acquaintance with the function of the brake control of the car;
Getting to know the operation of the brake control of the car;
Acquaintance with the structure of the car's brake control and its installation in the car;
Getting to know the types of car brake pads.

II. The content of the work.

Learning the function of the brake control of the car;
Learning the operation of the brake control of the car;
Studying the structure and installation of the car's brake control;
Learning the types of car brake controls.

III. Equipment and recommended tutorials.

Nexia car with brake control;
A set of color posters of a car with a schematic view of the brake control;
Schematic view of the brake control set of color posters of the truck;

IV. Order of work.

It is necessary to read and master the following:

- the car ;
- Acquaintance with types of car brake control;
- Acquaintance with the structure of the brake control of the car ;

- Acquaintance with the use of the brake network of the car ;
- Function and operation and application of pneumatic brake;
- Function and operation and application of hydraulic brake;

V. Procedure for drawing up the report.

5.1 Write a brief description of the function of the car's brake control;

5.2 Write a brief description of the structure and operation of the brake control of the car;

5.3 write information about the function and operation of the brake control of the car, four working brake networks;

5.4 Draw a pictorial drawing of the brake control of the car (Fig. 8.1);

5.5 Write information about the disc wheel brake and draw a pictorial drawing (Fig. 8.2);

5.6 Fill in the main indicators of the brake network in table 8.1.

The main technical indicators of the brake control.

Table 8.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
Car model							
Types of brake control							
How many types of brake network are there?							
The brake system is pneumatic or hydraulic							

Fig. 8.1. Coordinated pictorial drawing of brake control

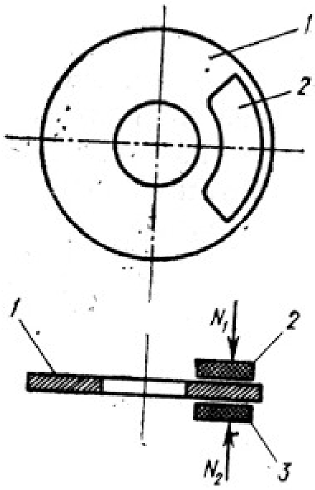


Figure 8.2. Illustrative drawing of a disc wheel brake.

VI. The following questions regarding laboratory work are answered orally.

6.1 Explain the function of car brake control?
6.2 Explain the structure of the car's brake control
6.3 Explain the types of car brake control?
6.4 Explain the function of car brake control?
6.5 Explain the operation of the braking system of a car?
6.6 Explain the construction of pneumatic brake?
6.7 Explain the structure of hydraulic brake?

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

1 5 - LABORATORY WORK

Topic: Compilation of the technical classification of the car .

V. Purpose of work.

Acquaintance with the technical classification of the car;
Getting to know the technical classification of the car.

VI. The content of the work.

Studying the technical classification of the car;
Learning how to make a technical classification of a car.

VII. Equipment and recommended tutorials.

Tiko and ZIL-130 cars;
A set of color posters of Tiko and ZIL-130 cars ;
Methodical instruction for the performance of laboratory work on learning to compile the technical classification of the vehicle N. 2007. ;
NIIAT. "Vehicle references". (in Russian) M: 1986.

VIII. Order of work.

It is necessary to read and master the following:

- the technical classification of the car ;
- Getting to know the technical classification of the car .

V. Procedure for drawing up the report.

5.1 Write a brief description of the general technical classification of the car;
5.2 Write a brief description of the technical classification of the car engine;
5.3 Write a brief summary of the technical classification of automobile units;
5.4 Complete the general technical classification of the vehicle and engine in Table 9.1;
5.5 Complete the technical classification of car mechanisms, systems and aggregates in Table 9.2.

Indicators of the general technical classification of the car and engine.

Table 9.1

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
Car model							
When and where the car was developed, year							
Load carrying capacity (number of people, with cargo), kg							
Car net weight, kg							
Maximum speed in high gear, km G' s							
Engine copy							
Fuel consumption, 100 km|l							
Car dimensions:							
A) full length							
B) the greatest width							

C) the greatest height						
G) base						
D) between the front wheels (track)						
Wheel formula						
engine brand						
number and location of cylinders						
cylinder diameter, mm						
piston path, mm						
working volume of the engine, l						
Compression level						
maximum power, kW						
maximum torque, n G' m						
number of revolutions of the crankshaft, ayl G' min						
operation of the cylinders						

technical classification of car mechanisms, systems and aggregates .

Table 9.2

No	Indicators	The main technical indicators of the car					
		Light car		Truck		Bus	Special car
				Boarded	self-destructive		
1		2	3	4	5	6	7
Car model							
Engine model							
KShM							
The number and location of cylinders							
Piston diameter and path, mm							
Compression level							
Crankshaft:							
The number of connecting rods							
The number of the base joint							
Block material							
Piston material							
Crankshaft material							
GTM							
Number of slots of the inlet valve, mm							
Exhaust valve clearance, mm							
Location of valves							
Crankshaft location							
Type of cooling system							

Radiator type						
Thermostat type						
Opening time of thermostat valve ’ t 0						
Type of coolant						
Type of lubrication system						
Oil capacity, l						
Pressure lubricated parts						
Oil pressure MPa (kg /cm ^{2})						
Oil pump type						
Type of mild detergent						
Coarse gasoline filter type						
Fine to coarse filter type						
Carburetor model and chamber number						
Gasoline type						
Gasoline capacity, l						
100 kmgasoline consumption, l						
Gas type						
Number of gas cylinders						
Volume of gas in one cylinder, m ^{3}						
100 kmgas consumption, m ^{3}						
1	2	3	4	5	6	7
Fuel pump pressure						
Number of high pressure plungers						
Coarse filter s o ni and type						
Number and type of fine filter						
Volume of the fuel tank, l						
Number and type of nozzles						
Fuel injection pressure at the injector, mPa						
Number of leading discs						
Number of drives						
The type of connection						
The presence of a clutch booster						
A gap between the discs						
The gap between the separating lever and the compression bearing, mm						
The full path of the pedal, mm						
Work path, mm						
Freeway, mm						
Work path, mm						
Gearbox type						
Number of steps (forward)						
Number of synchronizers						
Which transmission is added using a synchronizer						
Number of extensions						

I-speed						
II-speed						
III-speed						
IV-speed						
At V-speed						
Gearbox type						
Number of steps (forward)						
Number of synchronizers						
Which transmission is added using a synchronizer						
Number of extensions						
I-speed						
II-speed						
III-speed						
IV-speed						
At V-speed						
A type of reverse drive cardan transmission						
Cardan number						
Whether there is an intermediate support in the cardan transmission						
Type of main gear						
Transmission number of the main gear						
Differential type						
Number of satellites						
R ama types						
1	2	3	4	5	6	7
The number of body compartments						
Types of suspensions						
Types of dampers						
The highest turning angle of the outer wheels, mm						
Types of steering						
Types of steering mechanism						
Luft of steering wheel mm						
Types of brake control						
How many types of brake network are there?						
The brake system is pneumatic or hydraulic						

VI. The following questions regarding laboratory work are answered orally.

6.1 Explain the technical classification of a car?

6.2 Explain how to make a technical classification of a car?

6th Semester

1 6 - Laboratory work

Topic: Determining the number of gears in each gear of the transmission and gearbox.

The purpose of the work: to determine the number of transmissions of the gearbox .

The number of gears of the car gearbox under design is determined for the main speed.

The structure of transmission numbers of the transmission box of modern cars is selected according to geometric progression. In this case, the ratio of transmission numbers of the gearbox should form the basis of geometric progression "q", i.e.:

$$\frac{U_2}{U_1}=\frac{U_3}{U_2}=\frac{U_4}{U_3}=\frac{U_5}{U_4}=............\frac{U_n}{U_{n-1}}=q$$

here; U_1, U_2, U_3,.....,U_n numbers of transmissions in different transmissions;
n is the number of transmissions.

The basis of the geometric progression "q" is defined by the following expression:

$$q=\sqrt[n-1]{P_{k_1}/P_{k\max}}$$

where, P_{k_1} and $P_{k\max}$ -the traction force of the car in the first gear and the maximum traction force in the first speed.

The traction force of the car in the first gear is determined by the following expression:

$$P_{k_1}=\frac{M_H\cdot U_1}{r_k}\cdot\eta_{ky}\text{, N}$$

here; M_n - the nominal torque of the engine crankshaft,

$$M_H=9550\cdot\frac{N_{e.\max}}{n_N}=9550\cdot\frac{58{,}8}{5400}=104\ \text{N}\cdot\text{M}$$

here, $N_{e.\max}$ -the maximum power of the engine, $N_{e.\max}$ = 58.8 kW;

n_N - the number of revolutions of the crankshaft at the maximum power of the engine, n_N = 5400 /rpm.

1. U_1 - The number of 1-speed transmission of the gearbox

$$U_1=\frac{D_{1.v\max}\cdot G_a\cdot r_k}{M_{b.\max}\cdot\eta_{ky}}=\frac{0{,}35\cdot 15500\cdot 0{,}356}{121{,}6\cdot 0{,}903}=3{,}242$$

here, - $D_{1.v\max}$ the maximum dynamic factor of the car at the 1st speed, $D_{1.v\max}$ we accept =0.35 to =0.32...0.525 ; $D_{1.v\max}$

G_a - the weight of the car full of cargo, G_a =15500 n;
r_k is the rolling radius of the wheel u as follows,

$$r_k = 0{,}5 \cdot d + b \cdot (1-\lambda) = 0{,}5 \cdot 0{,}406 + 0{,}176 \cdot (1-0{,}13) = 0{,}356 \text{ m}$$

here; d—the inner diameter of the wheel tire entering the disk, d= 0.406 m,
b - tire width, b= 0.176 m,
l-tyre deformation coefficient,
for passenger cars from 0.125 to 0.15 for passenger cars, λ we accept = 0.13;
for buses and trucks λ = 0.09...0.11 is accepted.
$M_{b.\max}$ - the maximum torque of the engine crankshaft, $M_{b.\max}$ = 121.6 n·m,
η_{ku} - useful work coefficient of power transmission;

$$\eta_{ky} = \eta_{м} \cdot \eta_{y \cdot к} \cdot \eta_{кар}^{c} \cdot \eta_{бу} = 1 \cdot 0{,}97 \cdot 0{,}99^2 \cdot 0{,}97 = 0.92;$$

2. We determine the traction force at the first speed:

$$P_{k_1} = \frac{M_H \cdot U_1}{r_k} \cdot \eta_{ky} = \frac{104{,}0 \cdot 3{,}242}{0{,}356} \cdot 0{,}92 = 854{,}70 \text{ n;}$$

3. We determine the maximum traction force of the car in the first speed:

$$P_{k_{\max}} = \frac{M_{b.\max} \cdot U_1}{r_k} \cdot \eta_{ky} \frac{121{,}6 \cdot 3{,}242}{0{,}356} \cdot 0{,}92 = 999{,}34 \text{ n;}$$

4. We determine the basis of geometric progression:

$$q = \sqrt[n-1]{P_{k_1} / P_{k\max}} = \sqrt[4-1]{854{,}70 / 999{,}34} = 0{,}613$$

5. The limits of the geometric progression representing the number of gears of the car power transmission are determined by the following expression:
for the first pass:

$$U_I = U_1 \cdot q^{n-1} = 3{,}242 \cdot 0{,}613^{1-1} = 3{,}242 \cdot 0{,}613^0 = 3{,}242,$$

for the second pass:

$$U_{II} = U_1 \cdot q^{n-1} = 3{,}242 \cdot 0{,}613^{2-1} = 3{,}242 \cdot 0{,}613^1 = 1{,}988,$$

for the third pass:

$$U_{III} = U_1 \cdot q^{n-1} = 3{,}242 \cdot 0{,}613^{3-1} = 3{,}242 \cdot 0{,}613^2 = 1{,}217,$$

for the fourth pass:

$$U_{IV} = U_1 \cdot q^{n-1} = 3{,}242 \cdot 0{,}613^{4-1} = 3{,}242 \cdot 0{,}613^3 = 1{,}0.$$

So, the number of transmissions of the gearbox is as follows according to the basis of geometric progression q=0.613.

Extensions	I	II	III	IV
Transmission number	3,242	1,988	1.217	1.0

References:

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles"

"Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

17-LABORATORY WORK

Topic: Determining the car's center of gravity

To determine the center of the sail of the car, its three coordinates are determined:

a - the distance from the front wheel axis of the car to the center of the sail;

v - the distance from the axis of the rear wheel of the car to the center of the sail;

h - the distance from the center of the sail to the road surface.

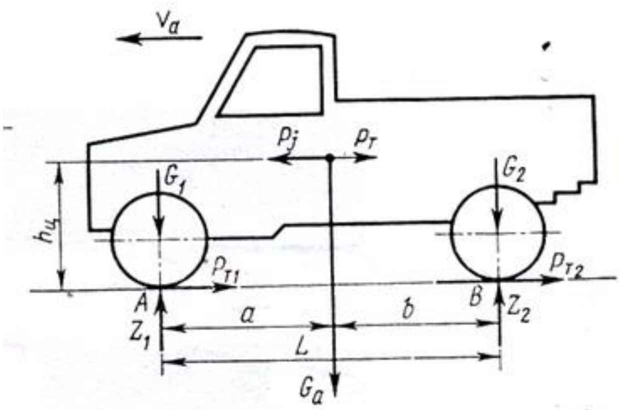


Figure 11.1. Coordinates of the car's sail center.

The values of the coordinates of the center of gravity are determined by the following expressions;

$$a = \frac{G_1}{G_a} \cdot L \text{, m}$$

$$b = \frac{G_2}{G_a} \cdot L \text{, m}$$

for cars $h = 0,5 \cdot B$, m

for trucks $h = 0,5 \cdot B$, m

where: G_1 is the load on the front wheel, kg;

G_2 - the load on the rear wheel, kg;

G_a - full weight of the car, kg;

L - the base of the car, m;

B - the distance between the front wheels (colea), m.

Car model	Those given					Calculated		
	G_1	G_2	G_a	L	B	a	b	h

1 8 - LABORATORY WORK

Topic: Determining the turning radius of the car in the longitudinal and transverse planes.

III. Purpose of work:

1.4.Acquaintance with the turning radius of cars in the longitudinal plane;
1.5.Acquaintance with the turning radius of cars in the transverse plane.

IV. Content of work:

2.9 Study of the types of radius of curvature of cars in the longitudinal plane ;
2.10 Study of the types of radius of curvature of cars in the transverse plane ;

The values of these radii are determined graphically as follows:
1. The turning radius of the car in the longitudinal plane is the radius of the circle that the car is driven on the front and rear wheels.

To determine this radius, the radius of the wheels is determined based on the given distance of the vehicle base (L), and the wheels are drawn on the scale, and a circle is drawn on these wheels and its radius is r_1.

Figure 3.1. The form of determining the longitudinal (r_1) and transverse (r_2) turning radii of the car.

2. The turning radius of the car in the horizontal plane is the radius of the circle passing the car to the wheels of the car and to the lowest point of the car's axle.
The average radius of a car wheel is determined by the following expression:

$$r_F = 0{,}5 \cdot d + b \cdot \left(1 - \lambda_{ш}\right), \text{ m}$$

where: the diameter of the d-tire entering the disk, m;
b-tire width, m;
A circle of the wheel is drawn on the specified radius r_F.

Car model	Given						It counts			The limiting value of r_1
	L	V	b	d	l_{sh}	h_{road}	r_F	r_1	r_2	

Values of the longitudinal radius of curvature:
for cars with an average capacity: up to 3.5...5.5 meters,
for small cars: up to 2.5...3.5 meters,
for small lift trucks: up to 2.5...3.5 meters,
for vehicles with an average carrying capacity: up to 3.0...5.5 meters,
the large loading capacity for cars: up to 5.0...6.0 meters.

1 9 - LABORATORY WORK

Topic: Determination of overturning of the car on the front and rear axis.

Purpose of work.
Determining the rollover angles of the front and rear axles of the car.
1. Determining the rollover angle on the rear axle of the car. (Figure 4.1)

4. Figure 1 . A car moving with downward acceleration on a slope.

can roll back under the influence of P_x force and overturning moment around the support point O_2 adjacent to the road surface .

In order for the car not to overturn, the sum of the moments of the forces relative to the reference point O_2 should be equal to zero, that is:

$$\sum M_{o_2} = 0$$

$$P_y \cdot b - P_x \cdot h = 0 \quad (1)$$

$$P_y = G_a \cdot \cos\alpha \quad (2)$$

$$P_x = G_a \cdot \sin\alpha \quad (3)$$

(2) and (3) into (1) ;

$$G_a \cdot \cos\alpha \cdot b - G_a \cdot \sin\alpha \cdot h = 0$$

simplifying this expression yields the following expression:

$$tg\alpha = \frac{b}{h};$$

where: b and h are the coordinates of the center of gravity.

The permissible limited overturning angle of the overturning angle,
for passenger cars: $\alpha = 45^0$ ga;
for trucks and buses $\alpha = 35....45^0$ will be equal to
In Fig. 13.b. A car moving on a slope with upward acceleration. When the car moves with acceleration from top to bottom, the front wheel of the car can roll forward under the influence of P_x force and overturning moment around the reference point O_1 adjacent to the road surface .

R_x and R_u is equal to zero, that is;

$$\sum M_{o_1} = 0$$

$$G_a \cdot \cos\alpha' \cdot (L-b) - G_a \cdot \sin\alpha' \cdot h = 0$$

from this $\cos\alpha' \cdot (L-b) = \sin\alpha' \cdot h = 0$

$$tg\alpha' = \frac{L-b}{h} = \frac{a}{h};$$

The permissible limited overturning angle of the overturning angle,
for passenger cars: $\alpha' \geq 60^0$ ga;
for trucks and buses $\alpha' = 60^0$ will be equal to
To determine the rollover angles, the coordinates of the center of gravity of the car calculated in the previous laboratory work (a, b, h) are taken.

Model of the car	a	b	h	α	α'

20 - LABORATORY WORK

Topic: Y e **to determine the angle at which the wheels can rise to a height without swaying.**

Determining rollover angles on the rear axles of the car.

1. Determining the rollover angle on the rear axle of the car.

A car moving with downward acceleration on a slope.
can roll back under the influence of P_x force and overturning moment around the support point O_2 adjacent to the road surface .

In order for the car not to overturn, the sum of the moments of the forces relative to the reference point O_2 should be equal to zero, that is:

$$\sum M_{o_2} = 0$$

$$P_y \cdot b - P_x \cdot h = 0 \, (1)$$
$$P_y = G_a \cdot \cos\alpha \; (2)$$
$$P_x = G_a \cdot \sin\alpha \; (3)$$

(2) and (3) into (1) ;

$$G_a \cdot \cos\alpha \cdot b - G_a \cdot \sin\alpha \cdot h = 0$$

simplifying this expression yields the following expression:

$$tg\alpha = \frac{b}{h};$$

where: b and h are the coordinates of the center of gravity.

The permissible limited overturning angle of the overturning angle,
for passenger cars: $\alpha = 45^0$ ga;
for trucks and buses $\alpha = 35....45^0$ will be equal to
To determine the rollover angles, the coordinates of the center of gravity of the car calculated in the previous laboratory work (a, b, h) are taken.

Model of the car	a	b	h	α

21 - LABORATORY WORK

Topic: Determining the stability of the car in the transverse plane.

Purpose of work.

Determining the rollover angle of a car moving with acceleration on a transverse inclined plane.

the angle, which ensures that the car moving on a transverse inclined plane moves without being pushed to the side or overturning, β represents the transverse stability of the car. (Fig. 6.1).

Vehicle O $_1$ around the reference point $P_x = G_a \cdot \sin\beta$ it can be overturned transversely (to the side) under the influence of force and overturning moment.

In order for the car to move without slipping, the moments of forces R $_x$ and R $_u$ should be equal to O, that is;

$$P_x \cdot h - 0{,}5 \cdot P_y \cdot B = 0 \; (1)$$

in this
$$P_x = G_a \cdot \sin\beta \,; \; (2)$$
$$P_y = G_a \cdot \cos\beta \,; \; (3)$$

(2) and We put **(** 3 **)** in (1) ;

$$G_a \cdot \sin\beta \cdot h - 0{,}5 \cdot B \cdot G_a \cdot \cos\beta = 0$$

from this we determine the angle of inclination;

$$tg\beta = \frac{0,5 \cdot B}{h};$$

where: V-distance between rear wheels,

for a passenger car $\beta \geq 45^0$,

for trucks and buses $\beta = 35^0$.

Car model	B	h	β

2 2 - LABORATORY WORK

Topic: Determining the critical speed of a car on a rollover in a turn.

Purpose of work.

Determining the critical rollover speed of a car turning on a slope when the turning center is below the slope and above the slope.

Q is the location of the vehicle's center of rotation above and below the plane.

1. When the turning center of the car is located below the slope when the car is turning on an inclined plane, the critical speed of the car for overturning while turning along the curve is determined by the following expression:

$$V_{a.\max} \leq \sqrt{g \cdot R \cdot \frac{B + 2 \cdot h \cdot tg\beta}{2 \cdot h - B \cdot tg\beta}}, (1)$$

2. If the center of the turn is located above the slope of the inclined plane, the critical speed of the car for overturning in the turn is determined by the following expression:

$$V_{a.\max} \leq \sqrt{g \cdot R \cdot \frac{B - 2 \cdot h \cdot tg\beta}{2 \cdot h + B \cdot tg\beta}} \quad , (2)$$

the turning radius R is large $B \geq h$ and the turning center is located below the slope, the stability of the car in the turn will be stronger.

3. If the car is turning on a plane, the maximum critical speed before the car overturns during the turn is determined by the following expression:

$$V_{a.kp} = \sqrt{g \cdot R \cdot B / 2 \cdot h}, (3)$$

Car model	R	B	h	$tg\beta$	$V_{a.max}$	AND $_{a.kp}$

2 3 - Laboratory work.

Determining the critical speed of the car on the slide.

1. the car's critical (limiting) speed β is equal to the vertical angle q0 of the car in order to move along a curve without being diverted from sliding on a straight road.

$$V_{kr} q2.21* \sqrt{d * R / h\text{м} - R} \geq Va\max \text{ mG's (1)}$$

where V is the distance between the front wheels of the car, m

R- Turning radius of the car road, m

h_{m}- The distance from the center of gravity of the car to the road surface is calculated according to:

2. $_{m}$ q0.75*B for trucks on the day-long road h_{m} q0.75*B when turning, if the turning center is located at the top of the car, then the car moves along a curved line in the plane without sliding to the side, and its critical speed is determined by the expression:

$$V_{krq} \sqrt{g * R * \frac{b + 2 * hm * tg\beta}{2 * hm - b * tg\beta}} \geq \text{And, max (2)}$$

3. If the car is located below the car while turning on a sunny road , In order for a vtom to move along a curved line in a plane without sliding and turning over, its critical speed is determined by the following expression :

$$V_{krq} \sqrt{g * R * \frac{B - 2 * hm * tg\beta}{2 * hm + B * tg\beta}} \geq \text{And, max (3)}$$

Here $\beta = 8....12^{0}$ is the slope angle of the road;

$V_{a.max}$- The maximum speed of the vehicle , mG's

Rq300...1000 m-turning radii of the design of highways.

PRACTICAL TRAINING

1- Practical training. Determination of wheel radii, useful work coefficient, number of transmissions and vehicle speed.

Purpose of work:	- Getting to know the kinematic parameters of the car and solving problems.
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. Rolling radius of the wheel:

$$r_F = \left[\frac{d}{2} + b \cdot (1 - \lambda)\right], \text{m}$$

where: *d* is the diameter of the tire circle entering the disc, m, *b* - tire width, m .

λ - coefficient of deformation (sag) of the tire under the influence of gravity:

- for λ new cars i =0.125 $\div$0.15.

- for λ trucks i = 0.09 $\div$0.1 1 accept i nadi .

2. $\eta_{к.у}$ FIK of power transmission (table 1):

$$\eta_{к.у} = \eta_м \cdot \eta_{у.к} \cdot \eta^c_{кар} \cdot \eta_{б.у}$$

Useful work coefficients of power transmission mechanisms are obtained from 1 .1 - j adval.

Table 1.1

Mechanisms	Useful work coefficients η_i
Fric ts ion clutch;	1.0
Hydraulic clutch;	0.97...0.98
Transmission box; a) spur gear	0.94...0.97
b) bevel gear	0.95...0.98
Cardan transmission Angle of deviation of the propeller shaft (relative to the frame) 0-7 ^{0}(car)	0.99
7 ^{0}-20 ^{0}(truck and bus)	0.98
Head gear: Single-stage, hypoid gear bevel gear.	0.94
Single stage hypoid gear bevel gear single stage cylindrical gear.	0.97
Two-stage (double) cone-cylinder gear transmission.	0.92
A pair of cylindrical gears of the idle gear	0.97...0.98
A pair of bevel gears	0.95...0.97

$\eta_м$ - FIK of the clutch - 1.0

$\eta_{у.к}$ - FIK of the gearbox - 0.97

$\eta_{кар}$ - FIK of cardan transmission - 0.99

$\eta_{б.у}$ - FIK of the main gear, in the main gear with a single bevel gear $\eta_{б.у}$ = = $\eta_к$ 0.95...0.97, in the double main gear $\eta_{б.у} = \eta_ц^a \cdot \eta_к^b$

$\eta_ц$ - FIK of a pair of cylinder gears, $\eta_ц$ =0.97...0.98 from which $\eta_{кон.}$ we get =0.97.

a , *b* - the number of double chevrons, *a* = 1, *v* = 0, *c* - the number of cardan crosses, *c* = 2.

3. Transmission end of power transmission :

$$U_{ку} = U_{бу} \cdot U_{ук}$$

where: $U_{бу}$ - the number of transmissions of the main gear, - the number of $U_{ук}$ transmissions q uti .

3.1 Transmission number of the main gear.

The transmission number of the main gear is determined by the following expression:

$$U_{б.у} = \frac{\pi \cdot n_N \cdot r_F}{30 \cdot V_{a\max}}$$

where: n_N is the maximum number of revolutions of the crankshaft, rev/min;

V_{max} - the maximum driving speed of the car, m/s.

3.2. The number of transmissions of the gearbox.

3.2.1 Determination of the transmission number of the first gear.

The number of transmissions in the 1st transmission, which ensures that the car moves without slipping, overcoming the maximum resistance of the road, is determined as follows:

$$U_{1\varphi} = \frac{G_a \cdot \psi_{\max} \cdot r_F}{M_{e\max} \cdot \eta_{ку} \cdot U_{бу}}$$

here, G_a - weight of the car with a full load, N;

M_e is the maximum torque of the engine (Course work (project) is taken from Table 2), N·m .

$\psi_{\max}$ - the maximum total resistance of the road

$$\psi_{\max} = f_{\max} \cdot \cos\alpha \cdot \sin\alpha = 0{,}0399 \cdot \cos 28^0 + \sin 28^0 = 0{,}50;$$

When the car is moving at maximum speed, the road resistance coefficient $f_{\max}$ is determined as follows:

$$f_{\max} = f_0 \cdot \left(1 + \frac{V_{a\cdot\max}^2}{2000}\right)$$

r_f is the rolling radius of the leading wheel, we determine the number of gears in the first gear by substituting m values:

The number of remaining gears of the gearbox is determined by the following expression:

$$U_{у.к} = \sqrt[n-1]{U_I^{n-k}}$$

where k is the index of the desired extension,

n is the number of steps in the gearbox, 1,2,3,4,5, etc.

4. Determination of the speed of movement of the car in different gears.

The desired speed of movement of the car in different gears is determined by the following expression:

$$V_{а.у.к} = 0{,}377 \cdot \frac{n_x \cdot r_F}{U_{у.к.х} \cdot U_{б.у}}$$

We write the results of calculating wheel radii, useful work coefficient, number of transmissions and vehicle speeds in the following tables (tables 1.2 and 1.3).

Table 1.2

t/r No	Naming of indicators	The result obtained
1.	Rolling radius of the leading wheel , r_F , m.	
2.	FIK of three transmissions K ., $\eta_{к.у}$.	
3.	end of power transmission , $U_{ку}$.	
4.	Number of transmissions of the main gear , $U_{бу}$.	
5.	Transmission number of the gearbox , $U_{ук}$.	
6.	Number of remaining gears of the gearbox:	
7.	first pass -$U_{у.к.I}$	
8.	second pass -$U_{у.к.II}$	
9.	third extension -$U_{у.к.III}$	
10.	fourth gear -$U_{у.к.VI}$	
11.	fifth gear -$U_{у.к.V}$	

Table 1.3

The number of revolutions of the crankshaft, n_x rpm	Vehicle speeds, V_a, km/h				
	Number of extensions				
	$U_I =$	$U_{II} =$	$U_{III} =$	It $_{IV} =$	$U_V =$

2-Practical training. Calculation of power, torque and traction forces.

Purpose of work:	- To study the meaning of the indicators on this topic and to solve the problem
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. Effective power of the engine for the desired number of revolutions of the crankshaft :

The effective power of the engine at any number of revolutions of the crankshaft is determined by the following expression.

$$N_{ex} = N_{eV\max} \cdot \frac{n_x}{n_N} \cdot \left[a + в \cdot \frac{n_x}{n_N} - c \cdot \left(\frac{n_x}{n_N} \right)^2 \right], \text{ k W}$$

where *a* , *v* , *c are the coefficients taking into* account engine types :

a =1.0 for carburetor engines ; *v* = 1.0; *c* = 1.0

- *a* =0.87 for diesel engines ; *v* = 1, 13 ; *c* = 1 is equal to

N_{ex}, n_x - looking for power and the number of revolutions of the crankshaft values

n_N - the number of revolutions of the crankshaft at maximum power, rev/min.

By substituting the determined values into the expression , the power of the engine is obtained for the intervals and the results are filled in table 2.1 .

2. Effective torque of the engine :

The desired effective torque of the engine at the desired number of revolutions of the crankshaft is determined by the following expression;

$$\mathrm{M_{ex}} = 9554 \cdot \frac{\mathrm{N_{ex}}}{n_N}, \text{ N} \cdot \text{m}$$

By substituting the determined values into the expression , the power of the engine is obtained for the intervals and the results are filled in table 2.1 .

2.1 - table

No	The number of revolutions of the crankshaft n_x, rpm	Engine power and torque	
		Ex, (kW)	M_{ex}, (N·m)

1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

3. Traction force on the leading wheel of the car :

When the car is moving in a straight line, the desired traction force applied to the leading wheel is determined by the gears as follows:

$$P_{T.x} = \frac{M_{e.x} \cdot U_{б.у} \cdot U_{у.к.х}}{r_F} \cdot \eta_{к.у}, \text{ N}$$

After calculating the remaining values of gears I, II, III, IV, V, all results are filled in table 2.2 .

2.2 .

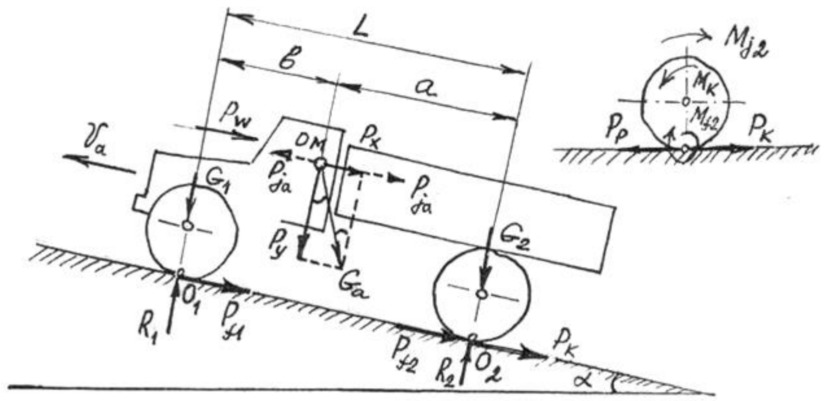
The number of revolutions of the crankshaft, n_x ayl / m in	Traction force of the car, R_{tx}, N				
	Extensions				
	I	II	III	IV	V

3-Practical training. Calculate the forces acting on the car

Purpose of work:	- To study the forces resisting the movement of the car and to determine the energy needed to overcome them
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the coursework (project) on the basis of the Short car reference.



Picture. Forces resisting vehicle motion

Equations to solve the problem

1. The resistance to climbing and the energy required to overcome it:

$$P_\alpha = G_a \cdot Sin\alpha, \text{ N} \qquad N_\alpha = \frac{P_\alpha \cdot V_{a.x}}{1000}, \text{ kW.}$$

where V_{ax} is the speed of the car in gears I, II, III, IV, V , km/h

2. The force of resistance to rolling and the power required to overcome it:

$$P_f = G_a \cdot f \cdot \cos\alpha, \text{ N} \qquad N_f = \frac{P_f \cdot V_{a.x}}{1000}, \text{ kW}$$

the car 80 km/is moving at a speed higher than the speed of the clock, the rolling resistance coefficient is determined using the empirical expression as follows:

$$f = f_0 \cdot \left(1 + \frac{V_{a.\max}^2}{2000}\right),$$

here; $V_{a\,max}$ is the maximum speed of the car, km //h.

f_o by road types below The values of are listed: $f_0(V_a < 80км/c)$ will be

0.018-0.020 on a satisfactory paved road
0.023-0.030 on a gravel road
0.020-0.025 on a gravel road
0.025-0.035 on a dirt road
0.100-0.300 on a sandy road
0.070-0.300 on a snowy road
f are accepted in the calculations .

3. The total resistance of the road and the energy required to overcome it:

$$P_\psi = G_a \cdot \Psi, \text{ N} \qquad N_\psi = \frac{P_\psi \cdot V_{a.x.}}{1000}, \text{ kW}$$

the total resistance coefficient of the road $\Psi = f \cdot \cos\alpha + \sin\alpha$ is equal to

4. Air resistance and the power to overcome it:

$$P_W = K \cdot F \cdot V_{a.x.}^2, \text{ N} \qquad N_W = \frac{P_W \cdot V_{a.x.}}{1000}, \text{ kW}$$

- the coefficient of overcoming air resistance is defined as follows by car type:
for a passenger car with a closed body....0.20-0.30;
for buses..................................0.40-0.60;
for trucks.........................0.60-0.80;
for auto-trains..................................0.81-0.96;

- the surface of the vehicle for cargo and buses is determined as follows:
$F = B \cdot H$, m ^{2}
- for cars
$F = 0{,}78 \cdot B_1 \cdot H$, m ^{2}

5. Inertia force and the power to overcome it:

$$P_{ja} = -\frac{G_a}{g} \cdot \delta_{айл} \cdot j_a \text{, H} \qquad N_{ja} = \frac{P_{ja} \cdot V_{a.x.}}{1000} \text{, kW.}$$

$_{is}$ a factor that takes into account rotating massesδ

$$\delta_{айл} = 1{,}04 + 0{,}04 \cdot U^2_{у \cdot к},$$

car acceleration when overtaking a car

$$j_a = \frac{(P_т - P_W - P\psi) \cdot g}{\delta_{айл} \cdot G_a} \text{, m/s}^2$$

leading torque applied to the leading wheel:

$$M_F = M_{e.x.} \cdot U_{бу} \cdot U_{у \cdot к.х.} \cdot \eta_{k \cdot y} \text{, N·m.}$$

traction force:

$$P_{T.x.} = \frac{M_F}{r_F} = \frac{M_{e.x.} \cdot U_{б \cdot у} \cdot U_{у \cdot к.х.}}{r_F} \cdot \eta_{ку} \text{, N} \qquad N_T = \frac{P_{T.x.} \cdot V_{a.x.}}{1000} \text{, kW}$$

wheel turning radius:

$$r_F = \left[\frac{d}{2} + в \cdot (1 - \lambda)\right] \text{, m}$$

where d is the inner diameter of the tire entering the disk;
v - tire width;
λ - tire deformation coefficient:
0.12-0.15 for a passenger car ; λ =
for trucks and buses – 0.09-0.11.

FIK of the power transmission

$$\eta_{к \cdot у} = \eta_M \cdot \eta_{у \cdot к} \cdot \eta^c_{кар} \cdot \eta_{бу} \cdot \eta^m_{под}$$

calculating the force acting on the car and the power consumed in table 3.1 .

Table 3.1

Forces acting on the car, N					Consumed power, kW				
P_α	P_f	P_ψ	P_W	P_{ja}	N_α	N_f	N_ψ	N_W	N_{ja}

Table 3.2

Consumed power, kW																								
N_α					N_f					N_ψ					N_W					N_{ja}				
Number of extensions																								
I	**II**	**III**	**IV**	**V**	I	II	III	IV	V	**I**	**II**	**III**	**IV**	**V**	I	II	III	IV	V	**I**	**II**	**III**	**IV**	**V**

4-Practical training. Calculation of gravity and force balance equations.

Purpose of work: - To study the forces resisting the movement of the car and to determine the energy needed to overcome them

Required tools: - Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the coursework (project) on the basis of the Short car reference.

1. Vehicle motion equation or traction balance:

$$P_T - P_f - P_\alpha - P_W - P_{ja} = 0 \text{ or } P_T = P_f + P_\alpha + P_W + P_{ja}$$

2. Balance of powers:

$$N_T = N_f + N_\alpha + N_W + N_{ja}, \text{ kW}$$

$$\text{or } N_e = \frac{N_T}{\eta_{ky}} = \frac{N_f}{\eta_{ky}} + \frac{N_\alpha}{\eta_{ky}} + \frac{N_W}{\eta_{ky}} + \frac{N_{ja}}{\eta_{ky}} \text{ kW}$$

$$N_{T.x.} = \frac{P_T \cdot V_{a.x.}}{1000};\ N_{f.x.} = \frac{P_f \cdot V_{a.x.}}{1000};\ N_{\alpha.x.} = \frac{P_\alpha \cdot V_{a.x.}}{1000};\ N_{W.x.} = \frac{P_W \cdot V_{a.x.}}{1000};\ N_{ja.x.} = \frac{P_{ja} \cdot V_{a.x.}}{1000}, \text{kW}$$

We will use the results obtained in Exercise 3 to solve the vehicle's traction and power balance equations and calculate them.

5- Practical training . Calculation of dynamic factor, dynamic characteristics. Calculate the fuel efficiency of the car.

Purpose of work: - Understanding the dynamic factor and dynamic description of the car, studying its physical meaning and solving problems

Required tools: - Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. The desired dynamic factor of the car :

$$Д_{a.x} = \frac{P_{m.x} - P_{W.x}}{G_a}$$

Dynamic factors are calculated separately for each transmission of the car. We calculate the dynamic factors of the car by replacing *the* R_{tx} and R_{wx} *values* calculated above , and the remaining values of I, II, III, IV, V transmissions are calculated and filled in table 5.1 .

5.1 - table.

Its dynamic factor depending on the speed of the car

Number of extensions									
U_I =		U_{II} =		U_{III} =		It $_{IV}$ =		U_V =	
V_a, km/h	D_{ax}, N	V_a, km/h	D_{ax}, N	V_a, km/h	D_{ax}, N	V_a, km/h	D_{ax}, N	V_a, km/h	D_{ax}, N

2. Building a description of the dynamic factor of the car.

Let's build a description of the dynamic factor of the truck.

For this, the scale of the dynamic factor is defined;

$$m_{Да} = \frac{Д_{a.\max}}{Д_{\max}}, \text{ 1/mm}$$

here, $D_{a.max}$ - the maximum dynamic factor of the truck, calculated as $D_{a.max}$ =………, D_{max} - section of the maximum dynamic factor, $D_{a.max}$ =………mm. On the basis of the received scale and transmission, a description of the change of the dynamic factors according to the speed of the car is constructed, i.e. $D_{ax} = f(V_a)$.

3. Construction of a nomogram showing the dynamic factor of an unloaded car.

$D_{o.max\,)}$ of an unloaded car is determined as follows:

$$Д_{o\max} = Д_{a\max} \cdot \frac{G_0}{G_a}, \text{ 1/mm}$$

here, G_0 - weight of the car without load, N

G_a - the weight of the car with its load, N

$D_{0)}$ of the truck is determined as follows:

$$m_{До} = m_{Да} \cdot \frac{G_a}{G_0}, \text{ 1/mm}$$

The dynamic factor of an unloaded car is analyzed according to the cross section;

$$Д_0 = \frac{Д_{0.\max}}{m_{до}}, \text{ mm}$$

calculated D_{aI} , D_{aII} , D_{aIII} ,……… values m_{aD} on the scale, D is scaled to the ordinate axis . D_{o1} , D_{o2} , D_{o3} , values are measured on the ordinate axis D_o on the scale $m_{Do.\ 0.1\text{-}0.1}$ to the same value on the ordinate axis ; 0.2-0.2; 0.3-0.3; …… the scale of dynamic factors is connected by a straight line. These drawn lines are called weight nomograms.

This nomogram helps to analyze the ability of the vehicle to overcome the road resistance at each weight. But this graph does not solve the problem of the transmission of power on the leading wheel through the condition of the teeth of the wheel on the road.

Therefore, it is necessary to add a graph to the nomogram of weights to control the condition of the leading wheel's movement without wobble.

In order to see the desired graph, dynamic factors are determined according to the condition of the engagement of the wheel with the road.

The dynamic ( ) factor, which takes into account the engagement of the leading wheels of the loaded car with the road, $Д_\varphi$ is determined by the following expression:

$$Д_{\varphi a} = \left(\frac{G_2}{G_a}\right) \cdot \varphi$$

empty car; $Д_{\varphi 0} = \left(\frac{G_{02}}{G_a}\right) \cdot \varphi$

If the front wheels of the truck are leading:

$$Д_{\varphi a} = \left(\frac{G_1}{G_a}\right) \cdot \varphi$$

G_1 *is the load on the front axle of the* truck , N ;

When the front wheels of an unladen vehicle are leading;

$$Д_{\varphi a} = \left(\frac{G_{01}}{G_a}\right) \cdot \varphi$$

G_{01} - the load on the front axle of an unloaded car, N

If all wheels of the car are leading, $Д_{\varphi a} = \varphi$; $Д_{\varphi 0} = \varphi$ will be equal to $Д_{\varphi a}$ and

$Д_{\varphi 0}$ values of dynamic factors are 0.1 of bite coefficient φ ; 0.2; 0.3; 0.4; 0.5; 0.6; For values 0.7 and 0.8, it is defined as follows:

$Д_{\varphi a}$ and $Д_{\varphi 0}$ the remaining values are calculated and the results are filled in Table 7.

The scales adopted are as follows; $m_{Da} = m_{Dph}$; $m_{D0} = m_{Д\varphi 0}$ and the values of these are $m_{Da} = m_{Dpha} =$ …….. $\frac{1}{\text{mm}}$ and $m_{Д0} = m_{Д\varphi 0} =$ …….. $\frac{1}{\text{mm}}$ will be equal. Based on the accepted scales, we determine the cross-sectional values of $Д_{\varphi a}$ var $Д_{\varphi 0}$:

$$Д_{\varphi a} = \frac{Д_{\varphi a}}{m_{д\varphi a}}, \text{ mm}$$

$$Д_{\varphi 0} = \frac{Д_{\varphi 0}}{m_{д\varphi 0}}, \text{ mm}$$

After determining the remaining values, the results are filled in table 7.

Table 5.2

Car condition	Dina-mic factor	Dynamic factors on the coefficients of engagement of the leading wheels with the road surface (φ).							
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Loaded front	D_{pha}								
	D_{pha}, mm								
Front without load	$D_{\varphi 0}$								
	$D_{\varphi 0}$, mm								

D_a *is* the dynamic (D_{pha}) factor on the engagement only when the car is fully loaded on the ordinate axis, and D 0 *is* $_{the}$ dynamic engagement factor of the unloaded car on the ordinate axis ($D_{\varphi 0}$) factor values are set.

Determined dynamic factor $Д_{\varphi a}$ and $Д_{\varphi 0}$ cross-sections $Д_{\varphi a}$ are $Д_{\varphi 0}$ placed on the ordinate axes and connected with a dotted straight line Table 5.2 (Fig. 5.1). On the abscissa axis, $D_{ax} = f\ (V_a)$ km/h , i.e., the maximum walking speed, is selected from Table 6 , and a dynamic passport of a dynamic car is built (Fig. 5.1).

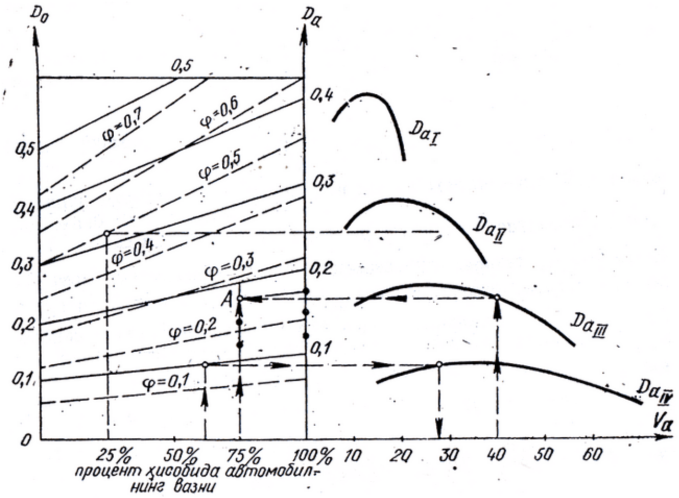


Figure 5.1 . Dynamic passport graph of the car .

Calculate the fuel efficiency of the car.

Purpose of work:	- To study the factors affecting the fuel economy of the car and to solve the problems
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the coursework (project) on the basis of the Short car reference.

1. The amount of fuel consumed by a car per hour depends on the speed of the car $Q_s = f(V_a)$, *which is determined as follows:*

$$Q_{s.x.} = \frac{K_{n.x.} \cdot K_{N.x.} \cdot g_{ё.N}\left(N_{f.x.} + N_{w.x.}\right)}{36 \cdot \rho_{ё} \cdot \eta_{к.у} \cdot V_{a.x.}}, \text{ kg/h}$$

here, ρ or - fuel density, kg/l.

- density of gasoline fuel, 0.75 kg/l;

- density of diesel fuel, 0.86 kg/l;

$\eta_{к.u}$ -the useful work coefficient of the power transmission is equal $\eta_{к.u}$ to = …… ;

And $_{a.x.}$ - speed of the car, m/s.

$K_{n.x.}$ -using the number of revolutions of the crankshaft coefficient and it is determined as follows

$$K_{n.x.} = \frac{n_x}{n_N}$$

Table 6.1 is filled in with the results of changes in the number of revolutions of the remaining crankshaft

K_N - coefficient of engine power utilization,

$$K_{N.x.} = \frac{N_{f.x.} + N_{W.x.}}{N_{e.x.}}$$

here, - $N_{f.x.}$ the power spent to overcome road resistance , kW

$N_{W.x.}$ -power used to overcome air resistance , kW

N_{ex} is the effective power of the engine, kW (the 2nd practical case is taken according to interval 9 from table 2.1).

$N_{f.x.}$ - the power spent to overcome road resistance is determined as follows:

$$N_{f.x.} = \frac{P_f \cdot V_{a.x.}}{1000}, \text{ kW},$$

where the values of V_a in the range from -10 km/s to 100 km/s are taken in m/s and the results of the change of the remaining values are filled in table 6.2.

Power expended to overcome air resistance.

$$N_{W.x.} = \frac{(P_W \cdot V_{a.x.})}{1000}, \text{ kW}$$

where the values of V_a in the range from -10 km/s to 100 km/s are taken in m/s and the results of the change of the remaining values are filled in table 6.2.

$g_{or\ N}$ - effective specific fuel consumption of the engine working at nominal power ;

$$g_{\ddot{e}.N} = \frac{3{,}6 \cdot 10^3}{Q_n \cdot \eta_e}, \text{ g/ k W} \cdot \text{s}$$

Q_n is the lower heating capacity of the fuel:

- for gasoline fuel, Q_n =43.93 MJ/kg;
- for diesel fuel, Q_n =42.50 MJ/kg;

η_e – effective efficiency of the engine:

- equal to 0.25...0.33 for a carburettor engine and η_e – we accept from it
- 0.35...0.40 ha t e ng for a diesel engine

Above $N_{f.x.}$, $N_{W.x.}$ and $N_{e.x.}$ using the values coefficient of engine power utilization - $K_{N.x.}$ we find ,

$$K_{N.x.} = \frac{N_{f.x.} + N_{W.x.}}{N_{ex}}$$

Table 6.1 fills in the results of the change of similar remaining values

P_f - road resistance,

$$P_f = G_a \cdot \psi, \text{ N},$$

G_a – full weight of the car, N

ψ – the total resistance coefficient of the road ,

$$\psi = f \cdot \cos\alpha + \sin\alpha = 0{,}018 \cdot \cos 2^0\, 181 + \sin 2\ ^0 18^1 = 0{,}058$$

$$P_f = G_a \cdot \psi \text{, N}$$

P_W - air resistance;

$$P_{W.x.} = K \cdot F \cdot \left(0{,}277 \cdot V_{a.x.}\right)^2 \text{, N}$$

F - transverse surface of the car, m ^{2};

K - coefficient of air resistance , for a passenger car;

The values of coefficients K n *and* $_K$ N *according* $_{to}$ the number of revolutions (*n*) and power (*N) are presented in table* 6.1 .

6.1 - table.

Engine types	*n* and *N* by degrees.								
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
$K_{N.x.}$ (carburetor or diesel)									
$K_{n.x.}$									

consumption of the car per hour is:

$$Q_x = \frac{K_{n.x.} \cdot K_{N.x.} \cdot g_{\ddot{e}\min} \cdot \left(N_{f.x.} + N_{W.x.}\right)}{36 \cdot \rho_{\ddot{e}} \cdot \eta_{\kappa.y} \cdot V_{a.x.}} \text{kg,}$$

here $g_{\ddot{e}\min}$ - the minimum specific fuel consumption (the coursework is selected from Table 2 and its value is obtained , i.e. $g_{\ddot{e}\min}$ = ……..g/kW·h

The calculation results are filled in table 6.2 .

6.2 .

Vehicle speed, km/h	Kuch, N		Power, kW		Fuel consumptio n, kg/s
	P_f	P_W	N_f	N_W	
10					
20					
30					
40					
50					
60					
70					
80					
90					

2. Fuel consumption of the car100 km

The fuel consumption of the vehicle is determined by the following expression;100 km

$$Q_s = \frac{K_n \cdot K_N \cdot g_{eN} \cdot \left(N_\varphi + N_W\right)}{36 \cdot \rho_ё \cdot \eta_{к.у} \cdot V_a}, \text{ l/100km}$$

6 - Practical training . Calculation of the braking characteristic of the car

Purpose of work:	- Studying the braking process of the car and solving problems.
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the coursework (project) on the basis of the Short car reference.

1. Car braking process (Fig. 7.1 a).

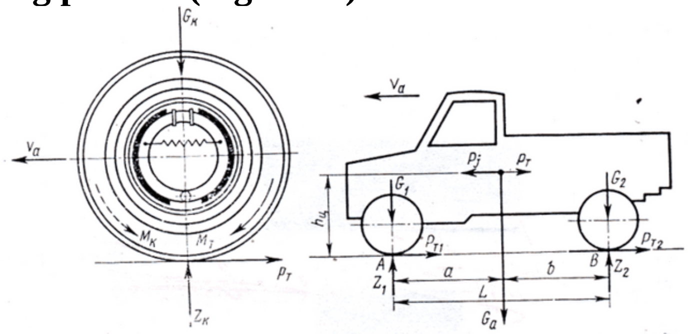


Figure 7.1. a) forces acting on the wheel when braking,
b) the forces acting on the vehicle during braking

2. Acceleration of the car during braking:

$$j_a = \frac{g}{\delta_{айл}} \cdot (\varphi + \psi + \frac{P_w}{G_a}), \text{ m/s}^2$$

3. Kinetic energy of a car traveling at a certain speed:

$$E_k = \frac{m_a \cdot V_a^2}{2},$$

here, m_a – car mass, kg;

V_a – vehicle speed, m/s.

Braking power of a speeding car to stop completely :

$$P_T = \frac{G_a \cdot V_a^2}{2 \cdot g \cdot S_T}, \text{ N}$$

5. Time and path of braking:

$$t_T = \frac{K_э \cdot V_a}{\varphi \cdot g}, \text{ s } \quad S_T = \frac{K_э \cdot V_a^2}{2 \cdot \varphi \cdot g}, \text{ m}$$

where $K_э$ – the effective coefficient of braking, φ – the coefficient of engagement between the tire and the road surface, $\varphi = 0{,}8$ is equal to

Driver reaction t_1 = 0.6-1.0 seconds.

Brake control operating time:
- for hydraulic drive t_2 = 0.03-0.05 s
- in the case of air handling, t_2 is equal to 0.2-0.4 s.

Deceleration rise time:
- for hydraulic brake t_3 =0.15-0.2 s,
- in the case of an air brake, it is around t_3 =1 c.

Full braking time :

$$t_4 = \frac{V_a}{g \cdot \varphi}, \text{ p}$$

- for hydraulic brake t_4 =0.2-0.3 s;
- for an air brake, t_4 is equal to 1.5-2.0 s.

Deceleration time t_5 =0.2-1.8 s.

6. Total braking time :

$$t_T = t_1 + t_2 + t_3 + t_4 + t_5, \text{ p}$$

7. Braking path :

$$S_T = V_a \cdot (t_1 + t_2 + t_3), \text{ m.}$$

Full braking time t_4 with the expression of Professor DP Velikanov :

$$S_4 = V_a \cdot (t_1 + t_2 + t_3) + \frac{K_э \cdot V_a^2}{2g \cdot \varphi}, \text{ s.}$$

here; $K_э$ – effective coefficient of braking .

- for trucks and buses $K_э = 1{,}2...1{,}4$.
- equal to for a passenger car . $K_э = 1{,}2$

Braking distance for a passenger car S =7.2 m; $S_{T=9.2\ m}$ for a 2-5 ton truck and $S_{T=11.0\ m}$ for a truck and bus over 5 tons .

8. Reaction forces when braking a car:

$$Z_1 = (G_a \cdot b + P_T \cdot h_M)/L$$

$$Z_2 = (G_a \cdot a - P_T \cdot h_M)/L$$

here h_M – is the height of the center of gravity , m.

R_T - braking force , N.

a, v -o are the coordinates of the centers of gravity , m

L is the base of the car, m

from the center of gravity of the car to the rear wheel axle :

$$a = L \cdot \frac{G_2}{G_a}, \text{ m.}$$

The distance from the center of gravity to the axle of the front wheels

$$в = L \cdot \frac{G_1}{G_a}, \text{ m.}$$

where G_1 and G_2 - gravity forces falling on the front and rear bridge, N.

G_a - full weight of the car, N

9. Vehicle braking power:

$$P_T = P_{T1} + P_{T2}\text{, N}$$

10. Braking forces on the axles when the car is stationary:

$$P_{T_1} = \varphi \cdot G_1\text{, N}$$

$$\text{and } P_{T_2} = \varphi \cdot G_2\text{, N}$$

11. When the car is moving:

$$P_{T_1} = \varphi \cdot Z_1\text{, N}$$

$$\text{and } P_{T_2} = \varphi \cdot Z_2\text{, N}$$

where Z_1, Z_2 - reaction forces when braking a car, N

12. Reaction forces on the wheels when the car is stationary:

$$Z_2^1 = G_a \cdot b$$

$$\text{and } Z_2^1 = G_a \cdot a$$

13. The coefficient of variation of the reaction force on the wheel:

$$m_1 = Z_1 / Z_1^1 = 1 + \varphi \cdot h_м / b,$$

$$m_2 = Z_2 / Z_2^1 = -\varphi \cdot h_м / a$$

The values of these coefficients when the car brakes are:
m_1 =1.5-2 and m_2 =0.5-0.7 should be in the range.

7-Practical training. Calculation of the stability characteristic of the car. Calculation of vehicle handling characteristics

Purpose of work:	-Study the factors affecting the stability of the car and solve problems.
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. Overturning of the car on the front and rear axis:

Determining the rollover angles of the front and rear axles of the car.

1. Determining the rollover angle on the rear axle of the car. (Fig. 8.1.a)

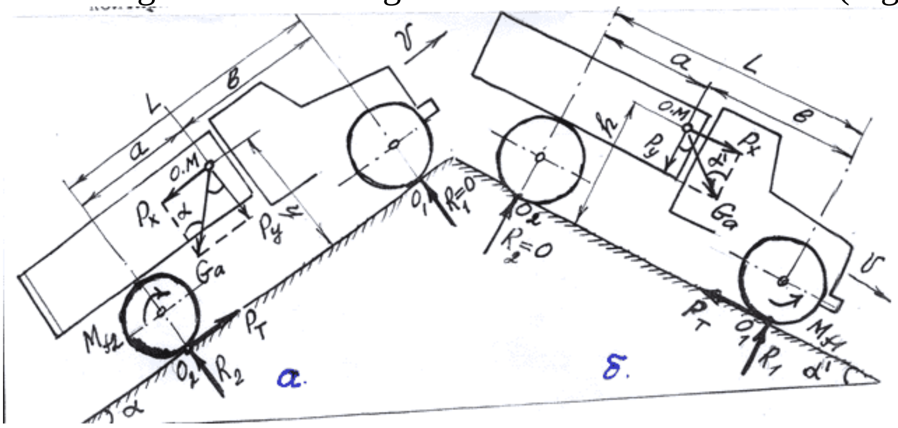


Figure 8.1, a-. With acceleration from bottom to top on an incline
a moving car.

can roll back under the influence of the force P x and the overturning moment around the support point O 2 adjacent to the road surface .

In order for the car not to overturn, the sum of the moments of the forces relative to the reference point O 2 should be equal to zero, i.e.:

$$\sum M_{o_2} = 0$$

$$P_y \cdot b - P_x \cdot h = 0 \; (1)$$

$$P_y = G_a \cdot \cos\alpha \; (2)$$

$$P_x = G_a \cdot \sin\alpha \; (3)$$

(2) and (3) into (1) ;

$$G_a \cdot \cos\alpha \cdot b - G_a \cdot \sin\alpha \cdot h = 0$$

simplifying this expression yields the following expression:

$$tg\alpha = \frac{b}{h};$$

where: b and h are the coordinates of the center of gravity.

The permissible limited overturning angle of the overturning angle,

for passenger cars: $\alpha = 45^0$ ga;

is equal to for cars and buses . $\alpha = 35 - 45^0$

In Figure 8.1.b, a car is moving with upward acceleration on a sloping road. When the car moves with acceleration from top to bottom, the car can roll forward under the influence of force P x and overturning moment about the reference point O 1 adjacent to the road surface of the front wheel.

R x and R u are equal to the sum of moments of forces equal to zero, that is;

$$\sum M_{o_1} = 0$$

$$G_a \cdot \cos\alpha' \cdot (L - b) - G_a \cdot \sin\alpha' \cdot h = 0$$

from this $\cos\alpha' \cdot (L - b) = \sin\alpha' \cdot h = 0$

$$tg\alpha' = \frac{L - b}{h} = \frac{a}{h};$$

The permissible limited overturning angle of the overturning angle,

for passenger cars: $\alpha' \geq 60^0$ ga;

is equal to for cars and buses . $\alpha' = 60^0$

To determine the rollover angles, the coordinates of the center of gravity of the car calculated in the previous experimental work (a , b , h) are taken.

Table 8.1

Model of the car	a	b	h	α	α^1

2. THE ANGLE AT WHICH THE REAR wheels can rise to a height without swaying:

Determining rollover angles on the rear axles of the car.

1. Determining the rollover angle on the rear axle of the car. (Figures 8.1.a

and 8.2)

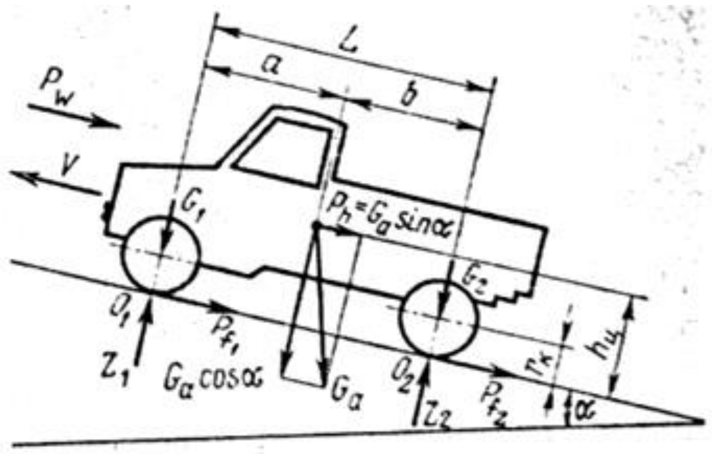


Figure 8.2. With acceleration from bottom to top on an incline a moving car.

can roll back under the influence of the force P_x and the overturning moment around the support point O_2 adjacent to the road surface .

In order for the car not to overturn, the sum of the moments of the forces relative to the reference point O_2 should be equal to zero, i.e.:

$$\sum M_{o_2} = 0$$

$$P_y \cdot b - P_x \cdot h = 0 \quad (1)$$

$$P_y = G_a \cdot \cos\alpha \quad (2)$$

$$P_x = G_a \cdot \sin\alpha \quad (3)$$

(2) and (3) into (1) ;

$$G_a \cdot \cos\alpha \cdot b - G_a \cdot \sin\alpha \cdot h = 0$$

simplifying this expression yields the following expression:

$$tg\alpha = \frac{b}{h};$$

where: b and h are the coordinates of the center of gravity.

Permissible limited overturning angle of the overturning angle, for passenger cars: $\alpha = 45^0$ ga;

is equal to for cars and buses . $\alpha = 35....45^0$

To determine the overturning angles, the coordinates of the center of gravity of the car calculated in the previous experimental work (a , b , h) are taken (table 8.2).

Table 8.2

Model of the car	a	B	h	α

3. Stability of the car in the transverse plane:

the angle that allows the car moving on a transverse inclined plane to move without being pushed to the side or overturning β represents the transverse stability of the car. (Figure 8.3).

Vehicle O_1 around the reference point $P_x = G_a \cdot \sin\beta$ can be overturned transversely (to the side) under the influence of force and overturning moment.

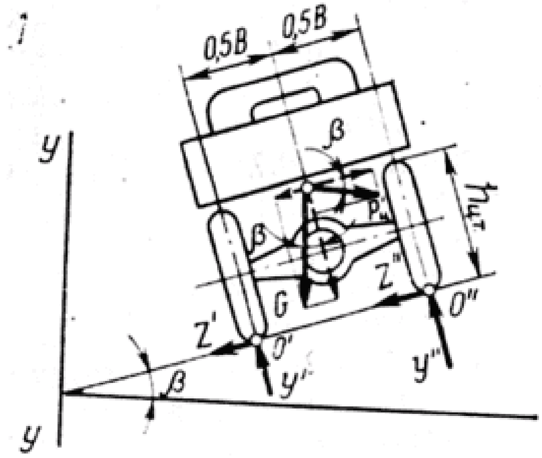


Figure 8.3. Transverse stability of the car.

In order for the car to move without sliding to the side, the moments of R_x and R_u forces should be equal to O *, that is;*

$$P_x \cdot h - 0{,}5 \cdot P_y \cdot B = 0 \ (1)$$

in this
$$P_x = G_a \cdot \sin\beta \ ; (2)$$
$$P_y = G_a \cdot \cos\beta \ ; (3)$$

(2) and **(** 3 **)** and (1) we put in;

$$G_a \cdot \sin\beta \cdot h - 0{,}5 \cdot B \cdot G_a \cdot \cos\beta = 0$$

from this we determine the angle of inclination;

$$tg\beta = \frac{0{,}5 \cdot B}{h};$$

where: *V* is the distance between the rear wheels,

for a car $\beta \geq 45^0$,

for trucks and buses $\beta = 35^0$.

We write the calculated results in table 8.3.

Table 8.3

Car model	B	h	β

4. The critical speed of the car on the rollover in the turn:

Determining the critical speed of a car turning on a slope for overturning when the turning center is at the bottom of the slope and at the top of the slope (Fig. 8.4).

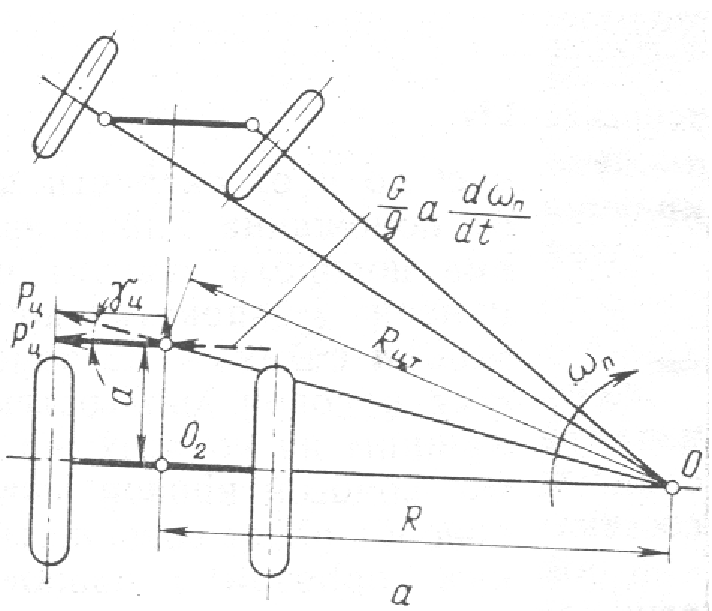


Figure 8.4. Q is the center of rotation of the car in the plane placement above and below.

1. When the turning center of the car is located below the slope when the car is turning on an inclined plane, the critical speed of the car for overturning while turning along the curve is determined by the following expression:

$$V_{a.\max} \le \sqrt{g \cdot R \cdot \frac{B + 2 \cdot h \cdot tg\beta}{2 \cdot h - B \cdot tg\beta}}, \quad (1)$$

2. If the center of the turn is located above the slope of the inclined plane, the critical speed of the car for overturning in the turn is determined by the following expression:

$$V_{a.\max} \le \sqrt{g \cdot R \cdot \frac{B - 2 \cdot h \cdot tg\beta}{2 \cdot h + B \cdot tg\beta}}, \quad (2)$$

the turning radius R is large $B \ge h$ and the turning center is located below the slope, the stability of the car in the turn will be stronger.

3. If the car is turning on a plane, the maximum critical speed before the car overturns during the turn is determined by the following expression:

$$V_{a.kp} = \sqrt{g \cdot R \cdot B / 2 \cdot h}, \quad (3)$$

Table 8.4

Car model	R	B	H	$tg\beta$	$V_{a.max}$	$AND_{a.kp}$

3. **The critical speed of the car on the slide:**
is equal to the angle of inclination of the road =0 β

$$V_{kr} = 2.21 \cdot \sqrt{d \cdot R / h_м - R} \ge V_{a\max} \text{ m/s } (1)$$

where V is the front of the car distance between wheels , m
R is the turning radius of the car 's axle , m
h_m - the distance from the center of gravity of the car to the road surface , is

determined as follows :

H_m =0.75· B for trucks on the cross road of the car h_m =0.75· If the turning center is located above the slope when turning B , its critical speed is determined by the following expression in order for the car to move along a curved line on an inclined plane without skidding to the side:

$$V_{kr} = \sqrt{g \cdot R \cdot \frac{b + 2 \cdot h_m \cdot tg\beta}{2 \cdot h_m - b \cdot tg\beta}} \geq V_{amax} \quad (2)$$

3. If the car is located at the bottom of the slope while turning on a transverse road, its critical speed is determined by the following expression in order for the car to move along a curved line on an inclined plane without sliding to the side and overturning:

$$V_{kr} = \sqrt{g \cdot R \cdot \frac{B - 2 \cdot h_m \cdot tg\beta}{2 \cdot h_m + B \cdot tg\beta}} \geq V_{amax} \quad (3)$$

where $\beta = 8^{1}\,12^{0}$ is the slope angle of the road;

$V_{a.max}$ is the maximum speed of the car, m/s

R = 300 - 1000 m - in the mud of the roads q iya y o' radii of twist sh .

Calculation of vehicle handling characteristics.

Purpose of work:	- Understanding and solving problems about the controllability of the car.
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. Tire sidewall push and push:

The distance from the turning center to the longitudinal axis of the vehicle is the turning radius R *in the case of no slippage of the wheels of the vehicle* (Fig. 9.1).

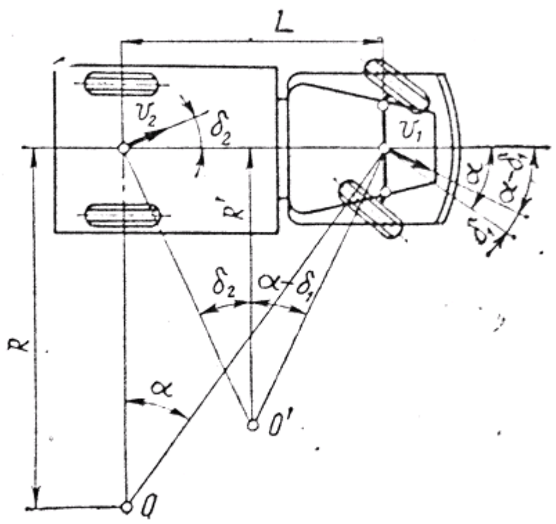


Figure 9.1. When there is no tire sideslip
car turning.

The transverse effect of the centrifugal force acting on a car moving in a straight line during a turn:

$$P_y = \frac{G_a V_a^2}{gR}, \text{ N.}$$

Lateral reaction forces of the road acting on the front and rear axles of a car moving straight in a turn:

$$R_{y_1} = \frac{G_1 V_a^2}{gR}, \text{ N.}$$

$$R_{y_2} = \frac{G_2 V_a^2}{gR}. \text{ N}$$

here ; G_1, G_2 - weight forces on the front and rear axles;
V_a - speed of the car; R - turning radius; g is the velocity of free fall.

Slip angle:

$$\delta_1 = \frac{P_y}{K_c},$$

here; K_s is the coefficient of sliding resistance.

- $_s$ =60-150 kN /rad for trucks and buses ;
- for car tires, K_s =is equal to 15-40 kN rad./

R **for an inelastic wheel** :

$$R = \frac{L}{tg\theta_T}, \text{ m.}$$

here is θ_T the turning angle of the outer wheel, grad.

Critical speed: (formula of Prof. VMPevzner):

$$V_{кр} = 3{,}6\sqrt{\frac{gL}{\frac{G_2}{K_{c2}} - \frac{G_1}{K_{c1}}}}, \text{ m/s}$$

here; L - car base;
G_1, G_2 - loading of the front and rear wheels;
K_{s1}, K_{s2} - coefficients of sliding resistance of front and rear cars.
Deflection of inelastic wheels: (Fig. 9.2.)

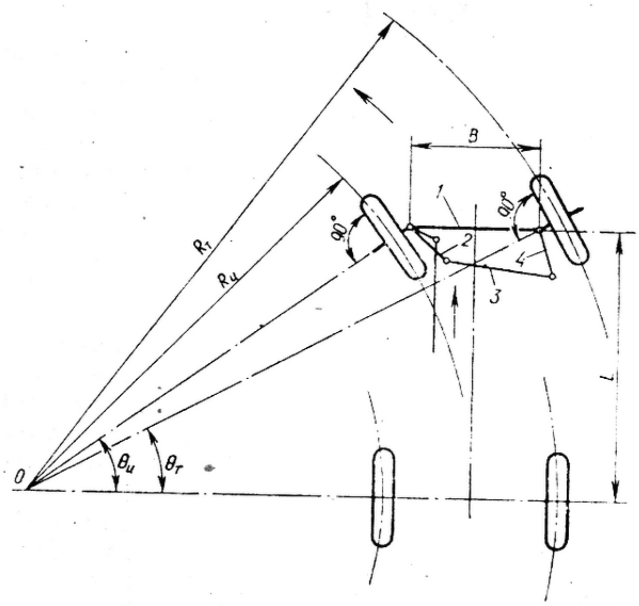


Figure 9.2. Deflection of an inelastic vehicle wheel.

1-2-3-4 steering trapezium; R_i, R_T - turning radii of the controlled inner and outer wheels; $\theta_И, \theta_T$ – steering angles of inner and outer wheels; *O* - turning center of the car; *R* - turning radius; *V* - the distance between the shafts; *L* - the base of the car.

Front wheel turning angles:

$$ctg\theta_T = \frac{R+b}{L}; \; ctg\theta_И = \frac{R-b}{L};$$

The equation for pure wheel rolling is:

$$ctg\theta_T - ctg\theta_И = \frac{2b}{L}$$

8-Practical training. Calculation of the car's handling and smoothness characteristics.

Purpose of work:	- Understanding and solving problems about the smoothness of the car.
Required tools:	- Ruler, pencil, eraser and calculator

How to do the exercise:

We record the initial data of the given car according to the option order of the course work (project) based on the Short car reference.

1. The arrogance of the car:

The values of the given radii are determined graphically as follows:

The turning radius of the vehicle in the longitudinal plane is the radius of the circle that the front and rear wheels of the vehicle try to pass.

To determine this radius, the radius of the wheels is determined based on the given distance of the vehicle base (L), the wheels are drawn on the scale, and a circle is tentatively drawn on these wheels, and its radius is r_1 (Fig. 9.1).

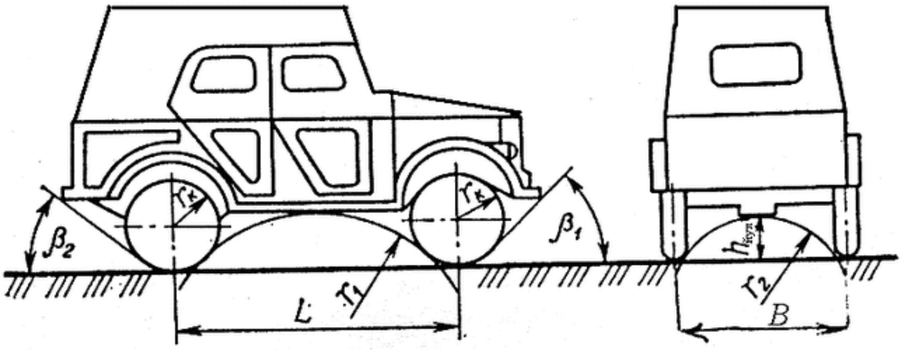


Figure 9.1. Longitudinal (r_1) and transverse (r_2) displacement of the car form of determination of radii.

The turning radius of the vehicle in the transverse plane is the radius of the circle tentatively transferred to the rear wheels of the vehicle and the lowest point of the rear axle of the vehicle.

The average radius of a car wheel is determined by the following expression:

$$r_F = 0,5 \cdot d + b \cdot \left(1 - \lambda_{ш}\right), \text{ m}$$

where : d - the diameter of the tire entering the disc, m;

b - tire width, m;

A circle of the wheel is drawn on the specified radius r_F.

Figure 9.1

Car model	Given						It counts			The limiting value of r_1
	L	V	b	d	l_{sh}	h_{road}	r_F	r_1	r_2	

Values of the longitudinal radius of curvature:

for cars with an average capacity: up to 3.5-5.5 meters,

for cars with small displacement: up to 2.5-3.5 meters,

for small lift trucks: up to 2.5-3.5 meters,

for vehicles with an average carrying capacity: up to 3.0-5.5 meters,

large lifting capacity for cars: up to 5.0-6.0 meters.

2. The largest vibration path (amplitude)

$$Z_{max} = \frac{2m \cdot g}{C},$$

here, t is the elapsed time after the start of oscillation, s;

S - the stiffness of the spring.

swing speed:

$$v = Z_{max} t \cdot \omega \cdot Cos\omega, \text{ m/s;}$$

vibrational acceleration:

$$j = -Z_{max} \cdot t \cdot \omega^2 \cdot Sin\omega, \text{ m/s}^2;$$

rate of increase in acceleration:

$$j' = -Z_{\max} \cdot t \cdot \omega^3 \cdot Cos\omega,\ \text{m/s}^3;$$

oscillation period:

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{c}{m}}},\ \text{s};$$

number of oscillations per minute (frequency) of the system:

$$n = \frac{60}{T} = \frac{30}{\pi} \cdot \sqrt{\frac{c}{m}},$$

The stiffness of the spring *S* is determined by the static displacement (deformation) of the spring, i.e

$f_{cm} = \frac{G}{C}$ and the number of oscillations $C = \frac{G}{f_{cm}}$ is $m = \frac{G}{g}$:

$$n = \frac{30}{\pi} \cdot \sqrt{\frac{g}{f_{cm}}} \approx \frac{300}{\sqrt{f_{cm}}},\ \text{vibration/min}$$

The static deformation of the spring is as follows according to the type of car:

For cars f_{cm} = 100- 250 mm;

For f trucks $_{\text{cm}}$ = 60- 120 mm;

For buses f_{cm} = 100- 200 mm.

LIST OF LITERATURE

Basic literature

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

Additional literature

1. Vakhlamov. VK "Automobili: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
2. Sidiqnazarov KM and dr. The car is in a new transport environment. T: 2007-188 p.
3. Ivanov. AM and dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.
4. Vakhlamov. VK "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.

5. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992

6. Mamatov.Kh, Turdiev.Yu, Kadirkhanov.M Fundamentals of automobile design and theory. Tashkent. "Teacher" 1982.

7. SM Kadyrov. MOQodirkhanov. Theory of engines and cars. Tashkent. Teacher. 1982

8. Kadyrov. SM Tiko car structure, troubleshooting and repair. Tashkent, "Teacher", 2001.

9. Kadirkhanov.MO Car processes and accounting Tashkent. "Teacher" 2003.

10. Carroll E. Goering, Marvin L. Stone, David W. Smith, Paul K. Turnquist. " Off-Road vehicle Engineering principles " , American Society of Agricultural Engineers, 2006.

11. David A. Crolla. "Automotive Engineering Powertrain, Chassis System and Vehicle Body", Amsterdam, Butterworth-Heinemann is an imprint of Elsevier, 2009.

12. Engineering Principles of Agricultural Machines Ajit K. Srivastava Michigan State University Carroll E. Goering University of Illinois Roger P. Rohrbach North Carolina State University Dennis R. Buckmaster The Pennsylvania State University Copyright 2006 by the American Society of Agricultural and Biological Engineers All rights reserved.

13. Sites where Internet information can be obtained:

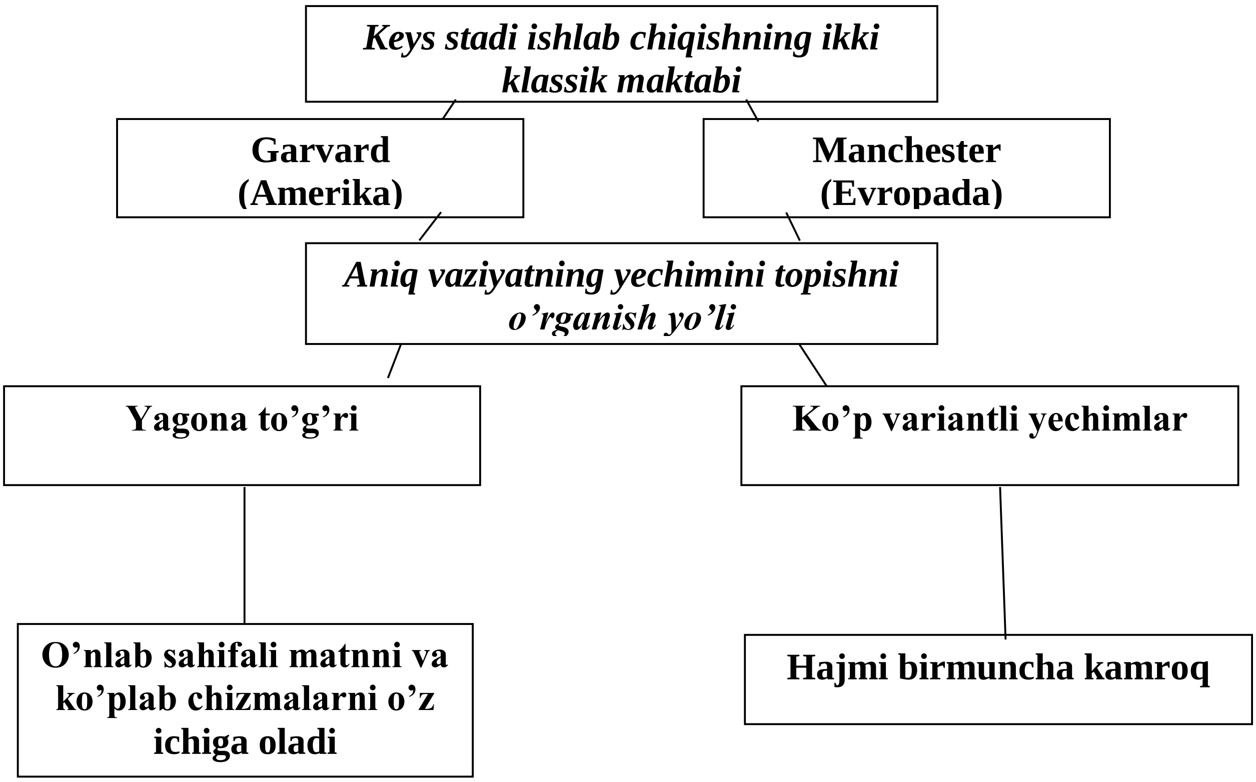
http://ru.wikipedia.org/wiki/'Avtotransportnoe_predpriyatie
http://www.mobilautotrans.ru
http://www.autoelectric.ru
http://www.mosautolab.ru
http://uzavtosanoat.uz /

COLLECTION OF CASES ON LABORATORY WORKS

Case -study is a method of education based on study, analysis of specific situations and achievement of socially significant results. This method, unlike the problem-based learning method, is based on making clear decisions based on the study of real situations. If it is used as a way to achieve a certain goal in the educational process, it has a methodological character, if it is carried out step by step in the study of a process, based on a certain algorithm, it has a technological aspect. reflects

This method was first used in 1920 at Harvard Business *School* . Harvard Business School faculty are quick to realize that there is no adequate textbook for a graduate business department. To solve this problem, the first step taken by the teachers of the business school was to interview leading business practitioners and write a detailed report on the activities of these managers and the factors affecting it. The lecture was presented to the listeners in the form of finding a solution based on a concrete situation faced by this or that organization, analyzing this situation and organizing a discussion independently or as a team. Later, the case method was widely promoted in business educational institutions. Nowadays, from the point of view of professional competence development, supporters of this method are increasing. Since the 1950s, business cases have become popular in Western European countries. Leading European business schools INSEAD , LBS , HEC , LSE , ESADE and others not only teach based on the case-study method, but also actively participate in the creation of cases.

Case study schools



CASE TYPOLOGY I

Typological signs	K ace type
Main sources i	**1. Conducted directly at the facility** **2. Education in process** **3. Scientific research**
The presence of the system	**1. The plot** **2. It 's you**
And the consistency of the account of suffering in time	**1. A case based on connecting the past and the present** **2. A case based on the reality that happened before** **3. Prospective case**
Case object	**1. Specific object oriented** **2. Organizational - institutional** **3. Multi-objective**
Method of presenting the material	**1. Story** **2. Essay** **3. Analytical information** **4. Journalistic investigation** **5. Report** **6. Essay** **7. Set of facts** **Collection of statistical materials** **9. A set of documents and production samples**
Size	**1. Short** **2. Medium in size** **3. Big**
Structural features	**1. It has a clear structure** **2. Not having a clear structure**
The method of presentation of the educational task	**1. Questionable** **2. Assignment style**
Didactic objectives	**1. Explain a problem, solution, or concept** **2. A training session dedicated to a topic / designed to develop skills and competencies in a subject** **3. Teaching analysis and evaluation** **4. Separating and solving the problem, teaching to make management decisions**
According to the method of presentation	**1. Print** **2. Electronic** **3. Video case** **4. Audio case** **5. Multimedia case**

1. Current situation

Cars have entered our lives so much that it is hard to imagine life without them. Today, in particular, transportation of raw materials and finished products, open pit mining of coal and ore, industrial construction of residential buildings and industrial enterprises, transportation of cargo, fertilizers and various products necessary for agriculture, wide demand Cars are used for timely delivery of goods directly to consumers and for other purposes. In addition to trucks, passenger cars are also very important in the daily life of the people of our country.

Where and when was the first car created, what was the vehicle before cars? When were engines created as a source of motion? What types of engines are there? Let's take a look at the history of the car to find answers to questions like what cars are being made today and so on.

The word "car" is a combination of the Greek words "autos" - self and Latin "mobilis" - moving, meaning "Self-moving". A car is a ground-moving vehicle, equipped with an engine with an independent energy source, and designed for the transportation of goods and people on non-rail roads with great comfort and safety. This description of the car distinguishes it from other vehicles.

Problem case. Question: What is the role and importance of the car in human life today? How the car prospects were achieved.

2. Existing situation

The city of Mannheim, located on the banks of the Rhine River in Germany, is considered the birthplace of the world's first automobile: in the spring of 1885, Karl Benz created a three-legged self-propelled carriage equipped with an internal combustion engine.

Benz's engines were in high demand and he dreamed of installing his engines in cars. Bents could not find a like-minded person and sponsor to realize this dream. Bents, unable to fulfill his dream in this company, is forced to sell his shares and leave the company.

Problem case. Question: How did Carl Benz get out of the situation? Has it been effective in the past?

3. Current situation.

Currently, one of the issues that will give the first impetus to the market economy is the establishment of the automobile industry in our republic and the regular development of this sector.

Problem case. Question: During the Russian Empire, why weren't automobile manufacturing enterprises built in our Russian republic?

4. Current situation.

In 1993, when our president Islam Karimov paid an official visit to South Korea, he paid special attention to this issue, as a result, the automobile company " *Asaka-DEU* " began to be established in our republic in cooperation with the Korean state. In cooperation with *DEU Corporation* of South Korea, an agreement was signed on assembly and production of small and medium-sized passenger cars and minibuses in our republic.

Problem case. Question: What made us produce cars in our country?

5. Current situation.

An engine is a machine that converts the chemical heat generated by the combustion of the working mixture into mechanical energy and uses energy to move the vehicle.

Assignment case. Question: What are the types of internal combustion engine structure?

MUSTA Q IL EDUCATIONAL COURSES

MUSTA Q IL EDUCATIONAL COURSES

A tentative list of recommended independent work topics. Content and scope of independent education of students

No	Independent study topics	Assignments given	done term	Size (at the hour) YeUTTUE, direction
1	The history of the creation of the car	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
2	The history of the creation of hybrid cars	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
3	History of automotive industry in Uzbekistan	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
4	Prospects of the automotive industry in Uzbekistan	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
5	History and prospects of the Samarkand Automobile Plant	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
6	History and perspective of GM Power train Uzbekistan automobile plant	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
7	History and prospects of the GM Uzbekistan automobile plant	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
8	History and perspective of MAN Avto Uzbekistan automobile plant	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
9	Development trend of car construction	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
10	Problems of disposal of old cars	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
11	Types of cars	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2

12	Advantages and disadvantages of cars with different components	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	2
13	Leading car manufacturers of the world	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
14	Evolution of the car engine	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
15	Engine fuel injection system	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
16	Common Rail supply system	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
17	Environmental characteristics of the car	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
18	Harmful substances in the exhaust gases of car engines	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
19	Catalytic neutralizers	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	2
20	The car is a source of noise and vibration	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
21	Structural failure of the car	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
22	Car bodies	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
23	Central tire pressure adjustment system	Summarizing from the literature. Fulfilling individual tasks	In the specifie d week	4
24	Anti-blocking system	Summarizing from the literature. Carrying out individual tasks	In the specifie d week	4
total				72 hour

No	Independent study topics	Assignments given	done mudd at	Size (at the hour) YeUTTUE, direction
1.	Grouping of loads and classification of specialized vehicles	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
2.	Vehicle coupling devices	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
3.	Analysis of the composition of dump trucks	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
4.	Analysis of the lifting mechanism of automobile dump trucks	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
5.	Rolling metal rolling stock vehicles	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
6.	Pipeline trains	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
7.	Trucks carrying heavy loads	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
8.	Motor trains carrying construction structures	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
9.	Trucks transporting forest metals	Summarizing from the literature. Fulfilling individual tasks	Designated week34a	2
10	Oil tankers	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1

11	Tanks carrying volatile cargo	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1
12	Food tankers	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1
13	Self-loaders with loaders	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
14	On-board self-loaders with removable bodies	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
15	Container carriers	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
16	Isothermal vans	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
17	Refrigerated vans	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
18	Design factors affecting drag-speed characteristics	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1
19	Operational factors affecting drag-speed characteristics	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1
20	Factors affecting fuel economy characteristics	Summarizing from the literature. Fulfilling individual tasks	In the specified week	1
21	Factors affecting braking properties	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2

22	Factors affecting controllability	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
23	Factors affecting the stability characteristic	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
24	Factors that influence the nature of turgidity	Summarizing from the literature. Fulfilling individual tasks	In the specified week	2
total				36 hours
Grand total				108

1-Independent work.
Topic: Development of automotive industry in Uzbekistan.

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information:

- prospects for the development of the automobile industry in our republic at the moment and cooperation agreements with the Republic of Uzbekistan and Korea on the initiatives of our resident IAKarimov . Establishment of a car factory together with UzD E U Avto "Uzvtosanoat" enterprises .
- z avod is equipped with state-of-the-art equipment and its production capacity (by years) and manufactured car models (by years) .
- Signing of joint cooperation agreements with own industry and Turkey's *Kochholding* organizations and the models of buses and trucks produced in Uzbekistan with these organizations (by years).
- Use of cars imported from Russia, Germany, America, Japan and other countries in various fields of our industry and car models .

2- Independent work.
Topic: Motor transport and environmental protection.

When performing independent work on a given topic, the student prepares a written report on the following questions based on literature and Internet information:

- composition of gases emitted from internal combustion engines and their impact on the environment.
- amounts of toxic gases emitted from carburetor and diesel engines and ways to reduce them.

- the effect of the amount of toxic gas emitted from the engines on human health and the types of diseases caused by it.
- modern equipment and devices used to reduce the amount of toxic gases emitted from engines.
- prospects for the development of electric cars, cars and engines with a low impact on the environment and human health.

3-Independent work.
Topic: Structure, operation of rotor-piston engines.

When performing independent work on the topic, the student prepares a written report on the following questions based on literature and Internet information:

- function, structure and operation of rotor-piston engines.
- disadvantages and advantages of rotor-piston engines.
- development prospects of rotor-piston engines.

4- Independent work.
Topic: The structure and operation of a gas turbine dvinatel.

When performing independent work on the topic, the student prepares a written report on the following questions based on literature and Internet information:

- the history of the use of gas turbine twin turbines.
- function, structure and operation of a gas turbine engine.
- two-wheel gas turbine car models.
- disadvantages and advantages of gas turbine dvinatel.
- ways to eliminate defects of a gas turbine dvinatel.
- prospects for the development of gas turbine dvinatel.

5-Independent work.
Topic: Structure, operation of a two-stroke carburetor engine.

When performing independent work based on the given topic, the student prepares visual aids and posters using literature and Internet information based on the following questions:

- the function, structure, operation of a two-stroke carburetor engine
- car models with a two-stroke carburetor engine
- disadvantages and advantages of two-stroke carburetor engines
- ways to eliminate defects of two-stroke carburetor engines
- development prospects of two-stroke carburetor engines

6- Independent work.
Topic: Structure of the engine air cooling system, prospects.

When performing independent work based on the given topic, the student prepares basic word phrases using literature and Internet information based on the following questions:

- structure, operation of the air cooling system of the engine
- car models with air-cooled engines
- disadvantages and advantages of the air cooling system of the engine
- ways to eliminate the defects of the air cooling system of the engine
- prospects for the development of the engine air cooling system

7-Independent work.
Topic: Structure and operation of engine crankcase ventilation.

When performing independent work based on the given topic, the student prepares visual aids and posters using literature and Internet information based on the following questions:

- function, structure, operation of the engine crankcase ventilation device
- car models with an engine crankcase ventilation device
- disadvantages and advantages of the engine crankcase ventilation device
- ways to eliminate defects of the engine crankcase ventilation device
- prospects for the development of the engine crankcase ventilation device

8-Independent work.
Topic: Structure and operation of the injector supply system.

When performing independent work on the topic, the student prepares a written report on the following questions based on literature and Internet information:

- history of use of injector supply systems.
- function, structure and operation of injector supply systems.
- car models with injector supply system.
- advantages and disadvantages of injector supply systems.
- ways to eliminate defects of injector supply systems.
- development prospects of injector supply systems.

9-Independent work.
Topic: Alternative fuels, their prospects.

When performing independent work based on the given topic, the student prepares a report using literature and Internet information based on the following questions:

- function, structure and performance of alternative fuel vehicles.
- alternative fuel car models.
- disadvantages and advantages of alternative fuel vehicles.
- development prospects of alternative fuel vehicles.

10-Independent work.
Topic: Construction of a multi-mode tuner.

When performing independent work based on the given topic, the student prepares a report using literature and Internet information based on the following questions:

- the function, structure and operation of a multi-mode adjuster
- car models with multi-mode adjuster
- disadvantages and advantages of multi-mode adjuster
- ways to eliminate the defects of the multimode adjuster
- development prospects of the multi-mode adjuster

11-Independent work.
Topic: Structure, operation of hydraulic clutch.

When performing independent work based on the given topic, the student prepares a handout based on the following questions using literature and Internet information:

- the function, structure and operation of the hydraulic coupling
- car models with hydraulic clutch
- disadvantages and advantages of hydraulic coupling
- ways to eliminate defects of the hydraulic coupling
- prospects for the development of hydraulic coupling

12-Independent work.
Topic: Structure and operation of a hydrotransformer.

When performing independent work based on the given topic, the student prepares a questionnaire based on the following questions using literature and Internet information:

- the function, structure and operation of the hydrotransformer
- hydrotransformer car models
- disadvantages and advantages of the hydrotransformer
- ways to eliminate defects of the hydrotransformer
- prospects of hydrotransformer development

13-Independent work.
Topic: Structure, operation of a large friction differential.

When performing independent work based on the given topic, the student prepares visual aids and posters using literature and Internet information based on the following questions:

- the function, structure and operation of a large friction differential

- car models with a large friction differential
- disadvantages and advantages of a large friction differential
- ways to eliminate the defects of the high-friction differential
- prospects for the development of a large friction differential

14-Independent work.
Topic: Structure, operation of interaxle differential.

When performing independent work based on the given topic, the student prepares schemes using literature and Internet information based on the following questions:

- the function, structure and operation of the inter-axle differential
- car models with inter-axle differential
- disadvantages and advantages of the inter-axle differential
- ways to eliminate defects of the inter-axle differential
- prospects for the development of the inter-axle differential

15-Independent work.
Topic: Function, types, operation of power steering.

When performing independent work based on the given topic, the student prepares a test based on the following questions using literature and Internet information:

- function, structure, operation of power steering
- models of cars with power steering
- disadvantages and advantages of power steering
- ways to eliminate defects of the power steering
- prospects for the development of power steering

16-Independent work.
Topic: Pressure hydraulic brake mechanism structure, operation of the adjuster.

When performing independent work based on the given topic, the student prepares a test using literature and Internet information based on the following questions:

- function, structure, operation of pressure adjuster of hydraulic brake mechanism
- car models with hydraulic brake mechanism pressure adjuster
- disadvantages and advantages of pressure adjuster of hydraulic brake mechanism
- ways to eliminate the defects of the pressure adjuster of the hydraulic brake mechanism
- prospects for the development of the pressure adjuster of the hydraulic

brake mechanism

Part 2 (Theory of operational characteristics of vehicles)

17-Independent work.
Topic: Methods of calculating the external speed description of the engine, their comparative analysis

17.1-Independent work.
Topic: The history of creation of the theory of operational characteristics

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information:

- the history of the creation of the theory of operational characteristics.
- the leading scientists of the Republic of Uzbekistan in the creation of the theory of operational characteristics and the literature published by them.
- operational characteristics of the car.

17.2-Independent work.
Topic: Description of the external speed of the engine.

will answer the following questions in writing on the basis of literature and Internet information on determining the external speed characteristics of the **Matiz-Chevrolet (*Best-5M/T*) light car engine:**

Vehicle by option: model ***Matiz-Chevrolet*** .

Full mass, m_a =1230 kg; Net weight m_0 = 855 kg ; Carrying capacity m_{load} = 104 kg ; He is a passenger $m_{y\ o'\ lovch}$ = 271 kg ; Height H = 1 , 485 m; Track V_1 =1 , 315 m ; Base L =2 , 340 m; Maximum walking speed, $V_{a\ max}$ =15 2 km/h; The greatest height H =1,393 m; The largest width, V_1 =1,662 m ; The number of crankshaft revolutions at maximum power n_N =5600 rev/min ; Maximum q power N_{emax} =45.5 kW ; Maximum screw torque M_{emax} =87.3 N·m.

Determining the maximum power of the engine when the Matiz-Chevrolet car moves at maximum speed:

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

$$N_{ev\max} = \frac{G_a \cdot \psi \cdot V_{a\max}}{1000 \cdot \eta_{ku}} + \frac{W \cdot \left(V_{a\max}\right)^3}{1000 \cdot \eta_{ku}}, \text{kW}$$

17.3-Independent work.

Topic: To determine the power of the Matiz-Chevrolet engine at the desired number of revolutions

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

$n_1 = n_{min}$ =500 rpm ; n_2 =0.2· n_N , rpm ; n_3 =0.4· n_N , rpm ; n_4 =0.6· n_N , rpm ; n_5 =0.8· n_N , rpm ; n_6 =0.9· n_N , rpm ; n_7 =1.0· n_N , rpm ; n_8 =1.1· n_N , rpm ; $n_9 = n_{max}$ =1.2· n_N , rev/min .

$$N_{ex} = N_{eV\max} \cdot \frac{n_x}{n_N} \cdot \left[a + в \cdot \frac{n_x}{n_N} - c \cdot \left(\frac{n_x}{n_N} \right)^2 \right], \text{ k W}$$

17.4-Independent work.
Topic: Matiz-Chevrolet car engine torque determination for the desired number of revolutions

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

$$\mathrm{M}_{ex} = 9554 \cdot \frac{\mathrm{N}_{ex}}{n_N}, \text{ Nm} \cdot .$$

17.5-Independent work.
Topic: Determination of the relative fuel consumption of the Matiz-Chevrolet engine at the desired number of revolutions

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

$$g_{yoN} = \frac{3.6 \cdot 10^3}{Q_n \cdot \eta_e}, \text{ g/ k W} \cdot \text{s}$$

$$g_{yo.x} = g_{yo.N} \cdot \left[a - в \cdot \frac{n_x}{n_N} + c \left(\frac{n_x}{n_N} \right)^2 \right], \text{ g/ k W} \cdot \text{s}$$

17.6-Independent work.
Topic: Determination of hourly fuel consumption of a Matiz-Chevrolet engine at the desired number of revolutions

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

$$G_{yox} = 10^{-3} \cdot g_{yox} \cdot N_{ex}, \text{ kg/h} .$$

17.7-Independent work.
Topic: Building a table according to the external speed characteristics of the Matiz-Chevrolet car engine

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information, drawing a graph:

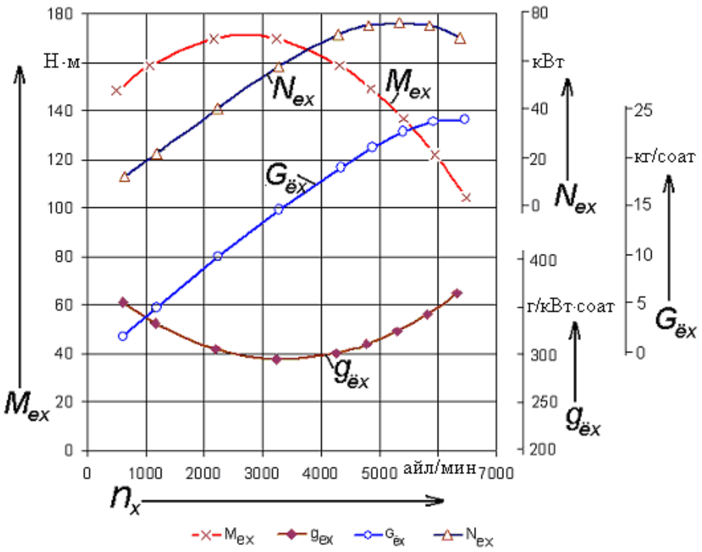
table

No	The number of	Indicators of external speed description.

	revolutions of the crankshaft n_x, rpm	Ex, (kW)	M_{ex}, (N·m)	g_{ex}, (g/kW·s)	$_{No}G$, (kg/h)
1.					
2.					
.. .					
8 .					

17.8-Independent work.
Topic: Graphic construction of Matiz-Chevrolet engine according to external speed characteristics

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information, drawing a graph:



Matiz-S h eurolet car engine external speed characteristic graph.

17.9-Independent work..
Topic: Traction-speed characteristics

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information:

- car dynamics.
- fuel economy.
- vehicle handling.
- vehicle stability.
- ability to pass road obstacles.
- smoothness of walking.
- traffic safety.

18-Independent work.
Topic: Solving the differential equation of car motion.

To solve the differential equation of motion of the car, we use the following equation:

$$P_T - P_f - P_\alpha - P_W - P_{ja} = 0 \text{ or } P_T = P_f + P_\alpha + P_W + P_{ja}$$

Through the equation, we solve each of its indicators with the help of problems.

When the car is moving in straight gear, the torque in the engine is 20 N·m, and the wheel radius is 0,32 m; transmission factor 0.9; the number of gears of the main gear is 4. Determine the traction force on the wheel.

Answer: P_T =225 N.

The front surface of the car 1,5 m^2, the air resistance coefficient is 0.4 N·s^2/m^4, the speed is 90 km/h. Determine the force of air resistance.

Answer: P_w =375 N.

A car weighing 28000 N moves in a straight gear with an acceleration of 0.42 m/s^2. Determine the force of resistance to acceleration of the car.

Answer: P_{ja} =1300 N.

The total weight of the car is 35500 N, the coefficient of resistance to wheel rolling is 0.018 for an asphalt road. Determine the rolling resistance force of the wheel.

Answer: P_f =639 N.

The total weight of the car is 8800 N, the angle of inclination is 10^0. Determine the force of resistance to the car's elevation.

Answer: P_a =1536 N.

19-Independent work.
Topic: Types of brake retarders, operation.

When performing independent work based on the given topic, the student prepares visual aids and posters using literature and Internet information based on the following questions:

- function, types, structure and operation of brake retarders
- car models with brake retarder and brake system equipment
- advantages and disadvantages of brake retarder and brake system devices
- ways to eliminate defects of brake retarder and brake system equipment
- development prospects of brake retarder and brake system equipment.

20-Independent work.
Topic: Structure, operation of anti-lock devices in the brake system

When performing independent work based on the given topic, the student prepares visual aids and posters using literature and Internet information based on the following questions:

- function, types, structure and operation of anti-lock devices in the brake system.
- car models with anti-lock braking system
- disadvantages and advantages of anti-lock devices in the braking system
- ways to eliminate defects of devices with anti-blocking devices in the braking system
- prospects for the development of anti-block devices in the braking system.

21-Independent work.

Topic: Influence of vehicle design and operating conditions on fuel economy. Abstract

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information:

Tico's car $V_a = 35$ is moving with a speed of m/s. In this case, $G_ё = 10,3$ kg/h. Determine the amount of fuel used by the car 100 kmto cover the distance in kg and liters.

Hourly fuel consumption of $G_ё = 20,3$ KamAZ-5320 when moving at a speed of m/s in $V_a = 25$ kg/h. Determine the amount of fuel consumed by the car for 1 t·km of work. Let YUK $K = 0,8$ be taken as the coefficient of utilization of buoyancy.

22-Independent work.

Topic: Writing an abstract based on Internet information.

When performing independent work, the student prepares a written report on the following questions based on literature and Internet information based on information for one of the sections of the following questions:

Recommended topics.

1. Development prospects of electric cars.
2. Cars with hybrid engines.
3. Gas-diesel cars.
4. Cars with jet engines.
5. The history of the creation of the diesel engine and its founder.
6. The history of the creation of the carburettor engine and its principles.
7. History of injection engine creation and its founders.
8. Motor-wheeled vehicles.
9. Cars with heavy duty.
10. Improving the aerodynamic characteristics of cars

23-Independent work.

Determination of stability of the car in the transverse plane. Problem solving

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

Determine the limit angle of transverse stability using the technical indicators of the Nexia car?

The chassis of the ZIL-130 car 1,7 m. Determine the limit angle of transverse stability for cases where $\beta_{чег} = f(h)$the height of the center of gravity is $h = 1{,}0$ м, 0,8 m, and 0,6 mdraw a graph.

Determine the probability that a moving car will overturn on its side under the conditions of the road adhesion coefficient . $\varphi = 0{,}5$Car track $B = 1{,}8$ м, height of the center of gravity $h = 1{,}2$ м.

24-Independent work.
Overturning of the vehicle on the front and rear axles Problem solving

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

The coordinate of the car's center of gravity is $a = 1{,}1$ м, $h = 1{,}1$ м. Will a car roll backwards on a straight uphill road with a slope of 24 ^{0} ? Ignore wind resistance and resistance to motion.

25-Independent work.
Determining the angle at which the leading wheels can rise to a height without stalling . The problem is eat

When performing independent work, the student solves the following questions in writing based on literature and Internet information:

Find the maximum slope of the road that the vehicle can climb based on the condition of the road. Coefficient of mixing $\varphi = 0{,}3$. The base of the car $L = 3$ м, the height of the center of gravity $h = 0{,}8$ м, the distance from the center of gravity to the front axle $b = 1{,}8$ м.

What should be the height of the center of gravity to ensure stable and level movement of the car on a road with a slope of 22 ^{0}? Car wheel $B = 1{,}6$ м.

26-Independent work.
Determining the critical speed of the car on the rollover in the turn Problem solving

solves the following questions in writing based on literature and Internet information:

The base *L* = 3.0 m, the distance from the center of gravity to the axis of the rear wheel *a* = 1.1 m. Coefficient of side thrust of the rear and front axles, respectively
$K_1 = 10^{-4} \cdot 1.7$ kg $^{-1}$ and $K_2 = 10^{-4} \cdot 2.2$ kg $^{-1}$, determine the critical speed of steady motion of a car with a weight of kN in a turn. $Q_a = 25$

COURSE WORK

Information provided:

Vehicle by option: model *Nexia* .

Full mass, m_a = 1404 kg;

Maximum walking speed, $V_{a\,max}$ = 156 km / h;

E ng great height H = 1,393 m;

E ng is greater than e , V_1 = 1.662 m.

1. Calculation and graph of the external speed description of the engine.

N_e *) given in the manual* of the short reference of the car (N IIAT) is determined by the method of testing the engine on a special device. In reality, the car moves against the resistance of various road conditions, load resistance, power transmission mechanism resistance , air and road resistance.

Determine the maximum power of the car engine (N_{emax}), the maximum number of revolutions of the crankshaft equal to the maximum power (n_N), hourly fuel consumption (G_{yo}) and specific fuel consumption (g_{yo}) to overcome the above resistances while driving at maximum speed necessary.

The maximum power of the engine when the car is moving at maximum speed is determined by the following expression:

$$N_{ev\max} = \frac{G_a \cdot f_v \cdot V_{a\max}}{1000 \cdot \eta_{\kappa.y}} + \frac{W \cdot (V_{a\max})^3}{1000 \cdot \eta_{\kappa.y}}, \text{kW} \tag{1}$$

where G_a is the full weight of the vehicle

$$G_a = m_a \cdot g = 1404 \cdot 9.81 = 13773 \text{ N};$$

g – kg to N is equal to 1kg = 9.81N

f_v - coefficient of resistance to wheel rolling

The coefficient of resistance to wheel rolling is determined by the following expression:

$$f_v = f_0 \cdot \left(1 + \frac{V_{\max}^2}{1500}\right) = 0{,}018 \cdot \left(1 + \frac{43{,}33^2}{1500}\right) = 0.04\ 1$$

f_0 - the coefficient that takes into account the condition of the road

, for asphalt t road *f* is equal to $_0$ = 0.018

W is the speed of the car ,
$W = K \cdot F$, $N \cdot s^2 / m^4$
K - coefficient of overcoming air resistance :
- for a passenger car K = 0.20...0.35,
- for a truck K = 0, 60 ... 0, 70 ,
- K=0.24...0.40 for the bus.

F - cross -sectional surface of the car:
for cars :

$$F = 0{,}78 \cdot B_1 \cdot H,$$

where B_1 is the width of the car , m
The greatest height of N-car , m
cross-sectional area of a passenger car:

$$F = 0{,}78 \cdot B_1 \cdot H = 0{,}78 \cdot 1{,}662 \cdot 1{,}393 = 1{,}81\,\text{м}^2$$

$$W = K \cdot F = 0{,}25 \cdot 1{,}81 = 0{,}45\,\text{Н} \cdot c^2/\text{м}^4$$

$$V_{\max} = 156 \cdot 0{,}277 = 43{,}33\,\text{м/c}$$

cross-sectional area for trucks and buses :

$$F = B \cdot H, \ m^2$$

here is the car's V - car , m
$\eta_{к.у}$ -FIK of power transmission (Table 1):

$$\eta_{к.у} = \eta_м \cdot \eta_{у.к} \cdot \eta^c_{кар} \cdot \eta_{б.у} = 1 \cdot 0{,}97 \cdot 0{,}99^2 \cdot 0{,}97 = 0{,}92$$

Useful work coefficients of power transmission mechanisms are obtained from 1- j adval.

Table 1

Mechanisms	Useful work coefficients η_i

Fric ts ion clutch; Hydraulic clutch; Transmission box; a) spur gear b) bevel gear Cardan transmission Angle of deviation of the propeller shaft (relative to the frame) 0-7 ^{0}(car) 7 ^{0}-20 ^{0} (truck and bus) Head gear: Single-stage, hypoid gear bevel gear. Single stage hypoid gear bevel gear single stage cylindrical gear. Two-stage (double) cone-cylinder gear transmission. A pair of cylindrical gears of the main gear A pair of bevel gears	1.0 0.97...0.98 0.94...0.97 0.95...0.98 0.99 0.98 0.94 0.97 0.92 0.97...0.98 0.95...0.97

$\eta_м$ - FIK of the clutch - 1.0

$\eta_{у.к}$ - FIK of the gearbox - 0.97

$\eta_{кар}$ - FIK of cardan transmission - 0.99

$\eta_{б.у}$ - FIK of the main gear, in the main gear with a single bevel gear $\eta_{б.у}$ = $\eta_к$ =0.95...0.97, in the double main gear $\eta_{б.у} = \eta_ц^a \cdot \eta_к^b$

$\eta_ц$ - FIK of a pair of cylinder gears, $\eta_ц$ = 0.97...0.98 from which we get $\eta_{кон.}$ = 0.97.

a , *b* - the number of even chevrons, *a* q1, *v* q0, *c* - the number of cardan cross-beams, *c* = 2.

Substituting the determined values into expression (1) , we determine the maximum power of the engine when the car moves at maximum speed:

$$N_{ev\max} = \frac{13773 \cdot 0{,}04 \cdot 43{,}33}{1000 \cdot 0{,}92} + \frac{0{,}25 \cdot 1{,}81 \cdot (43{,}33)^3}{1000 \cdot 0{,}92} = 66.07 \text{ kW}$$

1.2. Determination of the number of revolutions of the crankshaft.

To build a speed description, the intervals of the number of revolutions of the crankshaft are taken as follows. For carburetor engines, n_{min} =400...1200 rpm, from n_{max} = (0.1...1.2)· n_N 8 ranges are accepted.

For a carburetor engine, we take $n_1 = n_{min}$ = *500 rev/min, the rest are determined as follows:*

n_2=0.2· n_N=0.2·5400= 1080 rpm
n_3=0.4· n_N=0.4·5400= 2160 rpm
n_4=0.6· n_N=0.6·5400= 3240 rpm
n_5=0.8· n_N=0.8·5400= 4320 rpm
n_6=0.9· n_N=0.9·5400= 4860 rpm
n_7=1.0· n_N=1.0·5400= 5400 rpm
n_8=1.1· n_N=1.1·5400= 5940 rpm
$n_9 = n_{max}$=1.2· n_N=1.2·5400= 6480 rpm

The number of revolutions of the crankshaft for a diesel engine is n_{min} =350...700 rpm from n_N up to 4 intervals are accepted. The minimum number of revolutions is taken as $n_1 = n_{min}$ *=500 rev/min, the rest are determined as follows:*

n_2=0.43· n_N, rev / min
n_3=0.65· n_N, rev / min
n_4=0.86· n_N, rev / min
n_5= 1 , 0 · n_N, rev / min

Determined N_{emax}, n_x and using the given values n_N =5400 rpm, $N_{e.x}$, $M_{e.x}$, $G_{or\,x}$ and the values of $g_{or\,x}$ are determined for 8 intervals of the number of revolutions of the crankshaft, and the description of the external speed of the engine is constructed.

1.3. Determination of the effective power of the engine for the desired number of revolutions of the crankshaft.

The effective power of the engine at any number of revolutions of the crankshaft is determined by the following expression.

$$N_{ex} = N_{eV\max} \cdot \frac{n_x}{n_N} \cdot \left[a + в \cdot \frac{n_x}{n_N} - c \cdot \left(\frac{n_x}{n_N} \right)^2 \right], \text{ kW} \qquad (2)$$

where *a* , *v* , *c are coefficients that take into* account engine types :

- for carburetor engines a = 1.0; v = 1.0; c = 1.0
- a = 0.87 for diesel engines ; v = 1, 13 ; c = 1 is equal to

N_{ex}, n_x - looking for power and the number of revolutions of the crankshaft values

n_N is the number of revolutions of the crankshaft at maximum power, n_N = 5400 rpm .

By substituting the determined values into the expression (2) , the power of the engine is determined for the intervals:

$$N_{e1} = 66{,}07 \cdot \frac{500}{5400} \cdot \left[1 + \frac{500}{5400} - \left(\frac{500}{5400}\right)^2\right] = 6{,}63 \text{ k W}$$

$$N_{e2} = 66{,}07 \cdot \frac{1080}{5400} \cdot \left[1 + \frac{1080}{5400} - \left(\frac{1080}{5400}\right)^2\right] = 15{,}33 \text{ k W}$$

$$N_{e3} = 66{,}07 \cdot \frac{2160}{5400} \cdot \left[1 + \frac{2160}{5400} - \left(\frac{2160}{5400}\right)^2\right] = 32{,}77 \text{ k W}$$

the remaining values are calculated in the order given above and the obtained results are filled in table 2.

1.4. Determination of the effective torque of the engine

The desired effective torque of the engine at the desired number of revolutions of the crankshaft is determined by the following expression;

$$\mathrm{M_{ex}} = 9554 \cdot \frac{\mathrm{N_{ex}}}{n_N}, \text{ N} \cdot \text{m} \qquad (3)$$

$$\mathrm{M_{e1}} = 9554 \cdot \frac{\mathrm{N_{e1}}}{n_N} = 9554 \cdot \frac{6{,}63}{500} = 126{,}71 \text{ N} \cdot \text{m}$$

$$\mathrm{M_{e2}} = 9554 \cdot \frac{\mathrm{N_{e2}}}{n_N} = 9554 \cdot \frac{15{,}33}{1080} = 135{,}59 \text{ N} \cdot \text{m}$$

$$\mathrm{M_{e3}} = 9554 \cdot \frac{\mathrm{N_{e3}}}{n_N} = 9554 \cdot \frac{32{,}77}{2160} = 144{,}95 \text{ N} \cdot \text{m}$$

the rest are calculated in this order and the results are filled in table 2.

1.5. Determination of the effective specific fuel consumption of the engine.

The desired effective specific fuel consumption of the engine is determined by the following expression.

$$g_{\ddot{e}.x} = g_{\ddot{e}.N} \cdot \left[a - в \cdot \frac{n_x}{n_N} + c\left(\frac{n_x}{n_N}\right)^2\right], \text{ g/ k W} \cdot \text{s} \qquad (4)$$

where: a , v , c are the coefficients taking into account engine types :

- for carburetor engines a = 1.2; v = 1.0; c = 0.8;

a = 1.55 for diesel engines without a combustion chamber ; v = 1.55; c = 1.0;

The effective specific fuel consumption of the engine working at nominal power - $g_{or.N}$, defined by the following expression;

$$g_{ё.N} = \frac{3.6 \cdot 10^3}{Q_n \cdot \eta_e},$$

(5)

$$g_{ё.N} = \frac{3,6 \cdot 10^3}{Q_n \cdot \eta_e} = \frac{3,6 \cdot 10^3}{43,93 \cdot 0,28} = 292,67 \text{ гG' k W ·s}$$

Q_n is the lower heating capacity of the fuel:

- for gasoline fuel, Q_n = 43.93 MJ / kg;

- for diesel fuel, Q_n =42.50 MJ / kg;

η_e – effective efficiency of the engine:

- equal to 0.25...0.33 for a carburettor engine and $\eta_e - 0,28$ we accept from it

- 0.35...0.40 ha t e ng for a diesel engine

Putting the determined values (4), we determine the required effective specific fuel consumption of a carburetor engine:

$$g_{ё1} = 292,67 \cdot \left[1,2 - \frac{500}{5400} + 0,8 \cdot \left(\frac{500}{5400}\right)^2\right] = 326,12 \text{ g/ k W ·s}$$

$$g_{ё2} = 292,67 \cdot \left[1,2 - \frac{1080}{5400} + 0,8 \cdot \left(\frac{1080}{5400}\right)^2\right] = 302,04 \text{ g/ k W ·s}$$

$$g_{ё3} = 292,67 \cdot \left[1,2 - \frac{2160}{5400} + 0,8 \cdot \left(\frac{2160}{5400}\right)^2\right] = 271,60 \text{ g/ k W ·s}$$

g or are determined in this order and filled in Table 2.

1.6. Determination of hourly fuel consumption of the engine.

The desired hourly fuel consumption of the engine is determined by the following expression

$$G_{ё.x} = 10^{-3} \cdot g_{ё.x} \cdot N_{ex}, \text{ kg/h}$$

(5)

We determine the hourly fuel consumption of the engine by substituting the values \u200b\ *u200bof g* and N_{ex} determined above in the expression (5) :

$$G_{ё1} = 10^{-3} \cdot 326,12 \cdot 6,63 = 2,16 \text{ kg / hour}$$

$$G_{ё2} = 10^{-3} \cdot 302,04 \cdot 15,33 = 4,63 \text{ kg / hour}$$

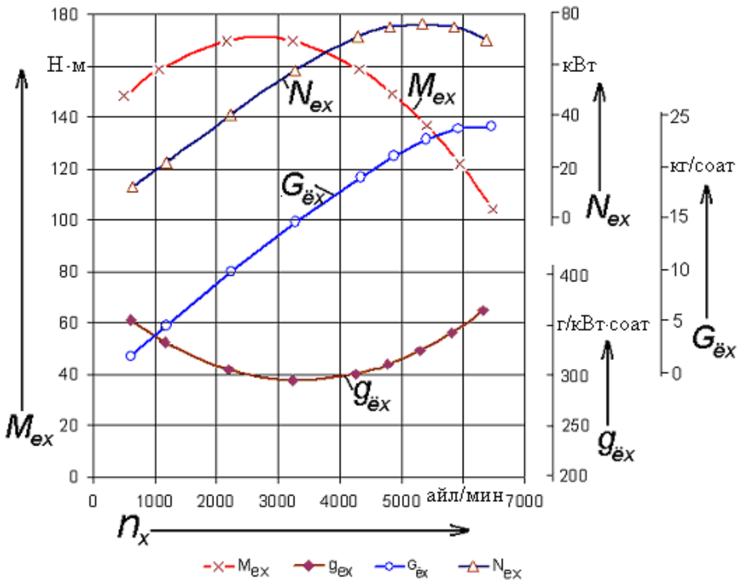
$$G_{ё2} = 10^{-3} \cdot 271,60 \cdot 32,77 = 8,9 \text{ kg / hour}$$

N_e defined above $_{.\,x}$, $M_{e\,.\,x}$, *g or The values of x* and *G* are filled in table 2.

Table 2

No	The number of revolutions of the crankshaft n_x, rpm	Indicators of external speed description.			
		Ex, (kW)	M_{ex}, (N·m)	$g_{or\,x}$, (g / kW·s)	$_{No}G$, (kg / h)
1.	500	6.63	126.71	326.12	2.16
2.	1080	15.33	135.60	302.04	4.63
3.	2160	32.77	144.95	271.60	8.90
4.	3240	49.16	144.95	259.89	12.78
5.	4320	61.31	135.60	266.92	16.37
6.	4860	64.81	127.41	277.45	17.98
7.	5400	66.07	116.89	292.67	19.34
8.	5940	64,68	104.03	312.58	20,22
9.	6480	60.25	88,84	337.16	20,32

Based on the indicators calculated and presented in Table 2, the description of the external speed of the car is built (Fig . 1).



Picture 1. Carburetor engine external speed characteristic graph.

2. Choosing a tire and determining the wheel radius.

2.1. Tire selection.

The tire is selected in two ways:

- on the tread
- according to the load on one wheel.

The load force on one rear leading wheel is determined as follows:

$$G_{1ет.кўп.муш.оғ} = \frac{G_{етачи\ кўпик}}{Z} = \frac{730}{2} = 3525{,}95\,\text{N}$$

here: G_{ek} - the force on the leading rear bridge, the value of which is determined as follows:

$$G_{ек} = 0{,}512 \cdot G_a = 0{,}512 \cdot 13773 = 7052 \text{ N}$$

R 14 *H tire* , which was loaded from the Vehicle Short Reference Manual (N IIAT) 365 kg, where tire e is *b* = 185 mm = 0.185 m , the diameter of the circle entering the rim of the disc *d* =14″(in), 1in =25.4 mm equal to $d = 14'' \cdot 25{,}4 = 3556мм = 0{,}3556$ m.

2.2. determining the rolling radius of the leading wheel.

The rolling radius of the leading wheel is determined by the following expression:

$$r_F = \left[\frac{d}{2} + b \cdot (1 - \lambda) \right], \text{m} \qquad (6)$$

where: *d* is the diameter of the tire circle entering the disc,

d = 0,3556 m, *b* - tire width, *b* = 0.185 m

λ - coefficient of deformation (sag) of the tire under the influence of gravity:

- for λ new cars i = 0.125 $\div$0.15.

= 0.15 for calculation . λ

- for λ trucks i = 0.09 0.1 1 accept i nadi . $\div$

We determine the radius of the wheel by substituting the values:

$$r_F = \left[\frac{0{,}3556}{2} + 0{,}185 \cdot (1 - 0{,}15) \right] = 0{,}335 \text{ m}$$

3. Determination of the transmission number of the power transmission.

3.1 Determination of the transmission number of the main gear.

The transmission number of the main gear is determined by the following expression:

$$U_{б.у} = \frac{\pi \cdot n_N \cdot r_F}{30 \cdot V_{a\max}} = \frac{3{,}14 \cdot 5400 \cdot 0{,}335}{30 \cdot 43{,}33} = 4{,}37$$

where: n_N is the maximum number of revolutions of the crankshaft,

n_N = 5400 rpm ;

V_{max} - the maximum driving speed of the car, V_{amax} = 43.33 m / s.

3.2. Determining the transmission numbers of the gearbox.

3.2.1 Determination of the transmission number of the first transmission.

the number of transmissions (U_I) in the first gear of the gearbox, two conditions must be satisfied for the movement of the car:

Condition 1: the maximum traction force applied to the driving wheel should be greater than or equal to the maximum resistance force of the road, i.e.:

$$P_{T\max} \geq P_{\varphi\max} \tag{7}$$

Condition 2: the maximum traction force applied to the leading wheel while the car is moving without jerking should be less than or equal to the maximum contact force of the wheel with the road surface, i.e.:

$$P_{T.\max} \leq P_{\varphi\max} \tag{8}$$

Based on the first condition, the number of transmissions in transmission 1, which ensures that the car moves without slipping, overcoming the maximum resistance of the road, is determined as follows:

$$U_{1\varphi} = \frac{G_a \cdot \psi_{\max} \cdot r_F}{M_{e\max} \cdot \eta_{ку} \cdot U_{бу}} \tag{9}$$

here, G_a - weight of the car with a full load, G_a =13773 N;

M_e is the maximum torque of the engine from Table 1

We get M_e =144.95 N· m .

$\psi_{\max}$ - the maximum total resistance of the road

$$\psi_{\max} = f_{\max} \cdot \cos\alpha \cdot \sin\alpha = 0{,}0399 \cdot \cos 28^0 + \sin 28^0 = 0{,}50;$$

When the car moves at maximum speed, the road resistance coefficient $f_{\max}$ is determined as follows:

$$f_{\max} = f_0 \cdot \left(1 + \frac{V_{a\cdot\max}^2}{1500}\right) = 0{,}018\left(1 + \frac{43{,}33^2}{1500}\right) = 0{,}04$$

r_f is the rolling radius of the leading wheel, r_f =0.335 m, we determine the number of gears in the first gear by substituting the values:

$$U_{1\varphi} = \frac{13773 \cdot 0{,}50 \cdot 0{,}335}{144{,}95 \cdot 0{,}92 \cdot 4{,}37} = 3{,}95$$

Based on the second condition, the transmission number of the gearbox, which ensures the car's smooth movement, is determined by the following expression:

$$U_{i\varphi} = \frac{G_a \cdot \psi \cdot m_2 \cdot r_F}{M_{e\cdot\max} \cdot \eta_{ku} \cdot U_{bu}}; \qquad (10)$$

where: m_1, m_2 are redistribution coefficients of reaction forces on the front and rear axles of the car.

φ- the bite coefficient between the road surface and the tire surface is φequal to 0.8 maximum torque of car engine i

From table 1, we take M_e =144.95 N·m

The force of gravity on the front axle

$$G_1 = G_a \cdot 0.48 = 13773 \cdot 0.48 = 6611.16 \text{ N};$$

The force of gravity on the leading bridge

$$G_2 = G_a \cdot 0.52 = 13773 \cdot 0.52 = 7162.08 \text{ N}.$$

The distance from the center of gravity of the vehicle to the wheel axis is determined as follows:

$$a = L \cdot \frac{G_2}{G_a} = 2{,}520 \cdot \frac{7162{,}08}{13773} = 1{,}31 \text{ m}.$$

The distance from the center of gravity to the axle of the front wheels

$$в = L \cdot \frac{G_1}{G_a} = 2{,}520 \cdot \frac{6611{,}16}{13773} = 1{,}21 \text{ m}.$$

Reaction forces affecting the front and rear wheels;

$$R_1 = \frac{G_a \cdot в}{L} = \frac{13773 \cdot 1{,}21}{2{,}520} = 6611 \text{ N};$$

$$R_2 = \frac{G_a \cdot a}{L} = \frac{13773 \cdot 1{,}31}{2{,}520} = 7162 \text{ N};$$

where L is the base of the car, L = 2,520 m.

We determine the redistribution coefficients of reaction forces:

$$m_1 = \frac{R_1}{G_1} = \frac{6611}{6611{,}16} = 1{,}0; \quad m_2 = \frac{R_2}{G_2} = \frac{7162}{7162{,}08} = 1{,}0;$$

we determine the number of transmissions of the second condition by substituting the values:

$$U_{I\varphi} = \frac{13773 \cdot 0{,}8 \cdot 1 \cdot 0{,}335}{144{,}95 \cdot 0{,}92 \cdot 4{,}37} = 6{,}32$$

the number of transmissions of the first transmission between the two numerical values of $U_{I\varphi}$ and $U_{I\varphi} U_I$, since it satisfies the above conditions: $P_{\varphi\cdot\max} \geq P_{T\cdot\max} \geq P_{\varphi\cdot\max}$ i.e. $U_{I\varphi} \geq U_I \geq U_{I\varphi}$ 6.32>3.54>3.95, we accept U_I

=3.54.

The number of remaining gears of the gearbox is determined by the following expression:

$$U_{у.к} = \sqrt[n-1]{U_I^{n-k}} \qquad (11)$$

where k is the index of the desired extension,

n is the number of steps in the gearbox, 1,2,3,4,5, etc.

The Nexia car has a 5-speed (step) gearbox installed, so we take n = 5, we determine the number of gears 1, 2, 3, 4, 5 by substituting the values:

$$U_2 = \sqrt[5-1]{3{,}54^{(5-2)}} = 2{,}58 \qquad U_3 = \sqrt[5-1]{3{,}54^{(5-3)}} = 1{,}88$$

$$U_4 = \sqrt[5-1]{3{,}54^{(5-4)}} = 1{,}37 \qquad U_5 = \sqrt[5-1]{3{,}54^{(5-5)}} = 1{,}0$$

Determine the speed of movement of the car in different gears .

The desired speed of movement of the car in different gears is determined by the following expression:

$$V_{а.у.к} = 0{,}377 \cdot \frac{n_x \cdot r_F}{U_{у.к.х} \cdot U_{б.у}} \qquad (12)$$

We determine the speed of the car by substituting *these values \u200b\u200bof* the determined n_x, r_f, $U_{uq.x}$ and U :

I -in transmission.

$$V_{a.I.1} = 0{,}377 \cdot \frac{500 \cdot 0{,}335}{3{,}54 \cdot 4{,}37} = 4{,}08 \text{ kmG's}$$

$$V_{a.I.2} = 0{,}377 \cdot \frac{1080 \cdot 0{,}335}{3{,}54 \cdot 4{,}37} = 8{,}81 \text{ kmG's}$$

$$V_{a.I.3} = 0{,}377 \cdot \frac{2160 \cdot 0{,}335}{3{,}54 \cdot 4{,}37} = 17{,}63 \text{ kmG's}$$

II - in transmission.

$$V_{a.II.1} = 0{,}377 \cdot \frac{500 \cdot 0{,}335}{2{,}58 \cdot 4{,}37} = 5{,}60 \text{ kmG's}$$

$$V_{a.II.2} = 0{,}377 \cdot \frac{1080 \cdot 0{,}335}{2{,}58 \cdot 4{,}37} = 12{,}09 \text{ kmG's}$$

$$V_{a.II.3} = 0{,}377 \cdot \frac{2160 \cdot 0{,}335}{2{,}58 \cdot 4{,}37} = 24{,}18 \text{ kmG's}$$

In transmission III.

$$V_{a.III.1} = 0{,}377 \cdot \frac{500 \cdot 0{,}335}{1{,}88 \cdot 4{,}37} = 7{,}68 \text{ kmG's}$$

$$V_{a.III.2} = 0{,}377 \cdot \frac{1080 \cdot 0{,}335}{1{,}88 \cdot 4{,}37} = 16{,}58 \text{ kmG's}$$

$$V_{a.III.3} = 0{,}377 \cdot \frac{2160 \cdot 0{,}335}{1{,}88 \cdot 4{,}37} = 33{,}17 \text{ kmG's}$$

In transmission IV.

$$V_{a.IV.1} = 0{,}377 \cdot \frac{500 \cdot 0{,}335}{1{,}37 \cdot 4{,}37} = 10{,}53 \text{ kmG's}$$

$$V_{a.IV.2} = 0{,}377 \cdot \frac{1080 \cdot 0{,}335}{1{,}37 \cdot 4{,}37} = 22{,}75 \text{ kmG's}$$

$$V_{a.IV.3} = 0{,}377 \cdot \frac{2160 \cdot 0{,}335}{1{,}37 \cdot 4{,}37} = 45{,}49 \text{ kmG's}$$

In V-gear.

$$V_{a.V.1} = 0{,}377 \cdot \frac{500 \cdot 0{,}335}{1{,}0 \cdot 4{,}37} = 14{,}44 \text{ kmG's}$$

$$V_{a.V.2} = 0{,}377 \cdot \frac{1080 \cdot 0{,}335}{1{,}0 \cdot 4{,}37} = 31{,}20 \text{ kmG's}$$

$$V_{aV.3} = 0{,}377 \cdot \frac{2160 \cdot 0{,}335}{1{,}0 \cdot 4{,}37} = 62{,}40 \text{ kmG's}$$

After determining the remaining values of gears I, II, III, IV, V, all the results are filled in Table 3 and drawn in the form of a graph, Fig. 2.

3 - table.

The number of revolutions of the crankshaft, n_x rpm	Vehicle speeds, V_a, kmG'hour				
	Number of extensions				
	It is $_I$ q3.54	U_{II} q2.58	U_{III} q1.88	*It is* $_{IV}$ q1.37	U_V q1,0
500	4.08	5.60	7.68	10.53	14.44
1080	8.81	12.09	16.58	22.75	31.20
2160	17.63	24,18	33.17	45,49	62.40
3240	26.44	36,27	49.75	68.24	93.60
4320	35.25	48.36	66.33	90.99	124.80
4860	39.66	54.40	74.62	102.36	140.40
5400	44.07	60.45	82,91	113.73	156.00
5940	48,48	66.49	91.21	125.11	171.60
6480	52.88	72.54	99.50	136.48	187.20

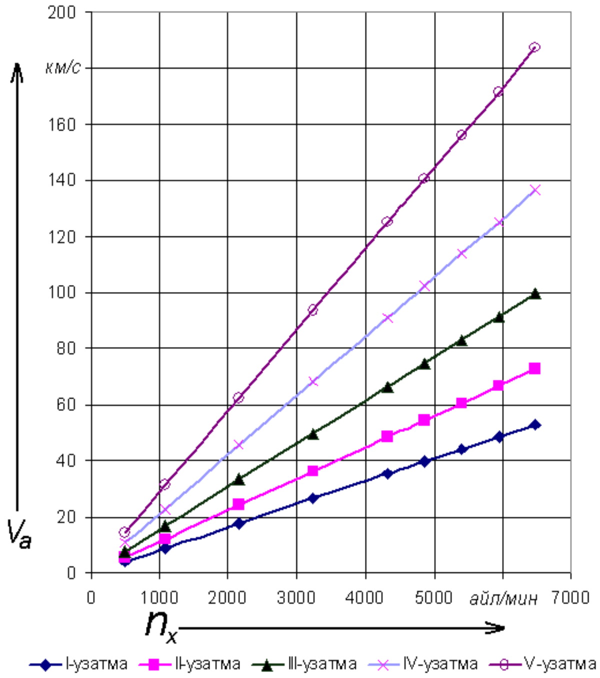


Figure 2. The graph of the speed of movement of the car in different gears.

5. Determining the force of air resistance affecting the car.

When the car moves at different speeds, the force of air resistance is determined by the following expression.

$$P_{W.X} = K \cdot F \cdot (0{,}277 \cdot V_{a.x})^2 \text{, N} \qquad (13)$$

here, K is the air resistance coefficient

for cars; K =0.20÷0.35

F is the front surface of the car

for a passenger car $F = 0{,}78 \cdot B_1 \cdot H$, m ^{2}

V_1 - the width of the car , m

N - the maximum height of the car, m;

$V_{a.x}$ - speed of the car in different gears, km/h.

1 kmG'h is equal to 0.277 m / s

V_1 =1.66 m for Nexia car ; N=1.39 m; F =0.78·1.66·1.39 = 1.80 m ^{2}.

by substituting the values, we determine the force of air resistance created by the car at different speeds:

I - in extension

$$P_{W.I.1} = 0{,}25 \cdot 1{,}80 \cdot (0{,}277 \cdot 4{,}08)^2 = 0{,}58 \text{ N}$$

$$P_{W.I.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 8,81)^2 = 2,69\,\mathrm{N}$$
$$P_{W.I.3} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 17,63)^2 = 10,76\,\mathrm{N}$$

II - in transmission

$$P_{W.II.1} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 5,60)^2 = 1,09\,\mathrm{N}$$
$$P_{W.II.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 12,09)^2 = 5,06\,\mathrm{N}$$
$$P_{W.II.3} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 24,18)^2 = 20,25\,\mathrm{N}$$

III - in transmission

$$P_{W.III.1} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 7,68)^2 = 2,04\,\mathrm{N}$$
$$P_{W.III.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 16,58)^2 = 9,53\,\mathrm{N}$$
$$P_{W.III.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 33,17)^2 = 38,10\,\mathrm{N}$$

IV -in transmission

$$P_{W.IV.1} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 10,53)^2 = 3,84\,\mathrm{N}$$
$$P_{W.IV.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 22,75)^2 = 17,92\,\mathrm{N}$$
$$P_{W.III.3} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 45,49)^2 = 71,69\,\mathrm{N}$$

In V-gear

$$P_{W.V.1} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 14,44)^2 = 7,23\,\mathrm{N}$$
$$P_{W.V.2} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 31,20)^2 = 33,72\,\mathrm{N}$$
$$P_{W.III.3} = 0,25 \cdot 1,80 \cdot (0,277 \cdot 64,40)^2 = 134,89\,\mathrm{N}$$

After calculating the remaining values of gears I, II, III, IV, V, all the results are filled in table 4 and drawn in the form of a graph Fig. 3.

Table 4.

The number of revolutions of the crankshaft, n_x rpm	Air resistance force acting on the car, R_{wx}, N.				
	Extensions				
	I	II	III	IV	V
500	0.58	1.09	2.04	3.84	7.23
1080	2.69	5.06	9.53	17.92	33.72
2160	10.76	20.25	38.10	71.69	134.89
3240	24,22	45,57	85.73	161.30	303.49
4320	43.05	81.01	152.41	286.76	539.54
4860	54.49	102.52	192.90	362.93	682.86
5400	67.27	126.57	238.14	448.07	843.03
5940	81.40	153.15	288.15	542.16	1020.07
6480	96.87	182.26	342.93	645.22	1213.97

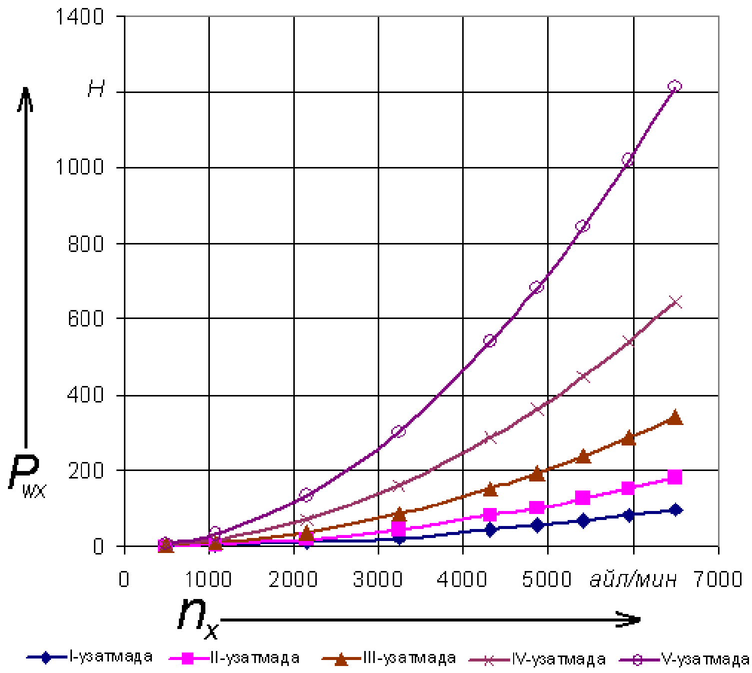


Figure 3. Graph of air resistance force affecting the car

6. Determination of traction force on the leading wheel of the car.

When the car is moving in a straight line, the desired traction force applied to the leading wheel is determined by the gears as follows:

$$P_{T.x} = \frac{M_{e.x} \cdot U_{б.у} \cdot U_{у.к.х}}{r_F} \cdot \eta_{к.у}, \text{ N} \tag{14}$$

here: *He* *is this* = 4.37, *r is equal to* $_f$ = 0.335 m, $\eta_{к.у}$ = 0.92.

In I-transmission

$$P_{T.I.1} = \frac{126{,}71 \cdot 4{,}37 \cdot 3{,}54}{0{,}335} \cdot 0{,}92 = 5398{,}14 \text{ N}$$

$$P_{T.I..2} = \frac{135{,}6 \cdot 4{,}37 \cdot 3{,}54}{0{,}335} \cdot 0{,}92 = 5776{,}5 \text{ N}$$

$$P_{T.I..3} = \frac{144{,}95 \cdot 4{,}37 \cdot 3{,}54}{0{,}335} \cdot 0{,}92 = 6174{,}88 \text{ N}$$

the rest are determined in this order, the results are filled in table 5 and calculated similarly;

II - in transmission

$$P_{T.II.I} = \frac{126{,}71 \cdot 4{,}37 \cdot 2{,}58}{0{,}335} \cdot 0{,}92 = 3935{,}44 \text{ N}$$

$$P_{T.II.2} = \frac{135{,}6 \cdot 4{,}37 \cdot 2{,}58}{0{,}335} \cdot 0{,}92 = 4211{,}28 \text{ N}$$

$$P_{T.II.3} = \frac{144{,}95 \cdot 4{,}37 \cdot 2{,}58}{0{,}335} \cdot 0{,}92 = 4501{,}71 \text{ N}$$

III - in transmission

$$P_{T.III.1} = \frac{126{,}71 \cdot 4{,}37 \cdot 1{,}88}{0{,}335} \cdot 0{,}92 = 2869{,}08 \text{ N}$$

$$P_{T.III..2} = \frac{135{,}6 \cdot 4{,}37 \cdot 1{,}88}{0{,}335} \cdot 0{,}92 = 3070{,}18 \text{ N}$$

$$P_{T.III..3} = \frac{144{,}95 \cdot 4{,}37 \cdot 1{,}88}{0{,}335} \cdot 0{,}92 = 3281{,}91 \text{ N}$$

IV -in transmission

$$P_{T.IV.1} = \frac{126{,}71 \cdot 4{,}37 \cdot 1{,}37}{0{,}335} \cdot 0{,}92 = 2091{,}66 \text{ N}$$

$$P_{T.IV..2} = \frac{135{,}6 \cdot 4{,}37 \cdot 1{,}37}{0{,}335} \cdot 0{,}92 = 2238{,}27 \text{ N}$$

$$P_{T.IV..3} = \frac{144{,}95 \cdot 4{,}37 \cdot 1{,}37}{0{,}335} \cdot 0{,}92 = 2392{,}63 \text{ N}$$

V- transmission

$$P_{T.V.1} = \frac{126{,}71 \cdot 4{,}37 \cdot 1}{0{,}335} \cdot 0{,}92 = 1524{,}9 \text{ N}$$

$$P_{T.V..2} = \frac{135{,}6 \cdot 4{,}37 \cdot 1}{0{,}335} \cdot 0{,}92 = 1631{,}78 \text{ N}$$

$$P_{T.V..3} = \frac{144{,}95 \cdot 4{,}37 \cdot 1}{0{,}335} \cdot 0{,}92 = 1744{,}32 \text{ N}$$

After calculating the remaining values of gears I, II, III, IV, V, all the results are filled in table 5 and drawn in the form of a graph, Fig. 4.

Table 5.

The number of revolutions of the crankshaft, n_x ayl G' m in	Traction force of the car, R_{tx}, N				
	Extensions				
	I	II	III	IV	V
500	5398.14	3935.44	2869.08	2091.66	1524.90
1080	5776.50	4211.28	3070.18	2238.27	1631.78
2160	6174.88	4501.72	3281.91	2392.63	1744.32
3240	6174.88	4501.72	3281.91	2392.63	1744.32
4320	5776.50	4211.28	3070.18	2238.27	1631.78
4860	5427.92	3957.15	2884.91	2103.20	1533.31
5400	4979.75	3630.42	2646.70	1929.54	1406.71

5940	4431.97	3231.07	2355.57	1717.29	1251.97
6480	3784.61	2759.12	2011.50	1466.45	1069.10

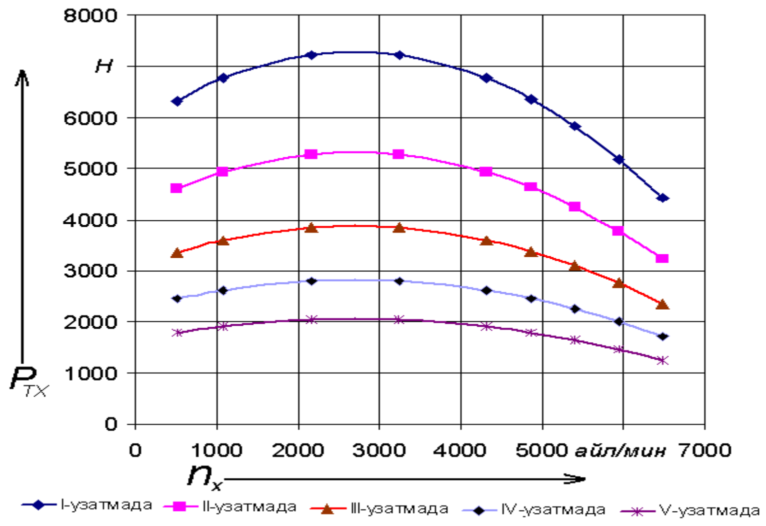


Figure 4. A graph of the traction force applied to the leading wheel of the car

7. Calculation of dynamic factor of the car.

the vehicle's unspent excess traction force (R_T - R_W) to its weight force (G_a) or the excess traction force corresponding to the weight unit of the vehicle is called the dynamic factor of the vehicle. Due to the excess traction, the car accelerates to overcome road resistance.

The relationship between the dynamic factor and the speed D_{ax} q f (v_a) is called the dynamic description of the car.

The desired dynamic factor of the car is determined by the expression in the tune:

$$Д_{a.x} = \frac{P_{m.x} - P_{W.x}}{G_a} \quad (15)$$

Dynamic factors are calculated separately for each transmission of the car. Let's calculate the dynamic factors of the car by substituting *the* R_{tx} and R_{wx} *values* calculated above :

I -in transmission

$$Д_{a.I.1} = \frac{5398,14 - 0,58}{13773} = 0,392 \text{ N}$$

$$Д_{a.I.2} = \frac{5776,5 - 2,69}{13773} = 0,419 \text{ N}$$

II - in transmission

$$Д_{a.II.1} = \frac{3935,44 - 1,09}{13773} = 0,286 \text{ N}$$

$$Д_{a.II.2} = \frac{4211,28 - 5,06}{13773} = 0,305 \text{ N}$$

$$Д_{a.I.3} = \frac{6174{,}88 - 10{,}76}{13773} = 0{,}448\,\text{N} \qquad Д_{a.II.3} = \frac{4501{,}72 - 20{,}25}{13773} = 0{,}325\,\text{N}$$

III - in transmission

$$Д_{a.III.1} = \frac{2869{,}08 - 2{,}04}{13773} = 0{,}208\,\text{N}$$

$$Д_{a.III.2} = \frac{3070{,}18 - 9{,}53}{13773} = 0{,}222\,\text{N}$$

$$Д_{a.III.3} = \frac{3281{,}91 - 38{,}10}{14040} = 0{,}236\,\text{N}$$

IV -in transmission

$$Д_{a.IV.1} = \frac{2091{,}66 - 3{,}84}{13773} = 0{,}152\,\text{N}$$

$$Д_{a.IV.2} = \frac{2238{,}27 - 17{,}92}{14040} = 0{,}161\,\text{N}$$

$$Д_{a.IV.2} = \frac{2392{,}63 - 71{,}69}{13773} = 0{,}169\,\text{N}$$

In V-gear

$$Д_{a.V.1} = \frac{1524{,}9 - 7{,}23}{13773} = 0{,}110\,\text{N}$$

$$Д_{a.V.2} = \frac{1631{,}78 - 33{,}72}{13773} = 0{,}116\,\text{N}$$

$$Д_{a.V.3} = \frac{1744{,}32 - 134{,}89}{13773} = 0{,}117\,\text{N}$$

The remaining values of gears I, II, III, IV, V are calculated and filled in table 6.

6 - table.

Its dynamic factor depending on the speed of the car

Number of extensions									
It is $_I$ = 3.54		*U* $_{II}$ = 2.58		*U* $_{III}$ = 1.88		*Its* $_{IV}$ = 1.37		*It is* $_V$ = 1.0	
V_a, km / h	D_{ax}, N	V_a, km / h	D_{ax}, N	V_a, km / h	D_{ax}, N	V_a, km / h	D_{ax}, N	V_a, km / h	D_{ax}, N
4.08	0.392	5.60	0.286	7.68	0.208	10.53	0.152	14.44	0.110
8.81	0.419	12.09	0.305	16.58	0.222	22.75	0.161	31.20	0.116
17.63	0.448	24,18	0.325	33.17	0.236	45,49	0.169	62.40	0.117
26.44	0.447	36,27	0.324	49.75	0.232	68.24	0.162	93.60	0.105
35.25	0.416	48.36	0.300	66.33	0.212	90.99	0.142	124.80	0.079
39.66	0.390	54.40	0.280	74.62	0.195	102.36	0.126	140.40	0.062
44.07	0.357	60.45	0.254	82,91	0.175	113.73	0.108	156.00	0.041
48,48	0.316	66.49	0.223	91.21	0.150	125.11	0.085	171.60	0.017
52.88	0.268	72.54	0.187	99.50	0.121	136.48	0.060	187.20	0.011

8. The dynamic passport of the car and the method of its construction.

8.1 Construction of the description of the dynamic factor of the car.

Let's build a description of the dynamic factor of the truck.

For this, the scale of the dynamic factor is determined;

$$m_{Да} = \frac{Д_{a.\max}}{Д_{\max}} = \frac{0{,}448}{250} = 0{,}0018 \text{ 1G'mm}$$

here, $D_{a.max}$ - the maximum dynamic factor of the truck, calculated as $D_{a.max}$ = 0.448 , D_{max} - section of the maximum dynamic factor, $D_{a.max}$ =250 mm. On the basis of the received scale and transmissions, the description of the change of the dynamic factors with respect to the speed of the vehicle is constructed, i.e. $D_{ax} = f(V_a)$.

8.2. The dynamic factor of an unloaded car construction of an indicative nomogram.

In the description of the dynamic factor of the truck, the axis is extended to the left and a weight scale is placed on it. From the starting point of the abscissa axis (O_2), D_a parallel to the ordinate axis and during the period when the car is not loaded, a scale line D_0 *is drawn, indicating its dynamic factor.* The value of the dynamic factor and its scale are determined for the new scale.

$D_{o.max)}$ of an unloaded car is determined as follows:

$$Д_{o\max} = Д_{a\max} \cdot \frac{G_0}{G_a} = 0{,}448 \cdot \frac{9690}{13773} = 0{,}315 \text{ 1G'mm}$$

here, G_0 - weight of the car without load, G_0 =9690 N

G_a is the weight of the car with its load, G_a =13773 N

$D_{0)}$ of the truck is determined as follows:

$$m_{Дo} = m_{Да} \cdot \frac{G_a}{G_0} = 0{,}0021 \cdot \frac{13773}{9690} = 0{,}0025 \text{ 1 / mm}$$

The dynamic factor of an unloaded car is analyzed according to the cross section;

$$Д_0 = \frac{Д_{0.\max}}{m_{до}} = \frac{0{,}315}{0{,}0025} = 123{,}74 \text{ mm}$$

calculated D_{aI}, D_{aII}, D_{aIII},……… values m_{aD} on the scale, D is scaled to the ordinate axis . D_{o1} , D_{o2} , D_{o3} , values are measured on the ordinate axis D_o on the scale $m_{Do.\ 0.1\text{-}0.1}$ to the same value on the ordinate axis ; 0.2-0.2; 0.3-0.3; …… the scale of dynamic factors is connected by a straight line. These drawn lines are called weight nomograms.

This nomogram helps to analyze the ability of the vehicle to overcome the road resistance at each weight. But this graph does not solve the problem of the transmission of power on the leading wheel through the condition of the teeth of the wheel on the road.

Therefore, it is necessary to add a graph to the weight nomogram to control the condition of the leading wheel without wobble.

In order to see the desired graph, dynamic factors are determined according to the condition of the wheel's engagement with the road.

The dynamic ( ) factor, which takes into account the engagement of the leading wheels of the loaded car with the road, $Д_{\varphi}$ is determined by the following expression:

$$Д_{\varphi a} = \left(\frac{G_2}{G_a}\right) \cdot \varphi$$

For an empty car; $Д_{\varphi 0} = \left(\frac{G_{02}}{G_a}\right) \cdot \varphi$

If the front wheels of the truck are leading:

$$Д_{\varphi a} = \left(\frac{G_1}{G_a}\right) \cdot \varphi$$

G 1 is the load on the front axle of the truck , N ;

When the front wheels of an unladen vehicle are leading;

$$Д_{\varphi a} = \left(\frac{G_{01}}{G_a}\right) \cdot \varphi$$

G_{01} - the load on the front axle of an unloaded car, N

If all wheels of the car are leading, $Д_{\varphi a} = \varphi$; $Д_{\varphi 0} = \varphi$ will be equal to $Д_{\varphi a}$ and $Д_{\varphi 0}$ values of dynamic factors are 0.1 of bite coefficient φ ; 0.2; 0.3; 0.4; 0.5; 0.6; For values 0.7 and 0.8, it is defined as follows:

$$Д_{\varphi a} = \frac{7162,08}{13773} \cdot 0,1 = 0,052$$

$$Д_{\varphi a} = \frac{7162,08}{13773} \cdot 0,2 = 0,104$$

$$Д_{\varphi a} = \frac{7162,08}{13773} \cdot 0,3 = 0,156$$

Similar calculations are made for subsequent values

$$Д_{\varphi 0} = \frac{9690}{13773} \cdot 0,1 = 0,070$$

$$Д_{\varphi 0} = \frac{9690}{13773} \cdot 0,2 = 0,141$$

$$Д_{\varphi 0} = \frac{9690}{13773} \cdot 0,3 = 0,211$$

$Д_{\varphi a}$ and $Д_{\varphi 0}$ the remaining values are calculated and the results are filled in Table 7.

The scales adopted are as follows; $m_{Da} = m_{Dph}$; $m_{D0} = m_{\Delta\varphi 0}$ and the values of these are $m_{Da} = m_{Dpha}$ =0.002168 $\frac{1}{\text{mm}}$ and $m_{D0} = m_{D\varphi 0}$ =0.00314 $\frac{1}{\text{mm}}$. Based on the accepted scales, we determine the cross-sectional values of $Д_{\varphi a}$ var $Д_{\varphi 0}$:

$$Д_{\varphi a} = \frac{Д_{\varphi a}}{m_{д\varphi a}} = \frac{0,052}{0,0018} = 24,81\,\text{mm}$$

$$Д_{\varphi 0} = \frac{Д_{\varphi 0}}{m_{д\varphi 0}} = \frac{0,070}{0,0025} = 23,61\,\text{mm}$$

After determining the remaining values, the results are filled in table 7.

7 – table

Car condition	Dina-mic factor	Dynamic factors on the coefficients of engagement of the leading wheels with the road surface (φ).							
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Loaded front	D_{pha}	0.052	0.104	0.156	0.208	0.26	0.312	0.364	0.416
	D_{pha}, mm	24.81	49.62	74.43	99.24	124.05	148.85	173.66	198.47
Front without load	$D_{\varphi 0}$	0.070	0.141	0.211	0.281	0.352	0.422	0.492	0.563
	$D_{\varphi 0}$, mm	23.61	47.23	70.84	94.46	118.07	141.69	165.30	188.92

D_a *is* the dynamic (D_{pha}) factor on the engagement only when the car is fully loaded on the ordinate axis, and D 0 *is* *the* dynamic engagement factor of the unloaded car on the ordinate axis ($D_{\varphi 0}$) factor values are set.

Determined dynamic factor $Д_{\varphi a}$ and cross- $Д_{\varphi 0}$ sections are placed on $Д_{\varphi a}$ the $Д_{\varphi 0}$ ordinate axes and connected with a dotted straight line Table 7 (Fig. 5). On the abscissa axis, $D_{ax} = f$ (V_a) km/h is selected from table 6 , i.e. the maximum walking speed, and a dynamic passport of a dynamic car is built (Fig. 5).

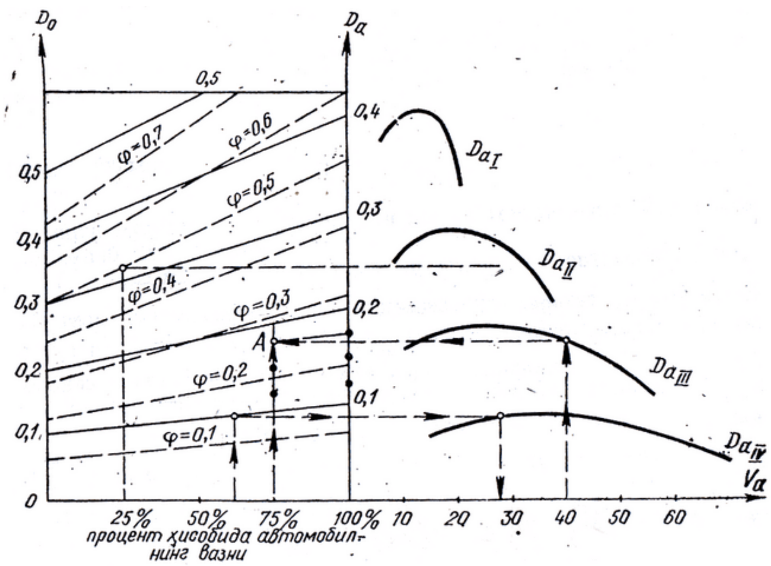


Figure 5. Nexia a vtomobilni ng dynamic passport graph gi.

9. Calculation of the description of the fuel economy of the car.

9.1 Fuel economy economic operational characteristics of the car

Fuel economy is considered part of the economic operating characteristics of the car.

Car fuel is used in large quantities in transport. The cost of fuel is 10...15% of the cost of a car in cargo transportation. Therefore, it is advisable to use car fuel sparingly.

The amount of fuel consumption depends on the construction of the car, speed of movement and climatic conditions.

fuel consumption of the car per hour depends on the speed of the car Q_s q f (V_a), *which is determined as follows:*

$$Q_s = \frac{K_n \cdot K_N \cdot g_{ё.N}\left(N_\varphi + N_w\right)}{36 \cdot \rho_ё \cdot \eta_{к.у} \cdot V_a}$$, kgG'hour

here, ρ_{yo} - fuel density, kg / l.

- density of gasoline fuel, 0.75 kg / l;

- density of diesel fuel, 0.86 kg / l;

$\eta_{к.u}$ - the efficiency coefficient of power transmission , $\eta_{к.u}$ = 0.92 is equal to ;

V_a - the speed of the car, V_a = 43.33 m / s.

K_n -using the number of revolutions of the crankshaft coefficient and it is determined as follows

$$K_n = \frac{n_x}{n_N}$$

$$K_n = \frac{n_1}{n_N} = \frac{500}{5400} = 0{,}093$$

$$K_n = \frac{n_2}{n_N} = \frac{1080}{5400} = 0{,}20$$

$$K_n = \frac{n_3}{n_N} = \frac{2160}{5400} = 0{,}40$$

Table 8 is filled with the results of changes in the number of revolutions of the remaining crankshaft

K_N - engine power utilization factor,

$$K_N = \frac{N_\varphi + N_W}{N_e}$$

here, - N_φ the power spent to overcome road resistance , kW

N_W -power used to overcome air resistance , kW

N_e is the effective power of the engine, kW from Table 1

9 is obtained according to the interval

N_φ - the power spent to overcome road resistance is determined as follows:

$$N_\varphi = \frac{P_\varphi \cdot V_a}{1000}, \text{ kW},$$

$$N_{\varphi_1} = \frac{P_\varphi \cdot V_a}{1000} = \frac{798{,}85 \cdot 2{,}77}{1000} = 2{,}22 \text{ k W}$$

$$N_{\varphi_2} = \frac{798{,}85 \cdot 5{,}54}{1000} = 4{,}44 \text{ k W}$$

$$N_{\varphi_3} = \frac{798{,}85 \cdot 5{,}54}{1000} = 6{,}66 \text{ k W}$$

where V_a -10 km/s to 100 kmG's values are obtained in m/s and the results of the change of similar remaining values are filled in table 9

Power expended to overcome air resistance.

$$N_W = \frac{(P_W \cdot V_{a.\max})}{1000}, \text{ kW}$$

$$N_{W_1} = \frac{K \cdot F \cdot V_a^3}{1000} = \frac{0{,}25 \cdot 1{,}80 \cdot 2{,}77^3}{1000} = 0{,}01 \text{ k W}$$

$$N_{W_2} = \frac{0,25 \cdot 1,80 \cdot 5,57^3}{1000} = 0,08 \text{ k W}$$

$$N_{W_3} = \frac{0,25 \cdot 1,80 \cdot 8,33^3}{1000} = 0,26 \text{ k W}$$

$g_{or\ N}$ - effective specific fuel consumption of the engine working at nominal power ;

$$g_{\ddot{e}.N} = \frac{3,6 \cdot 10^3}{Q_n \cdot \eta_e} = \frac{3,6 \cdot 10^3}{43,93 \cdot 0,28} = 292,67 \text{ гG' k W ·s}$$

Q_n is the lower heating capacity of the fuel:

- for gasoline fuel, Q_n = 43.93 MJ / kg;

- for diesel fuel, Q_n =42.50 MJ / kg;

η_e – effective efficiency of the engine:

- equal to 0.25...0.33 for a carburettor engine and $\eta_e - 0,28$ we accept from it

- 0.35...0.40 ha t e ng for a diesel engine

Using the above values of N_φ, N_W and N_e we find the coefficient of engine power utilization - K_N,

$$K_N = \frac{N_\varphi + N_W}{N_{ex}}$$

$$K_{N1} = \frac{N_\varphi + N_W}{N_{ex}} = \frac{2,22 + 0,01}{6,31} = 0,34$$

$$K_{N2} = \frac{N_\varphi + N_W}{N_{ex}} = \frac{4,44 + 0,08}{15,33} = 0,29$$

$$K_{N3} = \frac{N_\varphi + N_W}{N_{ex}} = \frac{6,66 + 0,26}{32,77} = 0,21$$

Table 8 is filled with the results of the change of similar remaining values

P_φ - road resistance,

$$P_\varphi = G_a \cdot \psi \text{, N,}$$

G_a – full weight of the car, G_a = 13773 N

ψ total resistance coefficient of the road ,

$$\psi = f \cdot \cos\alpha + \sin\alpha = 0,018 \cdot \cos 2^0 181 + \sin 2\,^0 18^1 = 0,058$$

$$P_\varphi = G_a \cdot \psi = 13773 \cdot 0{,}058 = 798{,}85, \text{ N}$$

P_W - air resistance;

$$P_W = K \cdot F \cdot (0{,}277 \cdot V_{a.\max})^2, \text{ N}$$

F -transverse surface of the car, 1,80 m^2;

K - air resistance coefficient , for a passenger car, K =0.25;

$$P_{W_1} = K \cdot F \cdot (0{,}277 \cdot V_a) = 0{,}25 \cdot 1{,}80 \cdot (0{,}277 \cdot 10)^2 = 3{,}48 \text{N}$$

$$P_{W2} = K \cdot F \cdot (0{,}277 \cdot V_a) = 0{,}25 \cdot 1{,}80 \cdot (0{,}277 \cdot 20)^2 = 13{,}93 \text{N}$$

$$P_{W3} = K \cdot F \cdot (0{,}277 \cdot V_a) = 0{,}25 \cdot 1{,}80 \cdot (0{,}277 \cdot 30)^2 = 31{,}35 \text{N}$$

of coefficients K_n and K_N according to the number of revolutions (n) and power (N) are presented in Table 8.

8 - table.

Engine types	*n* and *N* by degrees.								
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
K_N (with carburetor)	0.34	0.29	0.21	0.19	0.20	0.24	0.29	0.35	0.45
Kn	0.09	0.20	0.40	0.60	0.80	0.90	1.00	1.10	1.20

According to the speed, the fuel consumption of the car per hour is :

$$Q_x = \frac{K_n \cdot K_N \cdot g_{\text{ë}\min} \cdot (N_\varphi + N_W)}{36 \cdot \rho_{\text{ë}} \cdot \eta_{\kappa.y} \cdot V_a} \text{kg},$$

here $g_{\text{ë}\min}$ - the minimum specific fuel consumption is selected from table 1 and its value is calculated , i.e. $g_{\text{ë}\min}$ = 259.89 g / kWh

$$Q_1 = \frac{K_n \cdot K_N \cdot g_{\text{ë}\min} \cdot (N_\varphi + N_W)}{36 \cdot \rho_{\text{ë}} \cdot \eta_{\kappa.y} \cdot V_a} = \frac{0{,}09 \cdot 0{,}34 \cdot 259{,}89 \cdot (2{,}22 + 0{,}01)}{36 \cdot 0{,}75 \cdot 0{,}92 \cdot 2{,}77} = 0{,}26 \text{ kg}$$

$$Q_2 = \frac{0{,}20 \cdot 0{,}29 \cdot 259{,}89 \cdot (4{,}44 + 0{,}08)}{36 \cdot 0{,}75 \cdot 0{,}92 \cdot 5{,}54} = 0{,}50 \text{kg}$$

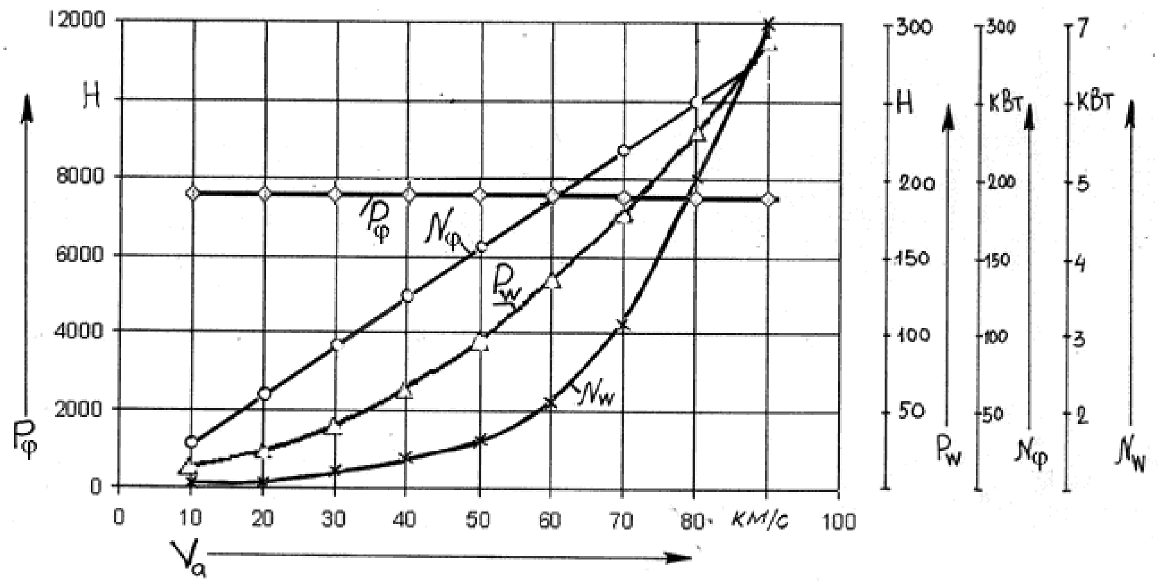
$$Q_3 = \frac{0{,}407 \cdot 0{,}21 \cdot 259{,}89 \cdot (6{,}66 + 0{,}26)}{36 \cdot 0{,}75 \cdot 0{,}92 \cdot 5{,}54} = 0{,}73 \text{kg}$$

Calculation results are filled in table 9.

Table 9.

Vehicle speed, km / h	Kuch, N		Power, kW		Fuel consumption, kg / h
	P_φ	P_W	N_φ	N_W	
10	798.85	3.48	2.22	0.01	0.26
20	798.85	13.93	4.44	0.08	0.50
30	798.85	31.35	6.66	0.26	0.73
40	798.85	55.74	8.88	0.62	1.03
50	798.85	87.09	11,10	1.21	1.48
60	798.85	125.40	13.31	2.09	2.06
70	798.85	170.69	15.53	3.32	2.89
80	798.85	222.94	17.75	4.95	4.12
90	798.85	282.16	19.97	7.05	6.07

According to the calculation results, the fuel efficiency of the car and the graph of the influencing power and the generated power are built on the basis of Table 9 (Fig. 6) .



6 cm . The force affecting the car and emerging powers

9.2 Vehicle 100 kmfuel consumption on the road

The fuel consumption of the vehicle is determined by the following expression;100 km

$$Q_s = \frac{K_n \cdot K_N \cdot g_{eN} \cdot (N_\varphi + N_W)}{36 \cdot \rho_ё \cdot \eta_{к.у} \cdot V_a} = \frac{1{,}20 \cdot 0{,}45 \cdot 257{,}89 \cdot (19{,}97 + 7{,}05)}{36 \cdot 0{,}75 \cdot 0{,}92 \cdot 43{,}33} = 6{,}01 \text{ lG'100km}$$

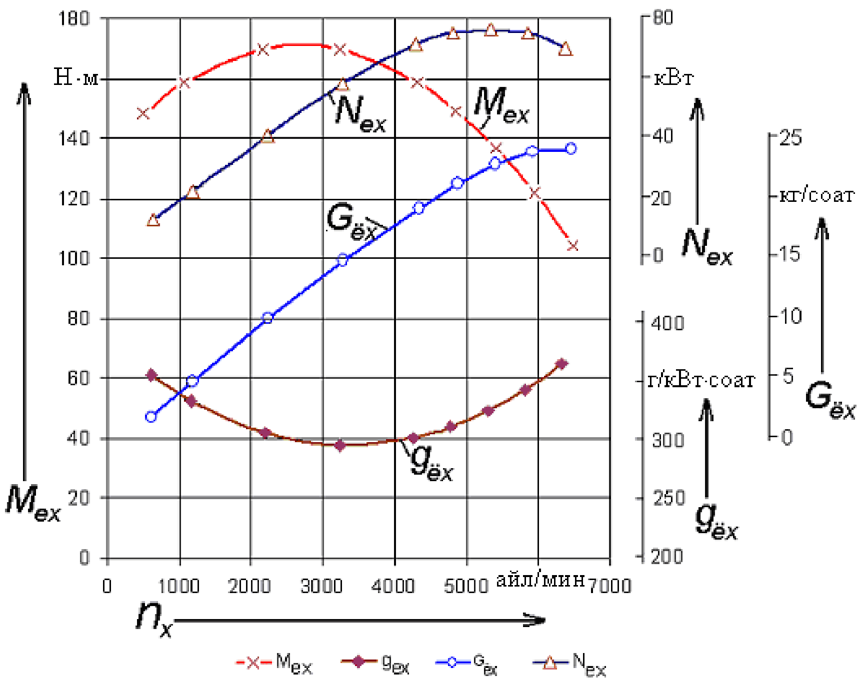
After the calculation of the course work on the subject

"Construction and theory of transport vehicles", an explanation of the calculation and a drawing in 3 sheets will be presented.

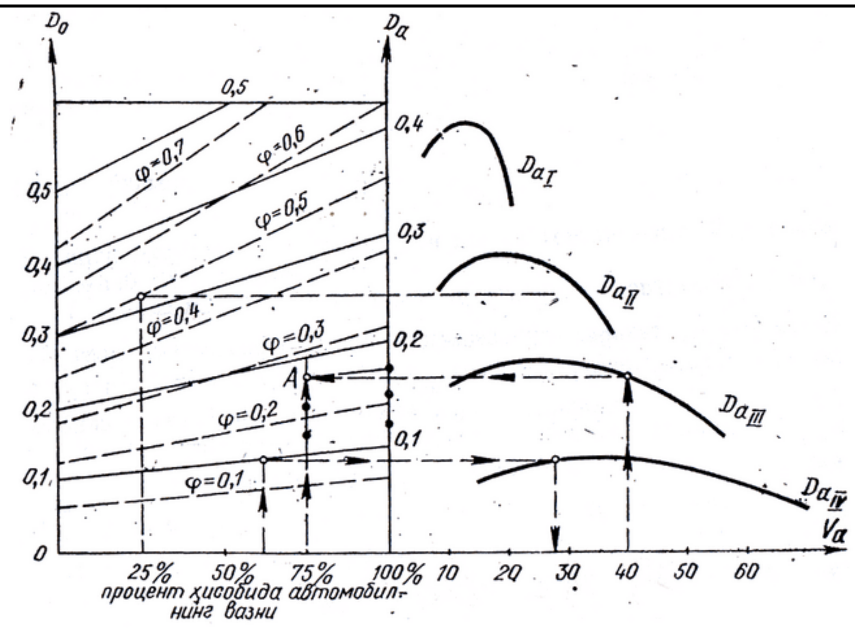
Registration of course work

25-30 pages of explanatory notes
In list 1–External speed specification and dynamic passport of the engine
In list 2- The traction force and the acting force and the generated forces on the leading wheel when the car is moving in different gears

DRIVE EXTERIOR SPEED SPECIFICATION

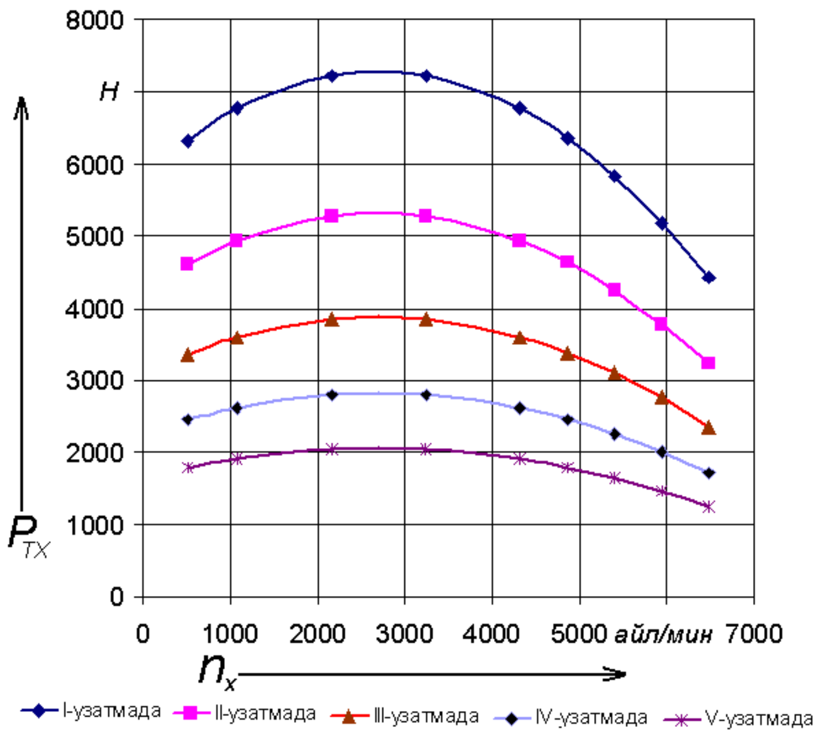


VEHICLE D INAMIK PASSPORT

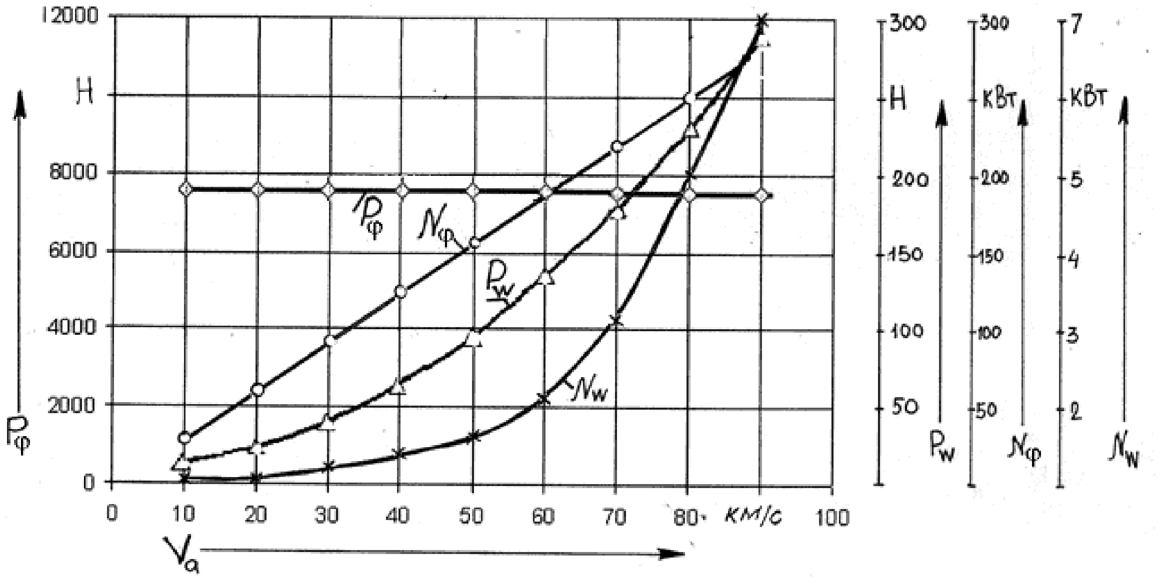


					01. EUUTT . Construction of cars . 38-T. 000.01
Uzg	There is	Document	Signature	Sana	of the Nexia passenger car , as well as calculation of the performance of the clutch.
He did it					Literature: x; Massa; Mashtab
Leader					
Advice					Sheet-1; Sheets-3
					External speed specification of the motor and dynamic passport
Checked					NamMPI , Faculty of Transport
Kaf.mud.					

WHEN DRIVING THE VEHICLE IN DIFFERENT GEARS
DRIVING WHEEL TRACTION FORCE



EFFECTIVE FORCE AND STORAGE FORCE



					01 .EUUTT . Construction of cars . 38-T. 000.01			
Uzg	There is	Document	Signature	Sana	Towing, speed and fuel economy characteristics of the NEXIA passenger car and calculation of clutch performance.	Literature	Massa	Mashtab
He did it						x		
Leader								
Advice						Sheet -2	Sheets-3	
					Traction force and the acting force and the resulting forces brought to the leading wheel when the car is moving in different gears	NamMPI , Faculty of Transport		
Checked								
Kaf.mud.								

Course work topics

1. Calculation of the towing, speed and fuel economy characteristics of the Damas minibus, as well as the performance of the gearbox.
2. ISUZU Calculation of traction, speed and fuel economy characteristics of the NP -30 truck, as well as the operation of the main drive.
3. Calculation of traction, speed and fuel efficiency characteristics of a VAZ-2106 passenger car, as well as the operation of the brake control.
4. ISUZU Calculation of traction, speed and fuel efficiency characteristics of the NP -37 bus, as well as the operation of the steering control.
5. MAN Calculation of the traction, speed and fuel economy characteristics of the TG truck, as well as the operation of the clutch.
6. Calculation of traction, speed and fuel economy characteristics of a VAZ-2107 passenger car, as well as the operation of the gearbox.
7. MAN bus, as well as the operation of the main drive.
8. the KAMAZ truck, as well as the working process of the brake control.
9. Matiz passenger car, as well as the operation of the steering system.
10. YUTONG bus, as well as operation of clutch.
11. DAF truck, as well as the performance of the gearbox.
12. Lacetti passenger car, as well as the operation of the main drive.
13. Changan truck, as well as the operation of the brake control.
14. TATRA truck, as well as the operation of the steering control.
15. Spark passenger car, as well as the operation of the clutch.
16. Calculation of Mercedes-Benz truck's towing, speed and fuel economy characteristics and transmission performance.
17. Aston Calculation of the towing, speed and fuel economy characteristics of a Martin car and the operation of the main drive.
18. JAC truck, as well as the operation of the brake control.
19. LABO truck, as well as the operation of the steering.
20. Calculation of traction, speed and fuel efficiency characteristics of the Ikarus-255 bus, as well as the operation of the clutch.
21. VOLVO truck, as well as transmission performance.
22. Malibu turbo model light know the car thrust , speed and fuel thriftiness features and as o siy do not pass work process feeling
23. Calculation of traction, speed and fuel efficiency characteristics of the UrAL truck, as well as the operation of the brake control.
24. IVECO truck, as well as the operation of the steering.
25. LADA Calculation of the traction, speed and fuel economy characteristics of the KALINA passenger car, as well as the operation of the clutch.
26. NISSAN truck's towing, speed and fuel economy characteristics and transmission performance.
27. Calculation of traction, speed and fuel efficiency characteristics of the UzOtayol-M50 bus, as well as the operation of the main drive.
28. Calculation of traction, speed and fuel efficiency characteristics of the BeLAZ truck, as well as the operation of the brake control.
29. Calculation of traction, speed and fuel efficiency characteristics of the MAZ truck, as well as the operation of the steering control.
30. Calculation of traction, speed and fuel efficiency characteristics of the KamAZ-53212 truck, as well as the operation of the clutch.

31. FIAT passenger car, as well as transmission performance.
32. Captiva passenger car, as well as the operation of the main drive.
33. VOLVO model avt o busning thrust , speed and fuel thriftiness features and to rm o z b of the company work process feeling
34. the LADA - PRIORA passenger car, as well as the working process of the clutch.
35. HYUNDAI truck's towing, speed and fuel economy characteristics and clutch operation.
36. LiAZ bus, as well as the operation of the gearbox.
37. the LADA - LARGUS passenger car, as well as the operation of the main drive.
38. Calculation of traction, speed and fuel efficiency characteristics of the MAZ truck, as well as the working process of the brake control.
39. SCANIYA bus, as well as steering operation.
40. BelAZ truck, as well as the operation of the clutch.
41. Calculation of traction, speed and fuel economy characteristics of the Nisa-521S cargo vehicle, as well as the operation of the gearbox.
42. Calculation of traction, speed and fuel efficiency characteristics of a gasoline truck TSV-6 ZIL-130, as well as the operation of the main drive.
43. Tatra-138 S 1 cargo vehicle, as well as calculation of the operation of the brake control.
44. UzOtayol 120.14 model truck traction, speed and fuel economy characteristics and calculation of steering operation.
45. Calculation of traction, speed and fuel economy characteristics of the ErAZ-762V truck, as well as the operation of the clutch.
46. Calculation of traction, speed and fuel economy characteristics of the GAZ-53-04 truck, as well as the operation of the gearbox.
47. Calculation of traction, speed and fuel efficiency characteristics of concrete mixer truck S-1036B MAZ-500, as well as the operation of the main drive.
48. Calculation of traction, speed and fuel efficiency characteristics of the UzOtayol M.23.9 bus, as well as the work process of the brake control.
49. Calculation of traction, speed and fuel efficiency characteristics of a Damas-van model, as well as the operation of the steering control.
50. Calculation of traction, speed and fuel economy characteristics of the MoAZ-6401 truck, as well as the operation of the clutch.
51. Calculation of towing, speed and fuel efficiency characteristics of the BelAZ-540A truck, as well as the operation of the gearbox.
52. Calculation of traction, speed and fuel economy characteristics of the Tico passenger car and the operation of the main drive.
53. Calculation of traction, speed and fuel efficiency characteristics of the MAZ-5549 truck, as well as the working process of the brake control.
54. Calculation of traction, speed and fuel efficiency characteristics of the LuAZ-969M passenger car, as well as the operation of the steering control.
55. Calculation of traction, speed and fuel economy characteristics of the ZIL-MMZ-555 truck, as well as the operation of the clutch.
56. Calculation of traction, speed and fuel economy characteristics of the URAL-375D truck, as well as the operation of the gearbox.
57. EPIC model light know the car thrust , speed and fuel thriftiness features and as o siy do not pass work process feeling

58. Calculation of traction, speed and fuel economy characteristics of the KrAZ-255B1 truck, as well as the operation of the brake control.
59. VOLVO -7900 model bus traction, speed and fuel economy characteristics and calculation of steering operation.
60. GENTRA passenger car, as well as the operation of the clutch.
61. Calculation of traction, speed and fuel economy characteristics of the MAZ-516B truck, as well as the operation of the gearbox.
62. LiAZ -6213 bus, as well as calculation of the operation of the main drive.
63. LADA - VESTA passenger car, as well as the working process of the brake control.
64. Calculation of traction, speed and fuel economy characteristics of the URAL-377N truck, as well as the operation of the steering control.
65. MAN Calculation of traction, speed and fuel economy characteristics of the Lion 's bus , as well as the operation of the clutch.
66. LADA Calculation of traction, speed and fuel economy characteristics of the CROSS passenger car, as well as transmission performance.
67. FORD truck, as well as the performance of the main transmission.
68. Gazelle - Next bus, as well as the operation of the brake control.
69. COBOLT passenger car, as well as the performance of the steering.
70. FIAT passenger car, as well as the operation of the clutch.
71. TRECKER passenger car, as well as transmission performance.
72. ONIX passenger car, as well as the operation of the main drive.
73. RENAULT passenger car, as well as the operation of the steering.
74. SISU model load know the car thrust , speed and fuel economy features and get along of the clutch work process feeling
75. DAF bus, as well as gearbox performance.
76. Calculation of traction, speed and fuel efficiency characteristics of the LAZ-695 bus, as well as the operation of the main drive.
77. JEEP passenger car, as well as brake control performance.
78. FORD truck, as well as steering performance.
79. VOLKSWAGEN truck, as well as the operation of the clutch.
80. MACK TRUCKS towing, speed, fuel economy and transmission performance calculations.
81. Calculation of traction, speed and fuel efficiency characteristics of UzOtayol.80.12 truck, as well as the working process of the steering control.
82. Calculation of traction, speed and fuel economy characteristics of the truck model JUK-A06, as well as the operation of the gearbox.
83. Calculation of traction, speed and fuel efficiency characteristics of UzOtayol M24.9 bus, as well as steering operation.
84. Calculation of traction, speed and fuel efficiency characteristics of the NIssA-521S bus, as well as the operation of the clutch.
85. Calculation of traction, speed and fuel efficiency characteristics of the truck K1040E ZIL-130V-1, as well as the operation of the brake control.

App

REPUBLIC OF UZBEKISTAN HIGHER AND SECONDARY SPECIAL

MINISTRY OF EDUCATION

Namangan engineering-construction institute

Faculty of Transport

Ground transportation systems department

From the subject **"Automotive construction".**

KURS IShI

Done by: ______________________________ group student

____

Accepted by: ______________________________

NO MATTER

REPUBLIC OF UZBEKISTAN HIGHER AND SECONDARY SPECIAL
MINISTRY OF EDUCATION

Namangan engineering-construction institute

Faculty of Transport early

Ground transportation systems department

From the subject **"Automotive construction".**

____

____

____

____

course work on the subject

EXPLANATORY NOTE

Done by: ______________________________________

Head: ____

H gesture is allowed:

Signature ________ Date ________

_________________ defended the price

Jury members: ______________________________

____

____

NO MATTER

To complete the course work on the subject **"The structure and theory of vehicles".**

ASSIGNMENT

1. The subject of the course work

____
____
____
______

2. Initial data: full mass, m_a = kg; maximum walking speed, $V_{a\,max}$ = m/s; the greatest height, H= mm; the largest e , V_1 = mm; the number of revolutions of the crankshaft at maximum power, n_N =ayl /min .

3. Literature and manuals :

1. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
2. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
3. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
4. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
5. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.
6. Vakhlamov. VK "Automobili: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
7. Sidiqnazarov KM and dr. The car is in a new transport environment. T: 2007-188
8. Ivanov. AM and dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.
9. Vakhlamov.VK "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
10. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992

4. The composition of the drawing part :

In list 1–External speed specification and dynamic passport of the engine

In list 2- Traction force and impact force brought to the leading wheel when the car is moving in different gears and the resulting forces

3 - on the list - working drawings of the parts of the mechanism of the Nexia car

5. Explanatory note section.

1. Introduction. 2. Calculation of the engine speed specification. 3. Choosing a tire and determining the wheel radius. 4. Determination of the transmission number of the power transmission. 5. Determine the speed of the car. 6. Forces affecting the car. 7. Calculation of dynamic factor and dynamic passport of the car. 8. Car fuel economy calculation. 9. Mechanism design calculation . 10. Summary. 11. Literature.

6. The duration of the course work is performed on the basis of the 4 order digital project in the explanation of each part of the table given in the form of the following table.

In the plan	Part 1 Section 1.2	Part 2 Section 3.4	Part 3 Section 5,6,7	Part 4 Section 8,9,10	Explanatory writing section	Graphics part	Protection
In practice							

Course work : ___________________

Leader: _______________

REPUBLIC OF UZBEKISTAN HIGHER AND SECONDARY SPECIAL MINISTRY OF EDUCATION

Namangan engineering - construction institute

Faculty of Transport

Full-time and special part-time education 5310600-Ground transport systems and their operation in connection with the defense of the course project (work) in the subject **"Automotive construction"**

ASSEMBLY Or NI

Namangan city «___»________________ 20__ year

Name and surname of the student ___________________________
Group ____
Rating book number ____________________________
The day of defense of the course project (work) «__»______________ 20_ year
The subject of the course project (work)

1. Questions about protection:

1.
____
2.
____
3.
____
4.
____

2. Conclusion of the defense team
1. According to the completed calculations ______
2. Drawing works ______
3. Answers to the questions asked ______
4. General ______

3. Members of the defense committee:

____

____

____

GLOSSARY

GLOSSARY.

In Uzbek language	In Russian	In English	Content
Shock absorber	**Shock absorber**	**Shock absorber**	When the car drives on an uneven road, it prevents the car frame and body from shaking by eliminating the wheel's deviation from the road.
Bus	**Bus**	**Bus**	It will be used around the city, within the city, between cities, going to certain places and for general work.
Car	**Car**	**Automobile**	It is a vehicle that moves on land, it is a wheeled machine equipped with an independent engine with an independent source of energy and having safety.
Car chassis	**Chassis car**	**Automobile chassis's**	Transmission of torque on the crankshaft of the engine to the leading wheels is made up of mechanisms designed to move and control the car.
Vehicle control mechanisms	**Automotive mechanism**	**Automobile drive mechanisms**	The driver is composed of the steering and brake controls necessary to move the car in the specified direction.
Head dosing device	**Basic measuring device**	**Main metering device**	It prepares a combustible mixture with an economical composition in the medium load range.
Coarse T grinder	**the water is clean**	**Crude clean**	The cleaner case is made of gauze, and the cleaner is installed on a net.
Differential	**Differential**	**Differential**	It allows the leading wheels to rotate at different angular speeds when the car is turning and driving over uneven road surfaces .
Environmental problem	**ecology of the problem**	**Ecology is a problem**	It includes the year problem and the exploitation problem
Economizer	**Economizer**	**Economizer**	It serves to prepare an enriched mixture for full strength.
Elastic element	**Elastic element**	**Elastic element**	Softens road bumps
The wheel	**Coleso**	**Wheel**	It is considered as a connecting link between the tire and the axle of the car, and it is necessary to install the tire
Launch device	**пусковое устройство**	**Starting device**	A cold engine is prepared with a suitable fuel mixture for reliable ignition mode.
Blinds	**Blinds**	**Blind**	It reduces the amount of air flowing through the radiator in cold weather. It ensures that the engine temperature does not drop excessively.

Camera	**Camera**	**Tube**	Connected rubber tube-ring. It will have a ventil for air intake.
Cardan hinge	**Cardan hinge**	**The cardan joint**	The shafts, the angle between the axes of which is variable, are connected with hinges and serve to transmit motion.
Valve springs	**Valve springs**	**The valve springs**	Ensures that the valve fits snugly against the seat and serves to hold it in the closed position.
Koromislo	**Koromyslo**	**The rocker arm**	It is a double-shouldered lever that serves to change the direction of movement of the pusher to the opening direction of the valve.
Crankshaft mechanism	**Krivoship connecting rod mechanism**	**Krivaship shatun mechanism**	**engines** , it receives the gas pressure created by the combustion of the working mixture through the piston and converts the piston's advance-reciprocation movement into the rotational movement of the crankshaft.
Makhovik	**Makhovik**	**The flywheel**	The inertial disc is attached behind the crankshaft
Special cars	**Spets car**	**Special automobiles**	It is equipped with mechanisms-devices and equipment that allow to perform certain works .
Gentle cleanser	**Myagkaya ochistka**	**Soft cleaning**	In the center of reducer A , a mesh cleaner made of steel with mesh ribs is installed on the steering wheel.
Fists	**Laughter**	**Cams**	The fists move the valve, and their number corresponds to the number of valves and their position is determined by the order of the engine
Front bridge	**front bridge**	**Front bridge**	A serves to install parts of the steering wheel of the car, suspensions and steering wheels.
Back bridge	**Zadny most**	**Back bridge**	A secondary transmission serves for the installation of differential half-axles of suspensions and leading wheels.
Pneumatic suspensions	**Air suspension**	**Pneumatic suspensions**	Air compressed into the cylinder acts as an elastic element. Compressed air provides elasticity in such suspensions.
Piston	**Piston**	**Piston**	It receives the gas pressure created by the combustion of the internal mixture in the cylinder and serves to transfer it to the crankshaft through its finger and connecting rod.
Racing cars	**Gonychnye car**	**Motor rally cars**	S are port cars, designed for participation in sports racing.
Rubber base	**Rubber base**	**Rubber stop**	Limits suspension movement.
Steering wheel	**Steering wheel**	**Rule steer**	A serves to change the direction of movement of the vehicle.
Salt working	**Idle mode is**	**Idle mode**	It prepares a mixture for stable operation

system	**systematic**	**system**	of the crankshaft at minimum rotation frequency.
Tires	**TIRE**	**Tires**	Improves the smoothness of the car by softening and damping the impulses received by the wheel from road irregularities.
Barbell	**Shtanga**	**The rod**	Serves to transmit power from the pusher to the coromyslo
Cylinder block	**Block cylinder**	**Cylinder block**	It is the body part of the engine in which the cylinders are located
Extinguishing element	**washing element**	**Absorbing element**	Dampens body vibration
Cooling system	**Sistema okhlodenia**	**Freeze system's**	Aigatel distributes the heat separated from the heated parts to the external environment and ensures the most comfortable thermal operation.
Stabilizer	**stabilizer**	**Stabilizer**	Reduces body roll
Liquid pump	**Pump**	**Water pump**	Constantly circulates the fluid in the system. Centrifugal pumps are widely used in the cooling system.
Thermostat	**Thermostat**	**Thermos**	Accelerates engine warm-up and serves to automatically maintain a comfortable temperature in the cooling system.
Acceleration pump	**Speed up the pump**	**Acceleration pump**	It serves to quickly enrich the mixture to ensure a sharp dynamic movement of the car.
Pusher	**tolcatel**	**The tappet**	It serves to transmit power along the axis from the camshaft fist to the valve stem or rod (coromyslo).
Ventilator	**Ventilator**	**Science**	It serves to increase the amount and speed of air passing through the radiator.
Half arrows	**Polovos**	**Half axles**	B serves to transfer torque from the differential to the leading wheels.
A light car	**Lyogkovoy car**	**Light automobile**	Depending on the size of the installed engines: 1, 2 lmedium to small; 1.2...1.8 l small; 1.8...3.5 liters and more than 3.5 liters.
Passenger cars	**Possajyrnye car**	**Passenger Automobiles**	passengers .
Fuel suction and drive pump	**Fuel tank and drive pump**	**Inflammable suck and drive pump's**	Fuel is sucked from the tank through a coarse cleaner and then driven through fine cleaners to a high pressure pump.

LIST OF LITERATURE

Basic literature

7. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
8. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles"

"Educational publishing house" TASHKENT-2014 y 158 p.
9. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
10. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
11. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

Additional literature

11. Vakhlamov. VK "Automobili: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
12. Sidiqnazarov KM and dr. The car is in a new transport environment. T: 2007-188 p.
13. Ivanov. AM and dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.
14. Vakhlamov. VK "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
15. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992
16. Mamatov.Kh, Turdiev.Yu, Kadirkhanov.M Fundamentals of automobile design and theory. Tashkent. "Teacher" 1982.
17. SM Kadyrov. MOQodirkhanov. Theory of engines and cars. Tashkent. Teacher. 1982
18. Kadyrov. SM Tiko car structure, troubleshooting and repair. Tashkent, "Teacher", 2001.
19. Kadirkhanov.MO Car processes and accounting Tashkent. "Teacher" 2003.
20. Carroll E. Goering, Marvin L. Stone, David W. Smith, Paul K. Turnquist. " Off-Road vehicle Engineering principles " , American Society of Agricultural Engineers, 2006.
21. David A. Crolla. "Automotive Engineering Powertrain, Chassis System and Vehicle Body", Amsterdam, Butterworth-Heinemann is an imprint of Elsevier, 2009.
22. Engineering Principles of Agricultural Machines Ajit K. Srivastava Michigan State University Carroll E. Goering University of Illinois Roger P. Rohrbach North Carolina State University Dennis R. Buckmaster The Pennsylvania State University Copyright 2006 by the American Society of Agricultural and Biological Engineers All rights reserved.
23. Sites where Internet information can be obtained:
http://ru.wikipedia.org/wiki/'Avtotransportnoe_predpriyatie

APPLICATIONS

HIGHER AND SECONDARY SPECIAL EDUCATION OF THE REPUBLIC OF UZBEKISTAN

NAMANGAN ENGINEERING CONSTRUCTION INSTITUTE

Listed : No. 5310600 20 21 years. "___ _______ "	"I CONFIRM" Vice- rector for academic affairs ____________M. Dadamirzayev "___" 202 1 year

VEHICLES OF TRANSPORTATION CONSTRUCTION

SCIENCE PROGRAM

Field of knowledge: 300000 - Production and technical field

Field of Study: 310000-Engineering i

Educational directions : 5310600-Ground transport systems and their operation (vehicle transport)"

NAMANGAN-2021

curriculum of the subject was created on the basis of **the** BD 5310600-1 9 curriculum of OO **MTV** and the working curriculum approved at the meeting No.

Compilers
R. Soliyev- NamMQI, head of the " Ground transport systems " department, doctor of technical sciences.
A. Madrakhimov - National Ministry of Education , Department of " Ground Transport Systems " senior lecturer .
- Head of the Ministry of **Education** , " Ground Transport Systems "

Reviewers :
A. Polvonov - NamMQI Associate Professor of the Department of Ground Transport Systems , tel
A. Abdurakhmonov - Firdavstrans servis LLC, head of the company

The curriculum of the subject was discussed at the "___" - number meeting of Yerusti Transport Systems Department in "___" in 2021 and was recommended for discussion at the faculty council.

Head of the department: ____ M. Boydadaev

curriculum of the subject "Transport" was discussed and recommended for use at the faculty council (minute __ of June __, 2021).

Chairman of the faculty council: ______ B. Makhmudov

It was agreed: Head of the Educational **Methodology Department ,** Assoc **.**
T. Joe **Rayev**

I. Relevance of educational science and its role in higher professional education

On May 4, 2020, the decision of the President of the Republic of Uzbekistan on measures to fundamentally improve the personnel training system in the field of transport was adopted.

In this decision, the system of training highly qualified personnel for the transport sector of the Republic will be fundamentally improved on the basis of advanced foreign experience and international standards, innovative forms and methods of teaching and modern pedagogical and information technologies will be widely introduced into the educational process, as well as network education. examples of strengthening the material and technical base of institutions and increasing their scientific potential were determined.

This subject forms the skills of evaluating the constructive potential of vehicles and using information and communication technologies in future specialists.

II. The goals and objectives of science

The purpose of teaching the subject is to form students' knowledge, skills and competence in accordance with the profile of the field in terms of the classification, structure, operation process of vehicles, as well as the ability to determine the ability to work effectively in certain operating conditions and to assess how well its construction is adapted to the given conditions.

The main tasks of science are as follows:

- to know the development and prospects of the automobile industry transport, the development and prospects of transport and specialized vehicles, the types, parts, nodes, mechanisms, systems of transport and specialized vehicles;
- to know the technical classification and dimensions of the vehicle and the influence of external conditions on operational characteristics;
- the formation of knowledge, skills and competence in accordance with the profile of the direction on the basis of the classification of the vehicle, the work processes of nodes and aggregates and the determination of their effective operation and dependence on work processes in specific operating conditions and the extent to which their construction is adapted to these conditions.

The following requirements are placed on the knowledge, study and skills of students in science:

- about the importance of vehicles in the national economy;
- about the operation of vehicles;
- to know the principle of operation of new technological equipment, the procedure for commissioning and their maintenance and repair system;
- about ways of improving vehicles;
- power unit characteristics and operating conditions vehicles technical to have an idea about the effect on operational indicators;
- use of scientific and technical literature;
- basic operation and description of the engine for the conditions of carrying out transport work

determining indicators;

- basic scientific and technical problems of transport vehicles and tara qq iot isti q balls;
- the function of vehicles, the structure of mechanisms and systems of aggregates;
- indicators of operational characteristics of vehicles;
- basic technical and economic requirements for vehicles;
- to know and be able to use the efficiency criteria of vehicles;
- calculation of vehicles and their assembly for specific operating conditions;
- adaptability and efficiency of vehicles to specific conditions of use development of recommendations for improvement;
- Selection and assembly of vehicles for specific operating conditions;
- calculating the performance characteristics of vehicles;
- it is necessary to have the skills of analyzing and evaluating the construction of vehicles;

III. The main theoretical part (lecture sessions)

Section 1. General structure of the vehicle

Module 1. Automotive development

to science . The goals and tasks of science. The history of the development of the automobile industry. Importance of road transport in the socio-economic development of the Republic.

General structure of the vehicle. General information. Tariff and duty of the vehicle. Passenger vehicle. Cargo transport vehicle. Trailer vehicle. The history of the development of automobile construction. General structure of the car. Technical characteristics and designation (marking).

Module 2. General structure of the engine

Internal combustion d vigatel. Car engine classification, general concepts and basic parameters. Principles of operation of various engines, four stroke engines, two stroke engines, rotor piston engines, gas tube engines. Engine designs. Mechanisms and systems of engines.

Crankshaft mechanism (KShM). KShM tariff and duty. The structure of KShM construction and the principle of their operation. Cylinder block head, piston, piston rings, piston pin, connecting rod, crankshaft, flywheel.

Gas distribution mechanism (GTM) . GTM tariff, function and classification. The structure of the GTM construction and the principle of their operation: valves: guide bushing: pusher: rod: koromislo: distribution shaft:

distribution shaft guide: hydraulic compensator. Description and diagram of gas distribution phase.

Cooling system . Tariff, function and classification of the cooling system . Coolant. The structure of the construction of the cooling system and the principle of their operation: radiator: shutter: liquid pump: fan: hydrocoupling: thermostat.

Lubrication system . Tariff function and classification of the lubrication system. Lubrication methods. Lubrication system construction structure and working principle: Oil pump. Oil elephants. Oil pan (paddon). Oil radiator. Valves. Crankcase ventilation.

Supply system of gasoline engines . Tariff function and general scheme of the supply system of carburetor engines. Combustible mixture and its preparation. Schemes of carburetor devices and their principle of operation. The structure and principle of operation of the devices of the supply system: filters: fuel pump: intake and exhaust pipes: fuel tank: extinguisher.

Advantages of a fuel injection system over a carburetor supply system. Scheme and principle of operation of the fuel injection system. The function and structure of the components of the injection system: electric fuel pump: ramp: injector: pressure adjuster: throttle valve: throttle valve position sensor: salt performance adjuster.

Engine supply system of gas cylinder cars. The general scheme and principle of operation of the gas cylinder supply system. Basic properties of gases. Functions and structure of the equipment used in the supply system of gas engines.

Supply system of diesel engines . Tariff, function and general scheme of the diesel engine supply system. Diesel engine fuel transfer system construction structure and their working principle fuel injection advance clutch: all mode regulator: high pressure fuel pump: injector: fuel drive pump.

The structure of the air supply system construction and the principle of their operation: air filter: pipe: pipe: compressor.

The structure of the construction of the used gas exhaust system and the principle of their operation: extinguisher: ejector: pneumatic cylinder: motor brake.

" Common -rail" system. Common-rail system construction structure and their working principle: low-pressure circuit (fuel tank, drive pump, fuel filter) high-pressure circuit (high-pressure pump, ramp, injector): electronic control unit and sensors.

Module 3. Transmission

Transmission. Clutch coupling . Definition function and classification of transmission. Stepped mechanical transmission. Hydraulic transmission. Electric transmission. Hydraulic transmission.

Definition, function and classification of clutch. The structure of the structure of the friction clutch and the principle of their operation.

The structure and principle of operation of clutch drives.

Gear box and distribution box. Tariff function and classification of gearbox. The structure of the construction of step mechanical transmissions and the principle of their operation: crankcase: shafts: gears: synchronizers: fasteners: locks. What is a multiplier and the scheme of the function of the demultiplier and the principle of operation. The function and principle of operation of the hydromechanical gearbox. Distribution box definition function and classification. The structure and principle of operation of the distribution box structure.

Cardan transmission . Definition, task and classification of the cardan transmission. The structure and principle of operation of the cardan transmission structure: cardan joints: cardan shafts: brikma with an intermediate support slot. Construction and operation of cardan joints with equal and unequal angular velocities.

Main transmission . **D differential and semi-axes.** Tariff, function and classification of main gear. Structure and working principle of the main gear structure: leading shaft: leading and driven gears.

Definition function and classification of differential. The structure and working principle of the differential construction: satellites box: satellites semi-axis shesternies: satellites axis.

Tariff function and classification of semi-axes. Construction of semi-axes.

Module 4. Walking part

The running part of the car . Function and types of lifting system. Types and construction of the function of the frame.

Structure and types of duty of Osman. Osman's construction. Operation and construction of the shock absorber.

Functions and types of wheels. Tire function, types and sizes. The structure of the hub and connecting elements of the wheel. Steering wheel mounting angles.

The function and types of the body: passenger car bodies: bus bodies: truck bodies and cabin. Body ventilation and heating system.

Module 5. Governing bodies

Steering wheel . Functions and types of the steering wheel. The main elements of the steering wheel. Stabilization of steering wheels. The function and construction of the steering mechanism. The function and construction of the steering wheel. Function and construction of power steering.

Brake management . Functions and types of brake control systems. Function, types and construction of the brake mechanism. Function and principle of operation of boosters of braking. The principle of operation of the brake chamber with a spring energy accumulator . Function scheme and principle of operation of the anti-lock braking system.

Specialized vehicles . Pros, Advantages and Disadvantages of ITV. Classification and tasks of ITVs.

Tariff, types and advantages of auto trains. Types of train coupling devices and their requirements.

Definition, function and classification of car body parts. Construction and working principle of lifting mechanism.

Tariff, function and classification of car tanks. Structure and principle of operation of technological equipment of automobile tanks.

Definition, function and classification of car vans.

Cooling systems of refrigerated vans.

II . The theory of operational characteristics of the car

Module 6. Operating characteristics of the car

Operating characteristics of the car. Speed characteristics of the engine. General information about the operational characteristics of the car. The relationship between vehicle construction and operational characteristics.

Types, graphs and operating points of motor speed characteristics.

Traction speed feature. Traction characteristics of the car. Wear resistance bands. Power and torque delivered to the wheel. FIK of the transmission. Traction characteristics of the car. Wheel radii.

Wheel resistance to rolling. The strength of the resistance to the movement to the height. Road resistance. Air resistance. Inertia force. Cohesive force between wheel and road. Normal road-to-wheel reactions.

The equation of motion of the car. Methods of solving the equation. Acceleration of the car. Forces acting on the car during the period of movement.Deriving the equation of motion of the car. Power balance of the car and their analysis. Dynamic factor and characteristics of the car. Car acceleration and its indicators.

Braking characteristics of the car. Braking performance gauges. Derive the equation of motion in braking. Braking dynamics. Time and path of deceleration, braking.

Fuel economy feature of the car. Fuel economy gauges Fuel economy indicators. Fuel consumption equation. Standardization of fuel consumption.

Vehicle handling and stability. Meters of controllability characteristics. Critical speed for controllability. Wheel lateral thrust and vehicle roll. The critical speed for the vehicle to roll over. Controlled wheel vibration.

Stability meters. Stability of the vehicle in the longitudinal plane. Stability of the car in the transverse plane.

The characteristic of the car. Concept of car ownership. Types of domestication. Profile thickness gauges. Basic pressure gauges. Generalized indicators of turgidity.

The smoothness of the car. Gait Fluency Meters. Car vibration. Free and forced vibrations. Car vibration. Effects of vibration and vibration on the human body.

Environmental characteristics of the car. Definition of environmental characteristics of the car, impact on the environment. Measures to reduce the negative impact of the car on the environment. Use of alternative fuel types. Size neutralizers. Hybrid cars. Electric cars.

Noise and vibration tariff, negative consequences. Construction measures to reduce the noise level. Problems of using old cars.

IV. Instructions and recommendations for laboratory work

The following topics are recommended for laboratory work:

1. General structure of the car.
2. General structure of the engine.
3. The general structure of the crankshaft mechanism.
4. The general structure of the gas distribution mechanism.
5. General structure of the cooling system.
6. General structure of the lubrication system.
7. Supply system of gasoline engines.
8. Supply system of diesel engine .
9. Transmission. Clutch coupling.
10. Extensions and distribution boxes.
11. Cardan transmission.
12. Main transmission.
13. Differential and semi-axes .
14. The running part of the car .
15. Car steering wheel .
16. Brake control of the car .
17. Compilation of the technical description of the car .
18. Determination of the number of gears in each step of the transmission and gearbox.
19. Determining the car's center of gravity.
20. Determination of the turning radius of the car in the longitudinal and transverse planes.
21. Overturning of the car on the front and rear axis.
22. Determining the angle at which the leading wheels can rise without swaying.
23. Determination of stability of the car in the transverse plane.
24. Determining the critical speed of the car on the rollover in the turn.
25. Determining the critical speed of the car on the slide.

V. Instructions and recommendations for practical training

1. Calculation of wheel radii, efficiency, number of gears and vehicle speed.
2. Calculation of power, torque and traction forces.
3. Calculate the forces acting on the car.
4. Calculation of gravity and force balance equations. Dynamic factor. Calculation of dynamic characteristics.
5. Calculate the fuel efficiency of the car.
6. Calculation of braking characteristics of the car.
7. Calculation of the stability characteristic of the car.
8. Calculation of vehicle handling characteristics.
9. Calculation of the car's handling and smoothness characteristics.

VI. Independent education and independent work

Independent education is organized in the following forms:

- Identifying and studying the latest achievements of science and technology from the internet system and periodicals, formalizing them in the form of an abstract and giving information about it in the department or seminars:
- Independent processing of information heard on a specific topic in lectures using handouts and mastering additional materials:
- practical assimilation of the construction of existing aggregates and nodes in the educational laboratory on the subject being studied.

A tentative list of recommended independent work topics.
Content and scope of independent education of students

The history of the creation of the car. The history of the creation of hybrid cars. History of automotive industry in Uzbekistan. Prospects of the automotive industry in Uzbekistan. History and prospects of the Samarkand Automobile Plant. History and prospects of GM Power train Uzbekistan automobile plant. History and perspective of GM Uzbekistan automobile plant. History and perspective of MAN Avto Uzbekistan automobile plant. Development trend of car construction. Problems of disposal of old cars. Types of cars. Advantages and disadvantages of cars with different components. Leading car manufacturers of the world. Evolution of the car engine. Engine fuel injection system. Common Rail supply system. Environmental characteristics of the car. Harmful substances in the exhaust gases of car engines. Catalytic neutralizers. The car is a source of noise and vibration. Structural failure of the car. Car bodies. Central tire pressure adjustment system. Anti-blocking system. Grouping of loads and classification of specialized vehicles. Vehicle coupling devices. Analysis of the composition of dump trucks. Analysis of the lifting mechanism of automobile dump trucks. Rolling metal rolling stock vehicles. Pipeline trucks. Trucks carrying heavy loads. Motor trains carrying construction structures. Trucks transporting forest metals.

Oil tankers. Tanks carrying volatile cargo. Food tankers. Self-loaders with loaders. On-board self-loaders with removable bodies. Container carriers
Isothermal vans. Refrigerated vans. Design factors affecting drag-speed characteristics. Operational factors affecting drag-speed characteristics. Factors affecting fuel economy characteristics. Factors affecting braking properties. Factors affecting controllability. Factors affecting the stability characteristic. Factors that influence the nature of turgidity

VII. Methodological instructions for course work

The purpose of the course work is to develop the ability of students to work independently , to acquire practical skills in applying the acquired theoretical knowledge, to accept technical solutions suitable for real conditions in direct production , and to acquire the skills of using modern techniques and technologies .

The scientific coursework is devoted to determining the indicators and characteristics of the vehicle's traction-speed and fuel economy operational characteristics . In particular, the description of the external speed of the engine, graphs of forces and power balance, the dynamic passport of the car, its acceleration, the time and path of increasing the speed, the movement on the given route, the description of fuel economy and xz The topic of the course work is given to each student separately.

VIII. Basic and additional educational literature and information sources

Basic literature

11. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
12. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
13. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
14. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
15. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

Additional literature

14. Vakhlamov. V.K. "Car: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
15. Sidiqnazarov K.M and dr. Motor transport is located in the surrounding area. T: 2007-188 p.
16. Ivanov. A.M. i dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.
17. Vakhlamov. V.K. "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelskiy tsentr" "Akademiya" 2004-528 p.
18. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992
19. Mamatov.Kh, Turdiev.Yu, Kadirkhanov.M Fundamentals of automobile design

and theory. Tashkent. "Teacher" 1982.
20. SM Kadyrov. MOQodirkhanov. Theory of engines and cars. Tashkent. Teacher. 1982
21. Kadyrov. SM Tiko car structure, troubleshooting and repair. Tashkent, "Teacher", 2001.
22. Kadirkhanov.MO Car processes and accounting Tashkent. "Teacher" 2003.
23. Carroll E. Goering, Marvin L. Stone, David W. Smith, Paul K. Turnquist. " Off-Road vehicle Engineering principles " , American Society of Agricultural Engineers, 2006.
24. David A. Crolla. "Automotive Engineering Powertrain, Chassis System and Vehicle Body", Amsterdam, Butterworth-Heinemann is an imprint of Elsevier, 2009.
25. Engineering Principles of Agricultural Machines Ajit K. Srivastava Michigan State University Carroll E. Goering University of Illinois Roger P. Rohrbach North Carolina State University Dennis R. Buckmaster The Pennsylvania State University Copyright 2006 by the American Society of Agricultural and Biological Engineers All rights reserved.
26. Sites where Internet information can be obtained:
http://ru.wikipedia.org/wiki/'Avtotransportnoe_predpriyatie
http://www.mobilautotrans.ru
http://www.autoelectric.ru
http://www.mosautolab.ru
http://uzavtosanoat.uz/

REPUBLIC OF UZBEKISTAN

HIGHER AND SECONDARY SPECIAL EDUCATION

NO MATTER ENGINEERING CONSTRUCTION INSTITUTE

Listed :	"I CONFIRM"
No.______________________	Vice- **rector for** academic affairs
	______ ______ M. Dadamirzayev
20 2 1 y. "____" ________________	"___" 20 2 1 years

VEHICLES OF TRANSPORTATION CONSTRUCTION SCIENCE

WORKING SCIENCE PROGRAM

Field of knowledge: 300,000 - Production and technical field

Field of study: 310000-Engineering work

Educational **directions** : 5310600-"Ground transport systems and their operation"

S is not r	Science content						N torture type	Total study hour
	Lecture	Practical training	Laboratory works	Seminar training	Independent education	Course work (project)		
Day section								
V	48	-	48	-	80	-	written	96
VI	32	16	16	-	72	Course work	written	64

SAMPLE-202 1

The working curriculum of science " ____"_______ 2019 of MTV . Curriculum approved by Order No. ______ and " Ground Transport Systems and Their Operation " approved in 2020 No. BD -____________-- was developed in accordance with the curriculum of science .

Developers:

R. Soliyev - NamMQI, head of the " Ground Transport Systems " department, Doctor of Technical Sciences.

A. Madrakhimov - senior lecturer of the Department of **"** Earth Transport Systems "

S.Imomnazarov - **Head** of the Department of " Ground Transport Systems "

Reviewers:

A. Polvonov - NamMQI Associate Professor of the Department of Ground Transport Systems , tel

A. Abdurakhmanov - head of Firdavstrans service LLC

The working curriculum of the subject **was discussed** at the "_____" **meeting** of the Yerusti Department of Transport Systems in "___" _________________, 2021 and was recommended for discussion at the faculty council.

Head of the department: ________________ M. Boydadayev

The working **curriculum of the subject** Transport It **was** discussed in the council of the faculty and recommended for use.

(Report No. "_____" dated "___" ________________, 2021).

Chairman of the faculty council: ________________ B. Makhmudov

K E L I Sh I L D I:

Departments of specialization:

Кафедра номи	Имзо	Кафедра мудири И.Ф.Ш
Кафедра номи	Имзо	Кафедра мудири И.Ф.Ш
Кафедра номи	Имзо	Кафедра мудири И.Ф.Ш
Кафедра номи	Имзо	Кафедра мудири И.Ф.Ш

Head **of** the **educational** department : _________ Assoc **.** T. **Joe** Rayev

reviewed and recommended by the **academic** council of the Namangan Engineering-Construction Institute . Minutes of meeting number ___ in "__"_____2021. (__ **-** listed with a number **)** .

Relevance of educational science and its role in higher professional education

On May 4, 2020, the decision of the President of the Republic of Uzbekistan on measures to fundamentally improve the personnel training system in the field of transport was adopted.

In this decision, the system of training highly qualified personnel for the transport sector of the Republic will be fundamentally improved on the basis of advanced foreign experience and international standards, innovative forms and methods of teaching and modern pedagogical and information technologies will be widely introduced into the educational process, as well as network education. examples of strengthening the material and technical base of institutions and increasing their scientific potential were determined.

This subject forms the skills of evaluating the constructive potential of vehicles and using information and communication technologies in future specialists.

The goals and objectives of science

The purpose of teaching the subject is to form students' knowledge, skills and competences in accordance with the profile of the field in terms of the classification, structure, operation process of vehicles, as well as the ability to determine the possibility of working effectively in certain operating conditions and how well its construction is adapted to the given conditions.

The main tasks of science are as follows:

- to know the development and prospects of the automobile industry transport, the development and prospects of transport and specialized vehicles, the types, parts, nodes, mechanisms, systems of transport and specialized vehicles;
- to know the technical classification and dimensions of the vehicle and the influence of external conditions on operational characteristics;
- the formation of knowledge, skills and competence in accordance with the profile of the direction on the basis of the classification of the vehicle, the work processes of nodes and aggregates and the determination of their effective operation and dependence on work processes in specific operating conditions and the extent to which their construction is adapted to these conditions.

The following requirements are placed on the knowledge, study and skills of students in science:

- about the importance of vehicles in the national economy;
- about the operation of vehicles;
- to know the principle of operation of new technological equipment, the procedure for commissioning and their maintenance and repair system;
- about ways of improving vehicles;
- power unit characteristics and operating conditions vehicles technical
to have an idea about the effect on operational indicators;
- use of scientific and technical literature;
- basic operation and description of the engine for the conditions of carrying out transport work
determining indicators;
- basic scientific and technical problems of transport vehicles and

tara qq iot isti q balls;
- the function of vehicles, the structure of mechanisms and systems of aggregates;
- indicators of operational characteristics of vehicles;
- basic technical and economic requirements for vehicles ;
- to know the criteria of vehicle efficiency and be able to use them;
- calculation of vehicles and their assembly for specific operating conditions;
- adaptability and efficiency of vehicles to specific conditions of use development of recommendations for improvement;
- Selection and assembly of vehicles for specific operating conditions;
- calculation of the performance characteristics of vehicles;
- it is necessary to have the skills to analyze and evaluate the construction of vehicles;

Interrelationship of the subject with other subjects in the curriculum and methodologically coherent sequence.

- This subject is the first specialized subject taught to students in the 5th-6th semester and is the basis for teaching a number of future specialized subjects.
- This discipline is inextricably linked with higher mathematics, physics, resistance of materials, theory of machines and mechanisms, machine details and theoretical mechanics.
-
- The role of science in science and production.
- Automobile and ITV are widely used in all production, processing, service, healthcare, defense and other sectors of our country and are an inseparable part of our life.
- There are special requirements for vehicles. The most important of them is ecological cleanliness. Therefore, it is desirable to produce the least environmentally harmful types of vehicles.

Modern information and pedagogical technologies in teaching science

- In order for students to master the science of "Transport vehicle construction", it is important to use advanced and modern methods of teaching, to apply new informational and pedagogical technologies. This technology includes the components and interrelationships of the methodical, substantive and communicative support of the interactive educational process and includes important issues that must be implemented:
- - study of advanced foreign and domestic laboratories;
- - compliance of DTS, curriculum and programs with today's requirements;
- - ensuring the consistency of the name and number, sequence and content of subjects.
- Based on these, advanced interactive technologies for organizing the educational process will be developed.
- Textbooks, educational and methodical manuals, lecture notes, handouts, electronic materials, as well as aggregates and units of modern cars and models are used in mastering the subject.
- The following main conceptual approaches are used in the design of the "Vehicle Construction" course :

- Person-centered education. This education, by its essence, envisages the full development of all participants of the educational process. This means that when designing education, it is necessary to approach based on the learning goals related to the future professional activity, not the personality of a specific learner.

- Systematic approach. **Educational technology** should embody all the signs of the system: logic of the process **,** interconnectedness of all **its links** , **integrity** .

- An activity-oriented approach. It represents education aimed **at** forming the process qualities of the person, activating and intensifying the activity of the learner, opening all his abilities and opportunities, initiative in the educational process **.**

- Dialogic approach. This approach implies the need to create **learning** relationships. As a result of it **, the creative activity** of a person increases, such as **self** - activation and ability **to** express **himself** .

- Organization of cooperative education. Democratic, egalitarian, means that it is necessary to pay attention to the introduction of cooperation in the formation of the content of the activity of the teacher and the learner and in the evaluation of the achieved results.

- Problematic education. One of the ways to activate the activity of the learner is by presenting the educational content in a problematic way. In this, the objective contradiction of scientific knowledge and methods of solving it,

- Independent creative activity is expected to form and develop dialectical observation, creatively apply them to practical activities.

- **Use of** modern means and methods of information presentation - use of new computer and information technologies **in the educational** process .

- Teaching **methods** and techniques. Lecture (introduction, topical, visualization), problem-based learning, case-study, pinboard, paradox and design methods, practical work.

- Forms of organization of training: lecture, dialogue, polylogue, frontal, collective and group based on dialogue cooperation **and** mutual learning **.**

- Teaching tools: in addition to traditional forms of teaching (textbook, lecture text) - computer and information technologies, visual-video-animations in science **, real** examples of details and aggregates and work on them **.**

- **interaction** based on operative feedback with listeners .

- Feedback methods and tools: observation, blitz survey **,** intermediate and current and final control results analysis based on training **diagnostics** .

- Management methods and tools: planning of training sessions in the form of a technological card that defines the stages of the training session, **the** joint **action of** the **teacher and the listener in achieving the set** goal , not only audience training **,** but also independent outside the audience. control of works.

- Monitoring and evaluation: systematic monitoring of learning outcomes both during the training session and throughout the course **.** At the end of the course, the knowledge of the trainees will be assessed by means of test tasks or written work options.

- **teaching** the subject "Construction of vehicles" computer technology, "Excel" spreadsheet programs are used. Assessment of students' knowledge on some subjects is done on the basis of tests and with the help of computers. Official economic indicators on **the** "Internet" network **are** used, handouts are prepared, intermediate and final controls are conducted based on **the test system and key words and phrases** .

MAIN PART

Lectures

Main part: Methodologically organic sequence of science

In the main part (lecture), the topics of the subject are presented in a logical sequence. The essence of each topic is revealed through key concepts and theses. **In** this, **the** knowledge and skills **necessary to** be delivered to students on the basis of DTS should be fully covered.

The requirement for the quality of the main part is the relevance of the topics, their compatibility with the demands of employers and the needs of production, covering the priority issues of socio-political and democratic changes taking place in our country **,** the liberalization of the economy, reforms in economic-legal and other fields, and science and it is recommended to take into account the latest advances **in** technology .

Section 1. General structure of the vehicle

Module 1. Automotive development

Lecture 1.

Topic: Introduction to science. (2 hours)

Plan:

1. The goals and tasks of science.
2. The history of the development of the automobile industry .
3. Importance of road transport in the socio-economic development of the Republic.

2nd lecture.

Topic: General structure of the vehicle. (2 hours)

Plan:

1. General information. Tariff and duty of the vehicle.
2. Passenger vehicle.
3. Cargo transport vehicle.
4. Trailer vehicle.
5. The history of the development of automobile construction.
6. General structure of the car.
7. Technical characteristics and designation (marking).

Module 2. General structure of the engine

3rd lecture.

Topic: Internal combustion engines . (4 hours)

Plan:

1. Car engine classification, general concepts and basic parameters.
2. Principles of operation of various engines, four stroke engines, two stroke

engines, rotor piston engines, gas tube engines.
3. Engine designs.
4. Mechanisms and systems of engines.

4th lecture.
Topic: Crankshaft mechanism (KShM). (2 hours)
Plan:
1. KShM tariff and duty.
2. The structure of KShM construction and the principle of their operation.
3. Cylinder block head, piston, piston rings, piston pin, connecting rod, crankshaft, flywheel.

Lecture 5.
Topic: Gas distribution mechanism (GTM) . (2 hours)
Plan:
1. GTM tariff, function and classification.
2. The structure of the GTM construction and the principle of their operation: valves: guide bushing: pusher: rod: koromislo: distribution shaft: distribution shaft guide: hydraulic compensator.
3. Description and diagram of gas distribution phase.

6th lecture.
Topic: Cooling system . (2 hours)
Plan:
1. Tariff, function and classification of the cooling system.
2. Coolant. The structure of the construction of the cooling system and the principle of their operation: radiator: shutter: liquid pump: fan: hydrocoupling: thermostat.

7th lecture.
Topic: Lubrication system . (2 hours)
Plan:
1. Tariff function and classification of the lubrication system.
2. Lubrication methods. Lubrication system construction structure and working principle: Oil pump. Oil elephants. Oil pan (paddon). Oil radiator. Valves.
3. Crankcase ventilation.

8th lecture.
Topic: Supply system of gasoline engines . (4 hours)
Plan:
1. Tariff function and general scheme of the supply system of carburetor engines.
2. Combustible mixture and its preparation.
3. Schemes of carburetor devices and their principle of operation.
4. The structure and principle of operation of the devices of the supply system: filters: fuel pump: intake and exhaust pipes: fuel tank: extinguisher.
5. of a fuel injection system over a carburetor supply system .
6. Scheme and principle of operation of the fuel injection system.
7. The function and structure of the components of the injection system: electric fuel pump: ramp: injector: pressure adjuster: throttle valve: throttle valve position sensor: salt performance adjuster.

9th lecture.

Topic: Engine supply system of gas cylinder cars. (2 hours)

Plan:

1. The general scheme and principle of operation of the gas cylinder supply system.
2. Basic properties of gases.
3. Functions and structure of the equipment used in the supply system of gas engines.

10th lecture.

Topic: Supply system of diesel engines . (4 hours)

Plan:

1. Tariff, function and general scheme of the diesel engine supply system.
2. Diesel engine fuel transfer system construction structure and their working principle fuel injection advance clutch: all mode regulator: high pressure fuel pump: injector: fuel drive pump.
3. The construction of the air supply system and the principle of their operation: air filter: pipe: pipe: compressor.
4. The structure of the construction of the used gas exhaust system and the principle of their operation: extinguisher: ejector: pneumatic cylinder: motor brake.
5. " Common -rail" system.
6. The structure of the "Common-rail" system construction and their working principle: low-pressure circuit (fuel tank, drive pump, fuel filter) high-pressure circuit (high-pressure pump, ramp, injector): electronic control unit and sensors.

Module 3. Transmission

11th lecture.

Subject: Transmission. Clutch coupling . (2 hours)

Plan:

1. Definition function and classification of transmission.
2. Stepped mechanical transmission.
3. Hydraulic transmission. Electric transmission. Hydraulic transmission.
4. Definition, function and classification of clutch.
5. The structure of the structure of the friction clutch and the principle of their operation.
6. The structure and principle of operation of clutch drives.

12th lecture.

Topic: Transmission box and distribution box. (4 hours)

Plan:

1. Tariff function and classification of gearbox.
2. The structure of the construction of step mechanical transmissions and the principle of their operation: crankcase: shafts: gears: synchronizers: fasteners: locks.
3. What is a multiplier and the scheme of the function of the demultiplier and the principle of operation.
4. The function and principle of operation of the hydromechanical gearbox.
5. Distribution box definition function and classification.
6. The structure and principle of operation of the distribution box structure.

13th lecture.

Topic: Cardan transmission . (2 hours)

Plan:

1. Definition, task and classification of the cardan transmission.
2. The structure and principle of operation of the cardan transmission structure: cardan joints: cardan shafts: brikma with an intermediate support slot.
3. Construction and operation of cardan joints with equal and unequal angular velocities.

14th lecture.

Topic: The main transmission . D differential and semi-axes. (4 hours)

Plan:

1. Tariff, function and classification of main gear.
2. Structure and working principle of the main gear structure: leading shaft: leading and driven gears.
3. Definition function and classification of differential.
4. The structure and working principle of the differential construction: satellites box: satellites semi-axis shesternies: satellites axis.
5. Tariff function and classification of semi-axes.
6. Construction of semi-axes.

Module 4. Walking part

15th lecture.

Topic: The running part of the car . (4 hours)

Plan:

1. Types and construction of the function of the frame.
2. Structure and types of duty of Osman.
3. Osman's construction.
4. Operation and construction of the shock absorber.
5. Functions and types of wheels.
6. Tire function, types and sizes.
7. The structure of the hub and connecting elements of the wheel.
8. Steering wheel mounting angles.
9. The function and types of the body: passenger car bodies: bus bodies: truck bodies and cabin.
10. Body ventilation and heating system.

Module 5. Governing bodies

16th lecture.

Subject: Steering . (2 hours)

Plan:

1. Functions and types of the steering wheel.
2. The main elements of the steering wheel.
3. Stabilization of steering wheels.
4. The function and construction of the steering mechanism.
5. The function and construction of the steering wheel.
6. Function and construction of power steering.

17th lecture.

Topic: Brake control . (2 hours)

Plan:

1. Functions and types of brake control systems.
2. Function, types and construction of the brake mechanism.
3. Function and principle of operation of boosters of braking.
4. The principle of operation of the brake chamber with a spring energy accumulator.
5. Function scheme and principle of operation of the anti-lock braking system.

18th lecture.

Topic: Specialized vehicles . (2 hours)

Plan:

1. Pros, Advantages and Disadvantages of ITV. Classification and functions of ITVs.

2. Tariff, types and advantages of auto trains.

3. Types of train coupling devices and their requirements.

4. Definition, function and classification of car body parts. Construction and working principle of lifting mechanism.

5. Tariff, function and classification of car tanks.

6. Structure and principle of operation of technological equipment of automobile tanks.

7. Definition, function and classification of car vans.

Cooling systems of refrigerated vans.

II . The theory of operational characteristics of the car

Module 6. Operating characteristics of the car

19th lecture.

Topic: Operating characteristics of the car. Speed characteristics of the engine. (4 hours)

Plan:

1. General information about the operational characteristics of the car.
2. The relationship between vehicle construction and operational characteristics.
3. Types, graphs and operating points of motor speed characteristics.

20th lecture.

Topic: Traction velocity characteristic. Traction characteristics of the car. Wear resistance bands. (4 hours)

Plan:

1. Power and torque delivered to the wheel.
2. FIK of the transmission.
3. Traction characteristics of the car.
4. Wheel radii.
5. Wheel resistance to rolling.
6. The strength of the resistance to the movement to the height.
7. Road resistance.
8. Air resistance. Inertia force.
9. Cohesive force between wheel and road.
10. Normal road-to-wheel reactions.

21st lecture.

Topic: Equation of motion of a car. Methods of solving the equation. Acceleration of the car. (4 hours)

Plan:

1. Forces acting on the vehicle during movement.
2. Derive the equation of motion of the car.
3. Power balance of the car and their analysis.
4. Dynamic factor and characteristics of the car.
5. Car acceleration and its indicators.

22nd lecture.

Topic: Braking characteristics of the car. (4 hours)

Plan:

1. Braking performance gauges.
2. Derive the equation of motion in braking.
3. Braking dynamics. Time and path of deceleration, braking.

23rd lecture.

Topic: Fuel economy feature of the car. (4 hours)

Plan:

1. Fuel economy gauges
2. Fuel economy indicators.
3. Fuel consumption equation.
4. Standardization of fuel consumption.

24th lecture.

Topic: Vehicle handling and stability characteristics. (4 hours)

Plan:

1. Meters of controllability characteristics.
2. Critical speed for controllability.
3. Wheel lateral thrust and vehicle roll.
4. Critical speed for side-slipping of the vehicle.
5. Controlled wheel vibration.
6. Stability meters.
7. Stability of the vehicle in the longitudinal plane.
8. Stability of the car in the transverse plane.

25th lecture.

Topic: The car's resilience. (4 hours)

Plan:

1. Concept of car ownership.
2. Types of domestication.
3. Profile thickness gauges.
4. Basic pressure gauges.
5. Generalized indicators of turgidity.

26th lecture.

Topic: Characteristics of the smoothness of the car. (2 hours)

Plan:

1. Gait Fluency Meters.
2. Car vibration.

3. Free and forced vibrations.
4. Car vibration.
5. Effects of vibration and vibration on the human body.

27th lecture.
Topic: Environmental features of the car. (2 hours)
Plan:

1. Definition of environmental characteristics of the car, impact on the environment.
2. Measures to reduce the negative impact of the car on the environment.
3. Use of alternative fuel types.
4. Size neutralizers.
5. Hybrid cars. Electric cars.
6. Noise and vibration tariff, negative consequences. Construction measures to reduce the noise level.
7. Problems of using old cars.

"Construction of vehicles" calendar thematic plan of the lecture on science 5 semester YeUTTUE course

T|r	The name of the topics	Separated hour
1	Introduction to science	2
2	General structure of the vehicle	2
3	**Internal combustion d vigatel**	**4**
3.1	Car engine classification, general concepts and basic parameters	2
3.2	Engine designs	2
4	Crankshaft mechanism	2
5	Gas distribution mechanisms	2
6	Cooling system	2
7	Lubrication system	2
8	**Supply system of gasoline engines.**	**4**
8.1	Tariff function and general scheme of the supply system of carburetor engines	2
8.2	Fuel injection system	2
9	Engine supply system of gas cylinder cars	2
10	**Diesel engine supply system**	**4**
10.1	Tariff, function and general structure of the diesel engine supply system	2
10.2	Function and general structure of " Common -rail" system	2
11	Transmission. Connection plug	2
12	**Gear box and distribution box.**	**4**
12.1	Transmission box	2
12.2	T distribution box	2
13	Cardan transmission.	2

14	**Main transmission. Differential and semi-axes.**	**4**
14.1	Main transmission	2
14.2	D differential and semi-axes	2
15	**The undercarriage of the car.**	**4**
15.1	Lifting system	2
15.2	Tire function, types	2
16	Steering wheel	2
17	Brake control	2
18	Specialized vehicles	2
	total	48

Calendar thematic plan of the lecture on "Construction of vehicles".
6 semesters YeUTTUE direction

T|r	The name of the topics	Separated hour
1	**Operating characteristics of the car. Speed characteristics of the engine**	**4**
1.1	Operational characteristics of the car	2
1.2	Speed characteristics of the engine	2
2	**Traction speed feature. Traction characteristics of the car. Wear resistance bands.**	**4**
2.1	Traction speed feature	2
2.2	Traction characteristics of the car	2
3	**The equation of motion of the car. Methods of solving the equation. Acceleration of the car.**	**4**
3.1	The equation of motion of the car	2
3.2	Methods of solving the equation. Acceleration of the car	2
4	**Braking characteristics of the car**	**4**
4.1	Braking process	2
4.2	Equation of motion in braking	2
5	**Vehicle fuel economy feature**	**4**
5.1	Vehicle fuel economy	2
5.2	Fuel consumption	2
6	**Vehicle handling and stability characteristics**	**4**
6.1	Meters of controllability characteristics	2
6.2	Vehicle stability feature	2
7	**The characteristic of the car**	**4**
7.1	Driving a car	2
7.2	Types of domestication	2
8	The smoothness of the car	2
9	Environmental characteristics of the car	2
	Total:	**32**

Recommended topics of laboratory training (5, 6, semester)

General structure of the car. Familiarization with the creation of cars, their development stages, general structure and technical indicators. Study of the general structure of the car and engine. Getting to know the performance indicators of engines.

General structure of the engine. To study the classification, general structure and main parameters of the car engine .

The general structure of the crankshaft mechanism . Study of the general structure of crank-rod mechanisms.

The general structure of the gas distribution mechanism. Study of the general structure of gas distribution mechanisms.

General structure of the cooling system . Study of the general structure of cooling and lubrication systems.

The general structure of the lubrication system . Study of the general structure of cooling and lubrication systems.

Supply system of gasoline engines . Getting acquainted with the function, structure, operation and location of the supply system of a gasoline engine. Fuel injection system. Getting acquainted with the function, structure, operation and location of the supply system of a gas-powered engine.

Supply system of diesel engine . Getting to know the function, structure, operation and location of the diesel engine supply system.

Transmission. Clutch coupling. Transmission. Getting to know the function, types, structure and operation of the clutch.

Extensions and distribution boxes. Getting to know the function, types, structure and operation of the gearbox. Getting to know the function and working principle of the distribution box.

Cardan transmission, main transmission, differential and half-axles . Getting to know the function, types, structure and operation of cardan transmission. Familiarity with the function, types, structure and operation of the main transmission. Getting to know the function, structure and operation of the differential. Familiarity with the function, types, structure and operation of semi-axes.

The running part of the car . Getting to know the types of running parts of the car. Getting to know the function of the running parts of the car. Getting to know the structure of the running parts of the car . Getting to know the operation of the running parts of the car. Acquaintance with the installation of the running parts of the car in the car.

Car steering wheel . Getting to know the types of car steering wheel . Getting to know the function of the car's steering wheel. Getting to know the structure of the car's steering wheel. Getting to know the operation of the steering wheel of the car. Acquaintance with the installation of the car's steering wheel in the car.

Brake control of the car . Getting to know the function of the brake control of the car. Getting to know the operation of the brake control of the car. Acquaintance with the structure and installation of the brake control of the car.
Getting to know the types of car brake pads.

Compilation of the technical description of the car . Get acquainted with the technical classification of the car. Getting to know the technical classification of the car.

Determination of the number of gears in each step of the transmission and gearbox. Familiarity with the functions and types of transmission. Determining the number of gears in each step of the gearbox.

Determining the car's center of gravity. Determining the coordinates of the car's sail center. Determining the distance from the front wheel axle of the car to the center of the sail.

Determining the turning radius of the car in the longitudinal and transverse planes . Acquaintance with the turning radius of cars in the longitudinal plane. Acquaintance with the turning radius of cars in the transverse plane.

Overturning of the car on the front and rear axis. Evaluative parameters. Determination of evaluative parameters. Graphical construction of the trajectory of the train. Specific features of determining maneuverability indicators by laboratory and computational methods.

Determining the angle at which the leading wheels can rise without swaying. Determining rollover angles on the rear axles of the car. Determining the rollover angle on the rear axle of the car.

Determination of stability of the car in the transverse plane. Determining the rollover angle of a car moving with acceleration on a transverse inclined plane.

Determining the critical speed of the car on the rollover in the turn. Driving a car on a curve without swerving from side to side on a straight road

Determining the critical speed of the car on the slide. Determining the critical rollover speed of a car turning on a slope when the turning center is below the slope and above the slope.

No	Laboratory exercises are thematic	hour
5th semester YeUTTUE direction		
1	General structure of the car	2

2	General structure of the engine.	4
3	The general structure of the crankshaft mechanism	4
4	The general structure of the gas distribution mechanism	2
5	Cooling general structure of the system	2
6	General structure of the lubrication system	2
7	Gasoline engine supply system	4
8	Diesel engine supply system	4
9	Transmission. Connection plug	4
10	Extensions and distribution boxes .	4
11	Cardan drive, main drive, differential and half axles	4
12	The undercarriage of the car.	4
13	Car steering wheel	2
14	Car brake control	2
15	Compilation of the technical description of the car	4
Total		**48**

No	Laboratory exercises are thematic	hour
6th semester YeUTTUE course		
1	Determination of the number of gears in each step of the transmission and gearbox.	2
2	Determining the car's center of gravity.	2
3	Determination of the turning radius of the car in the longitudinal and transverse planes.	2
4	Overturning of the car on the front and rear axis	2
5	Determining the angle at which the leading wheels can rise without swaying.	2
6	Determination of stability of the car in the transverse plane.	2
7	Determining the critical speed of the car on the rollover in the turn	2
8	Determining the critical speed of the car on the slide.	2
Total		**16**

Instructions for organizing practical training.

In practical training, students learn the basics of calculating the parameters related to the operational characteristics of the car.

Instructions and recommendations on the organization of practical training will be developed. In it, students enrich the knowledge and skills they have acquired on the main lecture topics by solving practical problems. It is also recommended to strengthen students' knowledge based on textbooks and manuals, use handouts, increase student knowledge by publishing scientific articles and theses, solve problems, prepare visual aids on topics, etc.

Calculation of wheel radii, efficiency, number of gears and vehicle speed. Getting to know the kinematic parameters of the car and solving problems.

Calculation of power, torque and traction forces. Study the meaning of the indicators on this topic and solve the problem

Calculate the forces acting on the car. To study the forces resisting the movement of the car and to determine the power required to overcome them

Calculation of gravity and force balance equations. To study the forces resisting the movement of the car and to determine the power required to overcome them.

Dynamic factor. Calculation of dynamic characteristics. Understanding and calculating the dynamic factor and dynamic description of the car.

Calculate the fuel efficiency of the car. Study and solve problems affecting the factors affecting the fuel economy of a car

Calculation of braking characteristics of the car. Learning the braking process of the car and solving problems.

Calculation of the stability characteristic of the car. Study of the factors affecting the stability of the car and solve problems.

Calculation of vehicle handling characteristics. Understanding and solving problems about the controllability of the car.

Calculation of the car's handling and smoothness characteristics. Understanding and solving problems about the smoothness of the car.

	Subjects of practical training YeUTTUE direction	**hour**
	6th semester	
1	Calculation of wheel radii, efficiency, number of gears and vehicle speed.	2
2	Calculation of power, torque and traction forces	2
3	Calculate the forces acting on the car	2
4	Calculation of gravity and force balance equations.	2
5	Dynamic factor. Calculation of dynamic characteristics . Calculate the fuel efficiency of the car.	2
6	Calculation of braking characteristics of the car	2
7	Calculation of the stability characteristic of the car. Calculation of vehicle handling characteristics	2
8	Calculating the car's handling and smoothness characteristics	2
	Total	16

Form and content of independent education organization

Independent education is organized in the following forms:

- Identifying and studying the latest achievements of science and technology from the internet system and periodicals, formalizing them in the form of an abstract and giving information about it in the department or seminars:
- Independent processing of information heard on a specific topic in lectures using handouts and mastering additional materials:
- practical assimilation of the construction of existing aggregates and nodes in the educational laboratory on the subject being studied.

Suggested freelance work topics.
Content and scope of independent education of students

No	Independent study topics	Assignments given
1.	The history of the creation of the car	Summarizing the topic, creating test questions and preparing presentations
2.	The history of the creation of hybrid cars	
3.	History of automotive industry in Uzbekistan	
4.	Prospects of the automotive industry in Uzbekistan	
5.	History and prospects of the Samarkand Automobile Plant	
6.	History and perspective of GM Power train Uzbekistan automobile plant	
7.	History and prospects of the GM Uzbekistan automobile plant	
8.	History and perspective of MAN Avto Uzbekistan automobile plant	
9.	Development trend of car construction	
10.	Problems of disposal of old cars	
11.	Types of cars	
12.	Advantages and disadvantages of cars with different components	
13.	Leading car manufacturers of the world	
14.	Evolution of the car engine	
15.	Engine fuel injection system	
16.	Common Rail supply system	
17.	Environmental characteristics of the car	
18.	Harmful substances in the exhaust gases of car engines	
19.	Catalytic neutralizers	
20.	The car is a source of noise and vibration	
21.	Structural failure of the car	
22.	Car bodies	
23.	Central tire pressure adjustment system	
24.	Anti-blocking system	
25.	Grouping of loads and classification of specialized vehicles	
26.	Vehicle coupling devices	
27.	Analysis of the composition of dump trucks	
28.	Analysis of the lifting mechanism of automobile dump trucks	
29.	Rolling metal rolling stock vehicles	
30.	Pipeline trains	
31.	Trucks carrying heavy loads	
32.	Motor trains carrying construction structures	
33.	Trucks transporting forest metals	
34.	Oil tankers	
35.	Tanks carrying volatile cargo	
36.	Food tankers	
37.	Self-loaders with loaders	
38.	On-board self-loaders with removable bodies	

39.	Container carriers	
40.	Isothermal vans	
41.	Refrigerated vans	
42.	Design factors affecting drag-speed characteristics	
43.	Operational factors affecting drag-speed characteristics	
44.	Factors affecting fuel economy characteristics	
45.	Factors affecting braking properties	
46.	Factors affecting controllability	
47.	Factors affecting the stability characteristic	
48.	Factors that influence the nature of turgidity	

Note: *Summarizing the topic, creating test questions and preparing presentations*

Methodological instructions for coursework

The purpose of the course work is to develop the ability of students to work independently , to acquire practical skills in applying the acquired theoretical knowledge, to accept technical solutions suitable for real conditions in direct production , and to acquire the skills of using modern techniques and technologies .

The scientific coursework is devoted to determining the indicators and characteristics of the vehicle's traction-speed and fuel economy operational characteristics . In particular, the description of the external speed of the engine, graphs of forces and power balance, the dynamic passport of the car, its acceleration, the time and path of increasing the speed, the movement on the given route, the description of fuel economy and xz The topic of the course work is given to each student separately.

Informative methodological assessment of the program

In the process of teaching this subject:

- From the electronic complex based on the module system for the lectures related to the structural sections of the " **Vehicle Construction " discipline:**
- From educational technologies and practical work games to study the construction of automobile aggregates and units produced in Uzbekistan in laboratory training :
- From 4-level animated multimedia prepared for Nexia, Damas and Matiz cars:
- It is envisaged to use educational films and posters showing the construction of aggregates and nodes of the car, the working process.

Criteria for evaluating students' knowledge of vehicle construction

Students' knowledge is based on the following criteria:

a student makes independent conclusions and decisions, can think creatively, observes independently, can apply the acquired knowledge in practice, understands the essence of science (subject), knows, can express, tell, and is considered to have an idea about science (subject) - 5 (excellent) grade;

when the student observes independently, can apply the acquired knowledge in practice, understands the essence of science (topic), knows, can express, tell, and has an idea about science (topic) - 4 (good) grade;

when the student is able to apply the acquired knowledge in practice, understands, knows, can express, tell the essence of science (topic) and has an idea about science (topic) - 3 (satisfactory) grade;

when it is considered that the student has not mastered the science program, does not understand the essence of the science (topic) and does not have an idea about the science (topic) - it is evaluated with a grade of 2 (unsatisfactory).

The content of the tasks created for the control types must provide an opportunity to objectively and accurately assess the student's learning.

Assessment of student knowledge

1. Assessment of students' knowledge is carried out in a 5-grade system. In this case, grades 5, 4 and 3 are the basis for transferring from one course to another, grades 0, 1 and 2 are not enough to enter the control types, and if the student cannot retake the subject within the specified time, he is considered an academic debtor.

2. Conducting the intermediate control type and evaluating the student's knowledge on this type of control is carried out by the professor-teacher who conducted training sessions on the relevant subject. Intermediate control scores must be summarized at least one week before the final control period and delivered to students by the subject teacher.

Conducting the final type of control and evaluating the student's knowledge on this type of control can be carried out by a professor who did not conduct training sessions or centrally using information communication technologies. If there is no expert in the subject other than the trained professor(s) in the specified subject, the head of the relevant department shall provide the dean of the faculty with an expert at least one month before the final inspection period. applies in writing. In these cases, the faculty dean is directly responsible for finding a subject specialist.

A professor who has conducted training in the relevant subject is prohibited from participating in the final type of control.

Professors and teachers of other higher education institutions in the relevant subject can be involved in conducting the final type of supervision based on an agreement.

3. The student must have passed the intermediate control type before the final control type for the relevant subject. It is the professor-teacher's responsibility to fully cover the students who are participating in the training during the mid-term examinations .

4. who did not pass the intermediate control type and 2”was evaluated with "(unsatisfactory)" grade for this control type will not be included in the final control type.

A student who is not included or not included in the final control type, as well as evaluated with "(unsatisfactory) grade" according to this control type, is considered an academic debtor.2”

5. If the student does not enter the intermediate and (or) final type of control for valid reasons, it is allowed to resubmit the corresponding type of control based on the order of the dean of the faculty.

6. The number of re-submissions by the student should not be more than 2 times during the period given to the student to resubmit the intermediate and (or) final type of control.

7. In case the student fails to pass the intermediate and (or) final type of control the first time, a commission is formed by the dean of the faculty. The composition of the commission is formed from professors and teachers of the relevant subject and experts in the field.

The commission will conduct the second intermediate and (or) final control and evaluate the student.

8. **informs the rector of the institute about the student who has not been able to pay the existing debt during the given period , and this student is dropped from the course based on the order of the rector .**

9. **A student left in the course continues to study the subject(s) in which he has not mastered the subject(s) in accordance with the approved curriculum for the relevant semester of this academic year on a fee-contract basis.**

10. Students who are dissatisfied with the evaluation result have the right to appeal to the Appeals Commission, which is organized by the dean of the faculty.

11. The commission chairman and at least four members are included in

the composition of the appeal commission from among the professors and teachers of the relevant subject who did not participate in the evaluation of the student.

12. If the student is dissatisfied with the evaluation result, he can file an appeal within 24 hours from the announcement of the evaluation result. The appeal submitted by the student must be considered by the Appeals Commission within 2 days.

13. The student has the right to participate in the consideration of the student's appeal.

14. The Appeals Commission will review the student's appeal and make an appropriate decision on its outcome. The decision indicates whether the student mastered the relevant subject or failed to master it. The appeals commission ensures that the relevant decision is delivered to the dean of the faculty and the student.

EVALUATION CRITERIA FOR THE SCIENCE OF TRANSPORT VEHICLE CONSTRUCTION

This subject is taught in the 1st semester according to the curriculum. Science is divided by direction as follows.

The name of the subject	Course of Study	Course	Semesters	Lecture	Experience	Practical training	coursework	Independent education	Total
Construction of vehicles	5310600-"Surface transport systems and their operation"	3	5 - 6	80	64	16	+	160	160

It is recommended that the distribution of ON and YaN grades be as follows, consisting of lecture (including problems, based on handouts), practical and seminar training hours.

Distribution by types of assessment

Semesters	Assessment forms								
	Intermediate assessment - 5 grades								final-5 marks
	I-ON				II-ON				
	Lecture	Practica	Laborator	Independent	Lecture	Practica	Laboratory	Independent	5 marks (written)

				educatio				education	
for the 5th semester	**1-9**	**-**	**1-7**	**1-12**	**10 -1 8**	**-**	**8-15**	**12-24**	
for the 6th semester	**1-4**	**1-8**	**-**	**25-37**	**5-9**	**-**	**1-8**	**38-48**	
Total :	**5 marks**				**5 marks**				**5 marks**

1- interim control tasks 18 hours in the 1st semester lecture and practical training sessions from being carried out so in oral form it is recommended to transfer . Each student can answer the mid-term control tasks orally during the communication during the process of handing in the reports of the practical exercises. Independent work tasks set for mid-term control are performed in written form.

2- midterm control assignments are recommended to be given in the form of written assignments after 18 hours of lectures and practical training in the 1st semester . This paper consists of 3 questions. Each student can answer the mid-term control tasks orally during the communication during the process of handing in the reports of the practical exercises. Independent work tasks set for interim control are performed.

After intermediate controls are conducted and evaluated, the average arithmetic value of all evaluations is calculated. This obtained result determines the student's mastery rate.

Final control is recommended in written form.

The bank of intermediate and final questions will be made available to students at the beginning of the training sessions according to the application.

Note : ***independent study topics, final control and Midterm questions will be delivered to students in the first session***

Recommended reading list

Basic literature

16. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
17. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
18. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
19. Mamatov.X Automobiles (Fundamentals of automobile construction). Part 1. Tashkent, "Teacher", 1995.
20. Mamatov.X Cars (Fundamentals of car construction). Part 2. Tashkent, "Teacher", 1998.

Additional literature

27. Vakhlamov. V.K. "Car: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.

28. Sidiqnazarov K.M and dr. Motor transport is located in the surrounding area. T: 2007-188 p.

29. Ivanov. A.M. i dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.

30. Vakhlamov. V.K. "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelskiy tsentr" "Akademiya" 2004-528 p.

31. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992

32. Mamatov.Kh, Turdiev.Yu, Kadirkhanov.M Fundamentals of automobile design and theory. Tashkent. "Teacher" 1982.

33. SM Kadyrov. MOQodirkhanov. Theory of engines and cars. Tashkent. Teacher. 1982

34. Kadyrov. SM Tiko car structure, troubleshooting and repair. Tashkent, "Teacher", 2001.

35. Kadirkhanov.MO Car processes and accounting Tashkent. "Teacher" 2003.

36. Carroll E. Goering, Marvin L. Stone, David W. Smith, Paul K. Turnquist. " Off-Road vehicle Engineering principles " , American Society of Agricultural Engineers, 2006.

37. David A. Crolla. "Automotive Engineering Powertrain, Chassis System and Vehicle Body", Amsterdam, Butterworth-Heinemann is an imprint of Elsevier, 2009.

38. Engineering Principles of Agricultural Machines Ajit K. Srivastava Michigan State University Carroll E. Goering University of Illinois Roger P. Rohrbach North Carolina State University Dennis R. Buckmaster The Pennsylvania State University Copyright 2006 by the American Society of Agricultural and Biological Engineers All rights reserved.

39. Sites where Internet information can be obtained:

http://ru.wikipedia.org/wiki/'Avtotransportnoe_predpriyatie
http://www.mobilautotrans.ru
http://www.autoelectric.ru
http://www.mosautolab.ru
http://uzavtosanoat.uz /

TESTS

5310600-"Ground transport systems and their operation (Automotive transport) for educational directions

Test assignments from the subject " Construction of vehicles ".

Source: A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015 , 332 pages.

#1. Science chapter - 1 . Science department-1. 1 Difficulty level - 1

Find out which answer fully describes the car's tariff?
A car is a mobile transport vehicle equipped with an engine with an independent energy source and designed to transport goods and people on the roads in cases of comfort and safety or to perform special tasks with the help of devices installed on it. wheeled vehicle
A car is a vehicle equipped with an engine, designed to transport passengers and cargo on roads
A car is a vehicle equipped with an engine, designed to transport passengers and cargo on roads
A car is a means of transport, designed to transport passengers and cargo on roads

#2. Science chapter - 1 . Science department-1. 1 Difficulty level - 2

Define the general structure of the car?
Engine, chassis and body
Engine, brake and steering control
Power transmission, cabin and springs
Engine, wheels and body

No. 3 . Science chapter - 1 . Science department-1. 1 Difficulty level - 1

When the engine works in which mode, the atmosphere is more toxic?
When running at full load
In walking mode
In drift mode
When operating at moderate load

No. 4 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 2

Identify the function of car engines?
The chemical energy produced by the combustion of fuel is converted into thermal energy and thermal energy into mechanical energy
It converts thermal energy of fuel into mechanical energy
The reciprocating motion of the piston is made by turning the crankshaft into a rotary motion
It converts chemical energy into thermal energy

No. 5 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 1

How many systems are there mainly in a car engine?
4
3
6
7th

No. 6 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 1

What types of engines are automotive engines?
Piston internal combustion engines
Piston external combustion engines
Internal combustion engines
External combustion engines

No. 7 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 2

By what measure is the performance of the engine construction evaluated?
Literary capacity
Specified power
Relative mass

Construction weight

No. 8 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 2

Identify which answer best describes the basic performance of an engine?
Displacement, displacement, cylinder diameter, piston path, compression ratio, power, number of crankshaft revolutions, specific fuel consumption, torque
Power, crankshaft revolutions, torque, hourly fuel consumption
Compression ratio, working volume, full volume, cylinder diameter
Comparison and hourly fuel consumption, torque

No. 9 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 1

Determine the mechanisms of the internal combustion engine?
Crankshaft mechanism, gas distribution mechanism
Turning and walking mechanism
Crankshaft and bell mechanism
Fastening and adjustment mechanism

No. 10 . Science chapter - 2 . Science department- 2 . 1 Difficulty level - 2

Determine which part of the crank mechanism performs all the processes of the engine work cycle?
Piston
Connecting rod
Crankshaft
Piston pin

No. 11 . Science chapter - 2 . Science department- 2 . 2 Level of difficulty - 1

Define the function of the crank mechanism?
The advance-retraction movement of the piston is converted into the rotational movement of the crankshaft through the connecting rod
It transmits the force of the gas produced by combustion in the cylinder to the piston
It transmits gas power through the connecting rod to the crankshaft
Ensures smooth rotation of the crankshaft and transmits torque to power transmission mechanisms

No. 12 . Science chapter - 2 . Science department- 2 . 2 Difficulty level - 2

Identify which parts of the crankshaft are moving parts?
Piston, piston pin, connecting rod, crankshaft, flywheel
Piston rings, piston, crankshaft
Connecting rod, cylinder, block, block head
Piston, block base, block-carter

No. 13 . Science chapter - 2 . Science department- 2 . 2 Difficulty level - 2

Identify which of the following parts receives gas pressure and transmits power to the crankshaft through other parts and performs preparatory processes?
Piston
Cylinder
Connecting rod
Piston pin

No. 14 . Science chapter - 2 . Science department- 2 . 2 Level of difficulty - 1

Determine how many times the punch shaft that drives the high-pressure fuel pump rotates when the crankshaft of the YaMZ-236 engine rotates twice?
One time
Twice
Three times
Four times

No. 15 . Science chapter - 2 . Science department- 2 . 3 Difficulty level - 2

Why is the camshaft gear marked?
To ensure correct installation of gas distribution phases
To set the ignition timing

To set the shaft to the position of stabilization of axial displacement
To prevent the gears from breaking

No. 16 . Science chapter - 2 . Science department- 2 . 3 Difficulty level - 1

Determine why it is necessary for the exhaust valve to open before the piston reaches its extreme points and close late?
Improves complete cleaning of cylinders from spent gases
Provides good valve cooling
It ensures complete combustion of the working mixture
Improves faster cooling of the cylinder

No. 17 . Science chapter - 2 . Science department- 2 . 3 Difficulty level - 3

Determine why the distance between the end of the valve stem and the end of the valve stem is necessary?
Parts of the gas distribution mechanism expand under the influence of heat, thereby creating a thermal crack.
To install all the valves evenly and maintain the heat evenly
Open and close the valves slowly so that all the heat does not escape
To keep the bars and bars from bending

No. 18 . Science chapter - 2 . Science department- 2 . 3 Difficulty level - 2

Which answer accurately describes the function of the gas distribution mechanism?
Injecting the combustible mixture or air into the cylinder through the timely intake valve and expelling the spent gas out of the cylinder through the timely exhaust valve
Combustible mixture entering the cylinders and exhaust gases from the cylinder
It enters the mixture through the inlet valve and releases the combustion product
Injecting the working mixture into the cylinder and expelling the smoke

No. 19 . Science chapter - 2 . Science department- 2 . 3 Difficulty level - 1

Determine the representation of the gas distribution phase?
Graphic representation of the opening and closing period of the intake and exhaust valves relative to the end points of the piston and the rotation of the crankshaft in degrees
Representation of the opening period of the intake and exhaust valves relative to the end points of the piston by the crankshaft rotation angles
Correspondence of the turning angle of the crankcase to the open position of the intake and exhaust valves at the same time
The flow of new fuel mixture and spent gases are reversed

No. 20 . Science chapter - 2 . Science department- 2 . 4 Level of difficulty - 2

What are the cooling networks of liquid movement?
Thermosiphon, mixed and forced
Thermosiphon, mixed
Thermosiphon, mandatory
Mixed, mandatory

No. 21 . Science chapter - 2 . Science department- 2 . 4 Level of difficulty - 1

Determine what happens when the engine runs without a thermostat?
When the engine runs from an acceptable (optimal) temperature to a lower temperature, the wear of the piston and cylinder increases, the oil does not reach the lubrication system in time, the parts work without oil, the wear of the joints increases
During the winter, the coolant in the engine gets too cold and the engine's operation mode is disturbed
In summer, the coolant around the cylinder heats up
Combustion of the combustible mixture inside the engine cylinder becomes worse

No. 22 . Science chapter - 2 . Science department- 2 . 4 Level of difficulty - 2

Identify how the engine cooling system works?
Accelerates the process of dispersing the heat in the engine cylinders, block crankcase and block cover

to the outside environment through liquid or air, and ensures efficient operation of the engine in comfortable conditions.
It evenly distributes the heat released from the heated parts of the engine to the external environment
Accelerates the process of dispersing the heat released from the engine parts and ensures the engine to work in an optimal mode
It cools the cylinder block by dispersing the heat from the hot parts of the engine to the outside environment

No. 23 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 1

Identify the function of the thermostat in the cooling system?
It provides short-path cooling of the engine to accelerate the heating of the liquid in the cylinder case after the engine is started, and long-path cooling of the engine when the engine overheats, and automatically adjusts the optimal temperature in the cooling system.
Prevents the engine from overheating
Accelerates the cooling of the coolant in the engine and ensures that it is at a normal temperature in the automatic mode.
Prevents the engine from overheating

No. 24 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 3

On what account does the centrifuge in the lubrication system turn or work?
Due to oil pressure
At the expense of the electric motor
At the expense of the engine
At the expense of air

No. 25 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 1

Determine what products the oil is contaminated with during the operation of the engine?
Dust and metal particles from the friction of parts
Dust particles
Metal particles from incomplete combustion
Body particles

No. 26 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 2

Determine the cause of oil quality deterioration during engine operation?
The oil becomes diluted and loses its lubricating properties
The viscosity of the oil increases
The viscosity and lubricity of the oil decreases
The viscosity of the oil decreases

No. 27 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 2

Find out where the oil goes from the oil nozzle of the centrifugal filter?
To the engine crankcase
To the oil main
To the oil radiator
Crankshaft

No. 28 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 2

Oil elbow v alga Find out what happens when you don't?
The crankshaft journals are corroded and the bearings melt
Connecting rod and support necks are eaten
Metal strips are formed on the crankshaft necks
The crankshaft becomes unusable

No. 29 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 1

this answer, determine whether the function of the lubrication system is fully rated?
Reduces friction and wear by continuously supplying oil to the surfaces between the moving parts and absorbs and cools the heat from the parts
Reduces friction and wear and repels oils from surfaces

It continuously supplies oil to the surfaces between the frictional parts of the engine
Partially cools the rubbing surfaces, absorbs metal particles formed during friction and cleans them

No. 30 . Science chapter - 2 . Science department- 2 . 5 Difficulty level - 1

Determine which part of the crankshaft additionally cleans the oil that goes to the connecting rod bearings?
Connecting rod neck
Core neck
Posangi
Makhovik

#31. Science chapter -2. Science Department-2. 6 Difficulty level -1

Which device constantly maintains the fuel level in the carburetor regulator?
Turtle
Atmospheric hole
Jiklyor
Air curtain

#3 2 . Science chapter -2. Science Department-2. 6 Level of difficulty - 2

which combustion mixture will cause a sudden drop in engine power, misfiring, and a loud muffler noise?
Deep
Liquefied
Liquid
Normal

#3 3 . Science chapter -2. Science Department-2. 6 Level of difficulty - 1

Define the function of the supply system of a carbureted engine?
The supply system cleans the air with fuel and prepares a combustible mixture of the required composition, enters the cylinder and expels the used gases.
With its flammability, it prepares a combustible mixture of the required composition from the air
Provides fuel to the car engine
Prepares a combustible mixture and expels the gas produced by combustion

#3 4 . Science chapter -2. Science Department-2. 6 Level of difficulty - 2

Which device of the carburetor balances the pressure in the valve chamber?
Atmospheric hole
Air curtain
Jiklyor
Camera with shield

#3 5 . Science chapter -2. Science Department-2. 6 Level of difficulty - 2

Determine which device of the carburetor adjusts the amount of combustible mixture delivered to the cylinder?
Throttle valve
Atmospheric hole
Jiklyor
Air curtain

#3 6 . Science chapter -2. Science Department-2. 6 Level of difficulty - 1

How many types of reducers are there in gas cylinder car engines?
Low and high
High
Low
Reducers are not differentiated

#3 7 . Science chapter -2. Science Department-2. 6 Difficulty level - 3

In the heaters installed on ZIL-138A and GAZ-53-27 cars, which thermal energy of the engine is used to preheat the compressed gas?
From the temperature of the used gases

From the temperature of the coolant
From atmospheric temperature
From temperature to cabinada

#3 8 . Science chapter -2. Science Department-2. 7 Difficulty level - 2

Which engine has the highest compression ratio?
In diesel
In the carburetor
Carburetor and diesel
In a turbine engine

#3 9 . Science chapter -2. Science Department-2. 7 Difficulty level - 2

Determine which part sprays the fuel into the cylinders.
Forsunka
Hand pump
Return valve
High pressure fuel pump

No. 40 . Science chapter -2. Science Department-2. 7 Difficulty level - 1

Define the function of high pressure fuel pump?
At the specified time, it injects a certain amount of fuel into the cylinder with high pressure
It ensures that fuel is injected into the cylinders at the right time
Improves fuel quality
Cleans the fuel according to the engine load and the number of revolutions of the crankshaft

No. 41 . Science chapter -2. Science Department-2. 7 Difficulty level - 2

How many ways are carburetor engines converted to gaseous fuel?
2
4
6
3

No. 42 . Science chapter -2. Science Department-2. 7 Difficulty level - 1

How many types of gas cylinder devices are divided into?
2
4
6
3

No. 43 . Science chapter -2. Science Department-2. 7 Difficulty level - 2

The starting pressure of the opening of the safety valve in the gas reducer?
1.68 MPa
0.68 MPa
1.76 MPa
1.80 MPa

No. 44 . Science chapter -2. Science Department-2. 7 Difficulty level - 3

Why is pipe blowing (pipe blowing) used in diesels?
Rapid filling of the cylinder with fresh air and rapid release of spent gases
It mixes cold air with hot air and keeps the engine running
Keeps the engine running smoothly
It has the main effect on the performance of the engine and ensures its operation

No. 45 . Science chapter - 3 . Science department- 3 . 1 Difficulty level - 1

Determine if the clutch disengages when the car is moving at a certain speed?
In order to reduce fuel consumption and wear of engine parts
To reduce moving masses
To disconnect the engine from the transmission
In order to reduce the amount of fuel

#46. Science chapter - 3 . Science department-3. 1 Difficulty level -1

Determine what the working method of the clutch is based on?
To use the forces of friction
To use the forces of inertia
To use centrifugal forces
To use the torque of friction

#4 7 . Science chapter - 3 . Science department-3. 1 Difficulty level -1

Which answer best describes the function of the clutch?
When the car is moving from a standstill and moving, the engine briefly disengages the crankshaft without power transmission and smoothly engages them
Transmits the engine torque from the engine to the drive wheels and ensures a smooth start of the vehicle.
Temporarily disconnects the engine from the power transmission when the vehicle is starting and moving
Temporarily disconnects engine rotation without power transmission

No. 48 . Science chapter - 3 . Science department-3. 1 Difficulty level - 2

Determine when the clutch is disengaged, that is, the engine is disengaged from the power transmission?
When descending
When braking on slippery roads
When the vehicle is moving from a standstill
When changing extensions

No. 49 . Science chapter - 3 . Science department-3. 1 Difficulty level - 2

Determine which of the following answers contains a complete list of all the components and mechanisms of the car's power transmission?
Clutch, gearbox, cardan drive, main drive, differential and half axles
Drive wheel, drive axle and clutch
Gearbox, cardan transmission and half-axles
Transfer case, cardan drive, main drive and half axles

No. 50 . Science chapter - 3 . Science department-3. 1 Difficulty level - 2

The operation of the friction clutch.......?
Mechanical, hydraulic, electromagnetic
Mechanical, hydraulic
Hydraulic, electromagnetic
Hydraulic, electromagnetic, single disc

No. 51. Science chapter -3. Science department-3. 2 Difficulty level -2

In which types of cars are cylindrical main gears used?
In front-wheel drive cars with a transverse engine
In cars with an upright engine
an engine (V) shape
In cars with a transverse engine

#5 2 . Science chapter -3. Science department-3. 2 Difficulty level - 3

Determine the sequence of motion transmission of double main gear gears?
A small bevel gear transmits to a large bevel gear and a small spur gear to a large spur gear
A large bevel gear drives a small cylindrical gear
A small bevel gear transmits to a small spur gear and a large bevel gear transmits a large spur gear to a large spur gear
A small bevel gear transmits a large spur gear to a large bevel gear

#5 3 . Science chapter -3. Science department-3. 2 Difficulty level - 3

What is the function of a synchronizer?
equalizing the angular velocities of the meshing gear teeth before meshing, the friction between the teeth is eliminated.
Accelerates the angular velocities of the connecting gear teeth and reduces chatter between the teeth
By equalizing their angular velocities before meshing, meshing gear teeth partially reduce the impact

between the teeth
Enables silent engagement of extension teeth

#5 4 . Science chapter -3. Science department-3. 2 Level of difficulty - 1

Determine what the function of the gearbox is?
The screwdriver in the motor changes the amount and direction of the torque
The engine disconnects the crankshaft from the power transmission for a long time
The screwdriver changes the amount of torque and the direction of movement
Changes the speed and direction of movement of the vehicle

#5 5 . Science chapter -3. Science department-3. 2 Difficulty level - 3

Determine the number of transmissions for each gear of the gearbox by which expression?
$U_K = \sqrt[n-1]{U_I^{\,n-k}}$
$U_K = \sqrt{U_I^{\,n-k}}$
$U_K = \sqrt{U_I^{\,n-1}}$
$U_K = \sqrt[n+1]{U_I^{\,n-1}}$

#5 6 . Science chapter -3. Science department-3. 2 Level of difficulty - 2

Find out what the mechanism of adding extensions consists of?
It does not allow two transmissions to merge at once
It does not allow extensions to separate by themselves
Prevents extensions from adding themselves
Easily add and remove extensions

#5 7 . Science chapter -3. Science department-3. 2 Level of difficulty - 1

Determine the function of cardan transmission from the given answers?
With the help of shafts whose axes are misaligned and can change their position, the torque is transmitted from one unit of the power transmission to another unit.
With the help of shafts whose axes are perpendicular to each other and changing their position, the torque is transmitted to another unit of the power transmission.
With the help of shafts whose axes are not aligned with each other and do not change their position, the torque is transmitted from one unit of the power transmission to another unit.
The screwdriver transmits the torque from the gearbox to the main gear

#5 8 . Science chapter -3. Science department-3. 2 Difficulty level - 3

Define the function of car power transmission?
With the help of several mechanisms, the torque received from the engine is transmitted to the leading wheels by changing the amount and direction of movement.
The torque from the engine is changed and transmitted to the leading wheels
The torque received from the engine through the unit and mechanisms performs its function by changing the torque
The torque from the motor changes the amount and direction

#5 9 . Science chapter -3. Science department-3. 2 Difficulty level - 2

Determine how the step gearbox changes the torque?
As a result of connecting different pairs of gears by changing the number of gears
As a result of separating and connecting extension teeth
As a result of disconnecting a pair of gears
As a result of changing gears

No. 60 . Science chapter -3. Science department-3. 4 Level of difficulty - 2

Which of the following cars uses cardan joints with the same angular velocity?
Gaz-66, Zil-131
Gazelle, Damas
Zil-130, Kamaz-5320
Nexia, tiko

#61. Science chapter -3. Science department-3. 4 Level of difficulty - 2

Identify which answer fully describes the function of the main gear?
The cardan always increases the amount of torque coming from the shaft or the engine, and transmits the torque to the half-axes at an angle of 90 degrees.
It changes the number of revolutions transmitted to the driving wheels
A propeller shaft or a screwdriver transmitted from the engine increases the torque and distributes it to the semi-axes
The screwdriver transfers the torque to the semi-axes by changing the amount and direction

#6 2 . Science chapter -3. Science department-3. 4 Level of difficulty - 2

Determine what are the requirements for the design of the main gear?
Having the smallest dimensions should work smoothly and without noise
It should provide the minimum number of transmissions
It should have a high efficiency
It should provide the number of transmissions with the required amount

#6 3 . Science chapter -3. Science department-3. 4 Level of difficulty - 1

Identify what types of primary transmission are used in modern cars?
Single main pass
Integrally located double main gear
Detachable double main gear
Hypoid single main gear

#6 4 . Science chapter -3. Science department-3. 4 Level of difficulty - 2

Find out what type of gearbox is installed in modern cars?
Phased
Frictional
Hydromechanic
Electromechanic

#6 5 . Science chapter -3. Science department-3. 4 Level of difficulty - 1

Identify the main function of the differential from the given answers?
When the car is turning, it transmits the number of revolutions of the driving pinion in the main gear to the leading wheels with a different number of revolutions.
When the car is turning, it transfers the rotational angular velocity of the leading wheels to the axles
When the car is turning, it ensures that the outer and inner leading wheels have different paths
The driving wheel allows its semi-axes to rotate at different angular speeds

#6 6 . Science chapter -3. Science department-3. 4 Level of difficulty - 1

From the given answers, identify the function of semi-axes?
The torque from the differential is transmitted to the driving wheels
Directly connects the drive wheels with the differential
It transmits the movement from the differential to the wheels
The rotational motion in the differential is transmitted to the leading wheels at different speeds

#6 7 . Science chapter -3. Science department-3. 4 Difficulty level - 3

On which shaft of the gearbox is the synchronizer installed?
It is on the mounting shaft
Yes, it is installed on the shaft
Intermediate shaft
The reverse is on the block shaft

#6 8 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 1

Identify the function of car suspension from the following answers?
Reduces dynamic loads on the wheels, reduces and dampens their vibrations, and controls the position of the car body during movement
A means of providing an elastic connection between bridges and frames or bodies
Reduces dynamic loads on the wheels
A structure that provides an elastic connection between wheels and bridges

#6 9 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 2

Identify the function of car frame from the given answers?
The base that holds the vehicle aggregates and mechanisms and receives the forces acting on it
Engine, cabin and body mounting part
Aggregates are fixed vehicle base
A unit that receives various forces of movement between the wheel and the suspension

No. 70 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 1

Identify the function of a car tire from the given answers?
Designed to reduce dynamic forces on the wheel
It provides a dynamic force acting on the wheel to increase its grip on the road.
Improves the engagement of the wheel with the road surface
Makes the car move smoothly

No. 71 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 1

Determine the function of the front and rear axle of the car from the given answers?
Aggregate that receives and absorbs impulse forces that appear between the suspension and wheels
Aggregate that receives the forces generated between the wheels and the suspension
Vehicle unit that receives any power
Aggregate reducing thrust forces

No. 72 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 2

Determine the function of shock absorber from the given answers?
A part that dampens the vibration of the car body
It dampens the vibrations caused by the up and down movement of the car wheel
It dampens the vibrations generated in the car's tread
Reduces vibrations that occur in a moving car

No. 73 . Science chapter - 4 . Science department- 4 . 1 Difficulty level - 2

What types of suspensions are used in most cars?
Spring, pneumatic, hydropneumatic, spring
Lever, telescopic, finger, push
Piston, pusher, lever, spring
Spring, piston, ring, bar

No. 74 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 2

What type of steering is used in cars?
Mechanically operated
Electric
Gear drive
Hydraulic drive

No. 75 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

Define controllable dimensions?
Turning radius, turning angles of front right and left wheels, slip angles of axles, dimensions of vehicle base and axles
Vehicle width, height, base, speed and fuel consumption
Dimensions of movement speed, turning speed, turning radius, location of the center of gravity
Front wheel radius, width, angular speed

No. 76 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

Determine in which answer the role of the steering wheel is fully given?
A device that allows the driver to change the direction of the car by turning the front wheels to the right or left
The driver is a set of mechanisms and parts that ensure movement in a specified direction
Changes the direction of movement of the front leading wheels
A driver, a mechanism that provides movement in a specified direction

No. 77 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 2

Identify which part hinges the pivot pin arms?
Transverse pull

Longitudinal traction
Front axle
Side wings

No. 78 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

Determine the torque on the steering shaft is transmitted to which part of the steering wheel?
To the steering mechanism
To the steering wheel
To the steering trapeze
To the steering wheel

No. 79 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

Determine which part of the steering wheel is hinged?
Longitudinal steering rack
Cross steering rack
Transverse side arm
Front axle

No. 80 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

What is the steering trapezoid made of?
Front axle, side arms and transverse steering rack
Axle axles, crossbars and side arms
Front axle, side arms and longitudinal steering rack
Front axle and side arms

No. 81 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 1

Define the function of the steering wheel?
It ensures that the front wheels turn at the same angle when turning
It ensures that the rotation speed of the wheels is the same during the turn
Prevents wheel slip during turning
It makes turning the wheels easier

No. 82 . Science chapter - 5 . Science department - 5 . 1 Difficulty level - 2

What part does the drive shaft rotate?
Steering gear screw
Steering wheel
Piston rod
Soshka Vali

No. 83 . Science chapter - 6 . Science department- 6 . 1 Difficulty level - 3

Parking grid of GAZ-53 car identify the type?
A snare drum
Disc friction
Ribbon drum
With cable well

No. 84 . Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

Which answer fully describes the function of a car's brake control?
A set of mechanisms and structures that act to slow down the movement of the car
A mechanism that slows down the movement of the car
A structure that serves to slow down the movement of the vehicle
A mechanism that performs the function of braking a car

No. 85 . Science chapter - 6 . Science department- 6 . 2 Difficulty level - 3

Find out which braking systems are used for the braking of cars with a large mass and intended for operation in mountain conditions?
Auxiliary brake
A brake that keeps the car in place
Working brake
Spare brake

No. 86 . Science chapter - 6 . Science department- 6 . 2 Difficulty level - 3

Determine how many degrees of freedom the car body and cabin vibrate in space?
Six
Three
Four
Two

No. 87 . Science chapter - 7 . Science section-7.1 Difficulty level - 1

Find out in which mode the engine's parts are eaten more strongly?
In sending away
the s a lt works
At medium load
At full load

No. 88 . Science chapter - 7 . Science section-7.1 Difficulty level - 2

Define the main indicators of the car?
Load capacity, tare weight, laden weight, turning radius, top speed, 100 kmfuel consumption, braking distance, base, width, height, engine type, vehicle type
Vehicle type, speed, base, height, width
Maximum speed, turning radius, load capacity, braking distance
Turning radius, weight with cargo, 100 kmfuel consumption, braking distance, length of the car

No. 89 . Science chapter - 7 . Science section-7.2 Difficulty level - 2

Determine the car's dynamics factor?
The ability to move cargo and passengers at the maximum average speed while maintaining traffic safety under specified road conditions
The ability to safely transport cargo on a designated route
The ability to transport goods on the road at an average speed
Ability to move quickly while maintaining safety

No. 90 . Science chapter - 7 . Science section-7.1 Difficulty level - 3

Define the dynamic factor of a vehicle?
The force per unit of full weight of the vehicle is called dynamic factor of the vehicle
the unused excess traction force to the vehicle's full weight force g $_{\alpha}$is called the dynamic factor of the vehicle
It is called the dynamic factor of gravity
Non-stop operation of the vehicle is called its dynamic factor

No. 91 . Science chapter - 7 . Science section-7.1 Difficulty level -2

What operational characteristics of the vehicle are determined?
Traction Dynamics, Braking Dynamics, Fuel Economy, Handling, Stability, Agility and Ride Smoothness
Gravitational force, inertial force, torque, laws of motion, load carrying capacity, gravity and center of gravity
Forces acting on a moving vehicle, dynamic factor, dynamic passport and fuel economy
Speed, acceleration, road slope, road resistance, wheel contact force with the road surface

No. 92 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Define the theory of operational characteristics of the vehicle?
The part that defines the laws of movement of the vehicle, operational characteristics, factors affecting the characteristics, improvement of the construction of the vehicle, economic efficiency and methods of efficient use of the vehicle.
The theory of operational properties is a science that studies the laws of motion and operational properties, a part based on such disciplines as theoretical mechanics, the theory of mechanisms and machines, resistance of materials
A department that teaches ways of further shaping the vehicle structure, optimal organization of the cargo transportation process, and methods of solving economic issues
A department that teaches ways to improve vehicle operation, performance, and fuel economy.

No. 93 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Define acceleration dimensions?
Time and path of acceleration
Path and period of acceleration
Acceleration period and amplitude
Acceleration time and frequency

No. 94 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Determine the balance of power of the forces acting on the vehicle?
* $N_K = N_a + N_f + N_W + N_{ja}$
$N_K = N_a - N_f - N_W - N_{ja}$
$N_K = N_a - N_f + N_W - N_{ja}$
$N_W = N_{ja} + N_f + N_a + N_k$

No. 95 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Determine the balance of forces acting on the vehicle?
$P_k = P_a + P_f + P_{ja} + P_W$
$P_a = P_f + P_{ja} + P_k + P_W$
$P_{ja} = P_k + P_a + P_f + P_W$
$P_{ja} = P_k + P_a + P_f + P_W$

No. 96 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Define vehicle traction dynamics?
It ensures that the vehicle moves at the maximum average speed under certain operating conditions
It ensures the movement of the transport vehicle on the designated road
Makes the vehicle move at an average speed
Ensures the movement of the vehicle with the maximum average speed

No. 97 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Determine the traction force of the vehicle?
$P_K = \frac{M_к}{r}$
$P_K = \frac{M_e}{r}$
$P_\varphi = G_a \cdot \varphi$
$P_\alpha = G_a \cdot \sin\alpha$

No. 98 . Science chapter - 7 . Science section-7.1 Difficulty level -3

Determine the equation of motion of the vehicle?
$\mathrm{P_k} + \mathrm{P}_\psi + \mathrm{P_{ia}} + \mathrm{P_w} = 0$
$\mathrm{P}_\varphi + \mathrm{P}_f + \mathrm{P_w} + \mathrm{P_{ia}} = 0$
$\mathrm{P_f} + \mathrm{P}_\varphi + \mathrm{P_k} + \mathrm{P}_\psi = 0$
$\mathrm{P_k} + \mathrm{P}_\psi + \mathrm{P_{ia}} + \mathrm{P_f} = 0$

No. 99 . Science chapter - 7 . Science section-7.1 Difficulty level -3

What indicators of the external speed description of internal combustion engines of the vehicle are determined by calculating?
$N_{ex}, M_{ex}, g_{ex}, g_{en}, G_{ёx}$
$P_e, M_x, g_e, n, G_ё, V_h$
$V_л, V_h, D, S, R$
$M_e, N_x, g_e, G_ё$

No. 100 . Science chapter - 7 . Science section-7.2 Difficulty level -2

Determine what type of wheel brake was used in the working brake system of the GAZ-53A car?
Kolodkal i
Disk
Drum type
Ribbon

No. 101 . Science chapter - 7 . Science section-7.3 Difficulty level -2

Define the function of disc brake?
A frictional brake where the force of friction occurs on both sides of the disc
Friction brake, which occurs on the surface of the friction disc
A frictional brake that occurs on one side of a rotating disc
A pad brake where the frictional force appears on the surface of the disc

No. 102 . Science chapter - 7 . Science section-7.3 Difficulty level -2

Define braking dimensions?
Amount of acceleration, braking time and braking distance
Time and path of acceleration of the wheel
Wheel deceleration time path
Time and path of rapid rotation of the wheels

No. 103 . Science chapter - 7 . Science section-7.3 Difficulty level -2

Define braking process?
Provides deceleration and effective braking of the vehicle
Reduces movement acceleration
Turns off movement speed
Accelerates wheel braking

#10 4 . Science chapter -7. Science section-7.4 Difficulty level -2

Determine the fuel consumption of a car engine in one hour?
$G_{ё} = g_e \cdot N_e \cdot 10^{-3}$
$G_{ё} = \frac{N_e}{g_e \cdot 10^3}$
$G_{ё} = \frac{10^3}{g \cdot N_e}$
$G_{ё} = \frac{g_e}{N_e \cdot 10^3}$

#10 5 . Science chapter -7. Science section-7.4 Difficulty level -2

by the car 100 kmto cover the distance?
$Q_S = \frac{g_e \cdot N_e}{10 \cdot \rho_{ё}}$
$Q_S = \frac{N_e \cdot 10}{g_{ё} \cdot \rho_{ё} \cdot V_a}$
$Q_S = \frac{g_e \cdot 10}{N_e \cdot \rho_{ё} \cdot V_a}$
$Q_S = \frac{10 \cdot g_e \cdot N_e}{\rho_{ё} \cdot V_a}$

#10 6 . Science chapter -7. Science section-7.4 Difficulty level -2

Determine what causes a thickened mixture when starting a cold engine?
With full closing of the air flap
With full throttle opening
By half-closing the throttle

By partially closing the air damper

#10 7 . Science chapter -7. Science section-7.4 Difficulty level -2

Determine what type of fuel pump is used in the supply system?
Diaphragmatic
Piston
Sh e sternal
Don't run away from the center

#10 8 . Science chapter -7. Science section-7.4 Difficulty level -2

Determine what composition of the combustible mixture is used when the engine operates at maximum load?
Enhanced
Liquefied
Liquid
Normal

#10 9 . Science chapter -7. Science section-7.4 Difficulty level -3

What indicators of the external speed description of internal combustion engines of the vehicle are determined experimentally?
$N_e, M_e, G_ё, g_e$
$N_{e,} P_e, \eta_e, V_h$
$M_e, g_e, P_i, V_л$
P_e, n, P_i, N_i

#1 10 . Science chapter -7. Science section-7.5 Difficulty level -2

Define the definition of a controlled property of vehicles?
Steering wheel and changing the direction of the car at the will of the driver
Steering wheel change the direction of movement by the trapezius
The ability to turn the car
Front wheel spin

#1 11 . Science chapter -7. Science section-7.5 Difficulty level -3

Determine the relationship between the turning angles of the front wheels?
$ctg\Theta_T - ctg\Theta_N = 2\frac{B}{L}$
$ctg\Theta_N + ctg\Theta_T = 2\frac{B}{L}$
$\frac{ctg\Theta_T}{ctg\Theta_N} = \frac{L}{2B}$
$ctg\Theta_T + ctg\Theta_N = 2\frac{B}{L}$

#11 2 . Science chapter -7. Science section-7.5 Difficulty level -3

Identify what type of brake mechanism is installed on the front wheels of modern passenger cars?
Disk
Roped
Drum barrel
Kolodkali

#11 3 . Science chapter -7. Science section-7.5 Difficulty level -3

wheel to move without wobble?
$P\varphi = G_2 \cdot \varphi \geq P_k$
$P\varphi = G_1 \cdot \varphi \geq P_k$
$P_k = G_2 \cdot \varphi \geq P_\varphi$

$P\varphi = G_1 \cdot \varphi \le P_k$

#11 4 . Science chapter -7. Science department-7. 8 Difficulty level - 1

Define the dynamic passport of a vehicle?
A collection of drawings illustrated together with speed dynamic factor graphs, weight nomograms and lead wheel slip control graphs
Aggregate graphs of dynamic factors, weights, and leading wheel wobble
Graphs of dynamic factors, nomogram of weights and forms of graphs of wheels without chattering
Compilation of traction characteristics, weight nomograms and all-wheel drive control charts

#11 5 . Science chapter -7. Science department-7. 8 Difficulty level - 3

Determine the transverse stability of the vehicle on an inclined road?
$tg\beta = B/2h_M$
$cos\beta = B/2h_M$
$\sin\,\beta = B/2h_M$
$ctg\beta = B/2h_M$

#11 6 . Science chapter -7. Science department-7. 8 Difficulty level - 3

Determine the geometric dimensions of the turgidity?
Front and back angles, longitudinal radius, transverse radius and height of the overhang
The distance between the bridge and the road surface and the wheel radius
Width, height and base of the car
The distance between the front and rear wheels

#11 7 . Science chapter -7. Science department-7. 8 Difficulty level - 3

What differentials are used in high-performance cars?
Inter-axle differential
Wheel differential
Inter-axle, inter-wheel differential
Differential

#11 8 . Science chapter -7. Science department-7. 8 Difficulty level - 1

What is the definition of road obstacle clearance of a vehicle?
The ability to drive the car in difficult road conditions and in off-road areas
The ability to pass through rocky and mountainous roads
The ability to walk on mountain and desert roads
The ability to walk in deserts

#11 9 . Science chapter -7. Science department-7. 9 Difficulty level - 3

Determine the stability of the vehicle on a longitudinal inclined plane?
$tg\alpha = \frac{B}{h_M}$
$\cos\alpha = \frac{B}{h_M}$
$\sin\,\alpha = \frac{B}{h_M}$
$ctg\alpha = \frac{B}{h_M}$

#1 20 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Cars are divided into ………….. according to their function .
Transportation, especially specialized racing and sports cars
Transportation, especially
Specialized racing
Specially designed for racing and sports cars

#1 21 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Car What kind of work is a wheeled machine?
A vehicle is a land-based vehicle, equipped with an independent engine with an independent energy source, designed for the transportation of goods and people on roads or with self-contained devices, with great comfort and safety.
The vehicle is a vehicle that moves on land and is equipped with an independent engine with an independent energy source
Designed for on-road transportation of goods and people or with self-contained devices with great comfort and safety
It is a means of transport, equipped with an independent engine with an independent source of energy, with great comfort and safety, intended for the transportation of goods and people on roads or with the help of built-in devices.

#1 22 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What are passenger cars for?
Designed for passenger transportation
To transport
To transport people and goods
Y to passenger and freight

#1 23 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

How are passenger cars divided?
Divided into two: cars and buses
Only passenger cars are available
It is divided into three categories: light, cargo, cars and buses
It is divided into four categories: light, passenger, cargo, cars and buses

#1 24 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

.. ..called a bus?
If the car is designed for more than 8 people,
If the car is designed for more than 7 people
If the car is designed for more than 18 people,
If the car is designed for less than 7 seats,

#1 25 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Depending on the task of the buses: will they be used in .... jobs?
Suburban, intra-urban, inter-city, destination and general
Around the city, in the city
It goes to certain places
Within city, intercity, destination and general

#1 26 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Depending on the length of the buses?
5 mvery small (minibus); 6...7.5 m small; 8...9.5 average; It is divided into 10.5...12 m big buses
5 mvery large (minibus); 6...7.5 m small; 8...9.5 average; 10.5...18 m are divided into large buses
5 mvery small than (minibus); 6...7.5 m small; 8...9.5 average; It is divided into 10.5...12 m big buses
5 mvery small (minibus); 8...9.5 average; It is divided into 10.5...12 m big buses

#1 27 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Depending on the size of the engines installed in passenger cars?
1, 2 l.to medium small; 1.2...1.8 l is small; 1.8...3.5 liters and more than 3.5 liters.
1, 4 l.to medium small; 1.2...1.8 l is small; 1.8...3.5 liters and more than 3.5 liters.
1, 3 l.to medium small; 1.2...1.8 l is small; 1.8...3.5 liters and more than 3.5 liters.
1, 5 l.to medium small; 1.2...1.8 l is small; 1.8...3.5 liters and more than 3.5 liters.

#1 28 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Trucks depending on the load weight:..... ?
Light weight 0.3...1 t; small weight 1...3; medium weight 3...5 t; heavy weight 5...8 t and very heavy

weight are divided into cars carrying more than 8 tons.
Small weight 1...3; medium weight 3...5 t; heavy weight 5...8 t and very heavy weight are divided into cars carrying more than 8 tons.
Medium weight 3...5 t; heavy weight 5...8 t and very heavy weight are divided into cars carrying more than 8 tons.
Heavy weight 5...8 t and very heavy weight more than 8 tons are divided into cars.

#1 29 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What are normal cars?
Various cargoes are transported in cars with opening walls (boards), and such cars are used for general work
Various loads are transported in cars, and such cars are used for general work
Throwing walls (boards) open and perform general work on such cars
Various cargoes are transported in cars with opening walls (boards).

#1 30 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What kind of vehicles are used to transport spilled and spilled goods?
In dump trucks, liquids in tank cars, and food in vans
In dump trucks, liquids are tanked
In their cars, liquids are in tank cars, and food is in vans
In tanker cars, and food in vans

#1 31 . Science chapter - 1 . Department of Science- 1 . 4 Level of difficulty - 1

If cargo and passengers are transported in a car with a universal body at the same time, it is called a .... car?
Cargo-passenger car
Light truck
Truck
Semi-trailer truck

#1 32 . Science chapter - 1 . Department of Science- 1 . 4 Level of difficulty - 1

As special cars...................?
It is equipped with mechanisms-devices and equipment that allow to perform certain works.
It is equipped with mechanisms-devices and equipment that do not allow to perform certain tasks.
It is equipped with mechanisms, devices and equipment that allow you to do all the work.
Semi-trailer truck

#1 33 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What are racing cars designed for?
Sports cars and participation in car sports racing
Sports and speed
Without sports cars, only participating in sports car racing
Take part in the car sports race with trucks

#1 34 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Identify the answer given the definition of normal cars?
A car with one leading axle is called a regular car.
A single-axle driven car that moves on hard and soft roads is called a regular car.
A single-axle driven vehicle that moves on paved and gravel roads is called a regular vehicle.
It is called a car that moves on paved roads.

#1 35 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Identify the answer given the definition of a passenger car?
A vehicle with two or three leading axles moving on bad and unimproved roads is called a hybrid vehicle.
A vehicle with two or three leading axles that moves on unimproved roads is called an all-wheel drive vehicle.
A vehicle with two or three leading axles that moves on rough roads is called an all-wheel drive vehicle.

A vehicle with two or three leading axles moving on adapted roads is called a hybrid vehicle.

#1 36 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What are the mechanisms of the car chassis?
Transmission of torque on the crankshaft of the engine to the leading wheels is made up of mechanisms designed to move and control the car.
The transmission of torque on the crankshaft to the driving wheels is made up of mechanisms designed to move and control the car.
Transmission to the driving wheels on the crankshaft of the engine is made up of mechanisms designed to move and control the car.
Torque transmission on the crankshaft of the engine is made up of mechanisms designed to move and control the car.

#1 37 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

How many mechanisms are included in the car chassis?
Power transmission, running gear and control mechanisms.
Power transmission, walking part
Undercarriage and control mechanisms.
Power transmission and control mechanisms.

#1 38 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What is the purpose of the clutch?
Disengaging the power transmission from the engine for a short time Disengagement and engagement when changing gears and disengaging when braking the vehicle
Idling the engine for a short period of time Shifting and engaging when changing gears and disengagement when braking the vehicle
Disengagement and engagement when changing gears and disengagement when braking the vehicle
Disconnecting the power transmission from the engine for a short period of time will reduce the movement when changing gears

#1 39 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The function of the gearbox?
Reducing or increasing the speed of the car serves to increase the torque on the leading wheels, change the direction of the car and stop the car.
Reducing or increasing the speed serves to increase the torque on the leading wheels, to change the direction of the car and to stop the car.
The increase serves to increase the torque on the leading wheels, to change the direction of the car and to stop the car.
Reducing or increasing the speed of the car, increasing the torque on the leading wheels, changing the direction of the car

#1 40 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

HALF axes task?
The torque in the half-axle gear in the differential to the driving wheels
To the leading wheels in the half-axle gear in the differential
Torque to the leading wheels
The torque on the half-axle gear to the leading wheels

#1 41 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The differential ....gives?
The torque transmitted through the main transmission distributes the torque equally to the semi-axes, besides this, it reduces the angular speed of the inner wheels and increases the angular speed of the outer wheels before turning the avomobile.
It distributes equally to the half-axes, besides that, before turning, the avomobile reduces the angular speed of the inner wheels and increases the angular speed of the outer wheels.
The screwdriver distributes the torque equally to the semi-axes, besides, it increases the angular speed of the outer wheels by reducing the angular speed of the inner wheels before turning the car.
The screwdriver transmitted through the main gear distributes the torque equally to the semi-axes,

increasing the angular speed of the outer wheels.

#1 42 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Find the sentence that correctly gives the function of the steering wheel?
It serves to change the direction of movement of the car.
It serves not to change the direction of movement of the car.
Serves to change the movement of the car.
The load serves to change the direction of movement of the vehicle.

#1 43 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Find the sentence that correctly states the function of the brake control?
Serves to slow down the vehicle and stop the vehicle.
It serves to slow down the speed and stop the car.
It serves to speed up the car and stop the car.
It serves to slow down the speed of the car.

#1 44 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The front bridge is used for ....?
It serves to install parts of the steering wheel of the car, suspensions and steering wheels. The rear axle is the main gear, the differential is the half-axle of the suspensions and the installation of the leading wheels
It serves to install the parts of the steering wheel of the car, the suspensions and the driving wheels, and the installation of the leading wheels
It is used to install wheels . The rear axle is the main gear, the differential is the half-axle of the suspensions and the installation of the leading wheels
It serves to install suspensions and driving wheels. The rear axle is the main gear, the differential is the half-axle of the suspensions and the installation of the leading wheels

#1 45 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The undercarriage of the car - ?
The car is made of a carriage that provides forward movement, and the frame or body serves as its basis.
It consists of a carriage that provides the forward movement of the car, and serves as a body
The engine is located outside the carriage, which provides forward movement, and the frame or body serves as its basis.
It is an external part of the carriage that ensures the movement of the car, and the frame or body serves as its basis.

#1 46 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What is the function of the ignition system?
Creates an electric spark and sends it to the cylinders in order to ignite the carbureted engine
A carbureted engine creates a spark for forced ignition and sends it to the cylinders in order
Creates an electric spark and sends it to the cylinders in order to ignite the carbureted engine
Creates a carbureted engine for forced ignition and sends it to the cylinders in order

#1 47 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Explain Yu.Ch.N and P.Ch.N?
The position (point) inside the cylinder where the piston rod is farthest from the crankshaft end is called the upper end point (U.CH.N). The lowest position (point) inside the cylinder closest to the crankshaft end of the piston top is called the lower end point (P.CH.N).
The upper position (point) inside the cylinder, which is farthest from the crankshaft end of the piston rod, is called the upper end point (YU.CH.N). The lowest position (point) of the piston top on the crankshaft is called the lower end point (P.CH.N).
The position (point) inside the cylinder, which is farthest from the piston rod end, is called the upper end point (YU.CH.N). The lowest position (point) inside the cylinder closest to the crankshaft end of the piston top is called the lower end point (P.CH.N).
The position (point) inside the cylinder, which is farthest from the crankshaft end, is called the upper end point (YU.CH.N). The lowest position (point) inside the cylinder closest to the crankshaft end of the piston top is called the lower end point (P.CH.N).

#1 48 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What is piston path?
The distance traveled by the piston from one end point to the other end point is called the piston stroke.
The distance traveled by the piston when it moves to a point is called piston travel
The distance traveled from one extreme point to the other extreme point is called piston stroke
The piston travel from one end point to another end point is called the piston path

#1 49 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The distance between the connecting rod of the crankshaft and the axis of the connecting rod is called ....?
Curved radius
Crankshaft radius
Connecting rod radius
Radius of gas distribution

#1 50 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The stroke of the piston is twice the radius of the curve. The volume created when the piston moves from the upper end point to the lower end point is called the .... of the cylinder?
Working capacity
Combustion volume
Cylinder volume
Full size

#1 51 . Science chapter - 1 . Department of Science- 1 . 4 Level of difficulty - 1

When the piston is at the upper end point, the surface formed above it is called the ....?
Volume The volume of the compression or combustion compartment
Compression is the volume of combustion
The volume of the combustion compartment
Size The size of the compression partition

#1 52 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

When the piston is at the lower end point, the cylinder cavity formed on it is called .... of the cylinder?
Full size
Combustion volume
Cylinder volume
Medium size

#1 53 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Part of the work cycle is called ....?
Tact
Cylinder
Cycle
Expansion

#1 54 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What indicators are included in the technical indicators of the engine?
For each copy of the vehicle, the manufacturer provides brief technical specifications, such as the vehicle's carrying capacity or number of passengers, weight with cargo, maximum speed, 100 kmfuel consumption, engine type, wheel formula and includes the exterior dimensions of the vehicle.
The vehicle's carrying capacity or number of passengers, weight with cargo, maximum speed, 100 kmfuel consumption, engine type, wheel formula and exterior dimensions of the vehicle.
Brief technical specifications are provided by the manufacturer for each copy of the vehicle.
100 kmincluding fuel consumption, engine type, wheel formula and exterior dimensions of the vehicle.

#1 55 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Adjustment of the crank mechanism?
Includes piston, piston rings, pin, connecting rod, crankshaft, liner and flywheel. Includes cylinder block, crankcase, crankcase and cylinder head.
Includes piston, piston rings, pin, liner and flywheel.

Includes piston, piston rings, pin, connecting rod, crankshaft, insert.
Includes piston rings, pin, connecting rod, crankshaft, liner and flywheel.

#1 56 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Adjustment of the crank mechanism?
Includes piston, piston rings, pin, connecting rod, crankshaft, liner and flywheel. Includes cylinder block, crankcase, crankcase and cylinder head.
Includes piston, piston rings, pin, liner and flywheel.
Includes piston, piston rings, pin, connecting rod, crankshaft, insert.
Includes piston rings, pin, connecting rod, crankshaft, liner and flywheel.

#1 57 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The function and structure of mahovik?
The flywheel is cast from cast iron. The flywheel takes part of the thermal energy in the engine and serves to drive the pistons from the extreme points (PCHN and YUCHN), perform auxiliary strokes (intake, compression and exhaust) and start the engine using the starter.
The flywheel is cast from cast iron. For this purpose, a straight toothed ring is pressed into the flywheel flange. In addition, the flywheel also acts as the driving disk of the working clutch.
Serves to perform auxiliary strokes (intake, compression and exhaust) and start the engine with the help of a starter.
The flywheel is cast from cast iron. The flywheel absorbs part of the thermal energy in the engine and releases it from the extreme points of the pistons (PCHN and YUCHN).

#1 58 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Is it a cylinder block?
It is the main part of the engine, and it is made integrally with the crankcase. In the upper part of the block there are holes for installing cylinders. In the block of cylinders, one row can be placed in an upright position or two rows of cylinders at an angle of 90^{0} in a V-shaped form . The cylinder block is made of gray cast iron for heavy trucks and aluminum alloy for light and medium-duty vehicles.
In the block of cylinders, one row can be placed in an upright position or two rows of cylinders at an angle of 90^{0} in a V-shaped form . The cylinder block is made of gray cast iron for large trucks, light and medium-duty vehicles
It is the main part of the engine, and it is made integrally with the crankcase.
In the upper part of the block there are holes for installing cylinders. In the block of cylinders, one row in an upright position or two rows of cylinders at an angle of 90^{0} in a V-shaped form can be placed

#1 59 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Piston............?
It receives the gas pressure generated by the combustion of the internal mixture in the cylinder and serves to transfer it to the crankshaft through its finger and connecting rod. In the upper part of the piston, the head has two babishkas and a guide part (sheath).
It receives the gas pressure generated by the combustion of the internal mixture in the cylinder and serves to transfer it to the crankshaft through its finger and connecting rod.
It receives gas pressure and serves to transfer it to the crankshaft through its finger and connecting rod.
At the top of the piston, there are two heads and a guide part

#1 60 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Are these piston rings?
Compression rings serve to reduce the leakage of gases from the cylinder to the crankcase, as well as squeeze excess oil from the cylinder walls (oil drain rings). The rings are made of gray cast iron or steel and are locked from the inside of the cylinder with the help of cutouts.
Compression rings reduce the passage of gases through the cylinder and also serve to squeeze excess oil from the cylinder walls (oil suction rings).
Compression rings serve to increase the passage of gases from the cylinder to the crankcase, as well as to remove excess oil from the cylinder walls (oil drain rings).
The rings are made of gray cast iron or steel and are locked from the inside of the cylinder with the help of cutouts.

#1 61 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

A piston finger.............. makes a chance?
Serves for free movement of the piston to the connecting rod and attachment to it. It is made of steel with an inner hole, its surface is polished with a high-frequency current, and it is fastened to the piston heads with the help of two stopper rings. This method of fastening the piston pin to the joint
Serves for movement and attachment to it. It is made of hollow cast iron and the surface is heated with high frequency current
Serves for free movement of the piston to the connecting rod and attachment to it. It is made of hollow steel and has a high surface
It is made of steel with an inner hole, its surface is polished with a high-frequency current, and it is fastened to the piston heads with the help of two stopper rings. This method of fastening the piston pin to the joint

#1 62 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Is connecting rod .... installed?
It serves to transfer gas pressure from the piston to the crankshaft during the working stroke (expansion process), and from the crankshaft to the piston during the auxiliary strokes (intake, compression and exhaust processes). The connecting rod is made of steel and consists of a cross-section rod, the upper head is integral and the lower head is detachable. A bronze bushing is pressed into the upper head, and connecting rod inserts are installed in the lower one.
Transmission of gas pressure from the piston to the crankshaft during the working stroke (expansion process), and from the crankshaft to the piston during the auxiliary strokes (intake, compression and exhaust processes)
A bronze bushing is pressed into the upper head, and connecting rod inserts are installed in the lower one. In V-shaped engines, two connecting rods per one connecting rod neck of the crankshaft
The connecting rod is made of steel and consists of a cross-section rod, the upper head is integral and the lower head is detachable.

#1 63 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Crankshaft .... is rotated?
Taking the gas pressure force from the pistons through the connecting rods, it is converted to torque through the crankshaft
To the torque through Krivoship
Taking the pressure force from the pistons through the connecting rods, it is transferred to the torque through the crankshaft
The connecting rod is made of steel and consists of a cross-section rod, the upper head is integral and the lower head is detachable.

No. 164 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Fixing the engine to the frame reduces?
It is carried out with the help of claws or brackets made in the engine and flywheel housings. The fastening supports are elastic, they are provided with rubber pads and springs.
It is done with the help of brackets. The fastening supports are elastic, they are provided with rubber pads and springs. Such elastic fastening prevents vibrations caused by uneven operation of the engine and insufficient balancing of rotating masses, as well as shocks from the frame to the engine during the movement of the car.
Elastic fastening prevents vibrations caused by uneven operation of the engine and insufficient balancing of rotating masses, as well as impulse shocks from the frame to the engine during the movement of the car.
It is carried out with the help of claws or brackets made in the engine and flywheel housings.

No. 165 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What is a steering trapezoid?
The controller turns the wheels to different angles at the same time.
Turns the blades to different angles.
Turns the wheels to different angles at the same time.
The controller turns the wheels to different angles at different times.

No. 166 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

What is the steering wheel composed of?
From the steering mechanism and steering
Steering wheel and steering wheel
Steering wheel and steering belt
Steering trapezoid and mechanism

No. 167 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Types of steering mechanism in modern cars ?
Worm, screw and gear
Glaboid and roller
Screw and gear
Worm and screw

No. 168 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Osman's type has been determined by the given answer?
Independent and independent
Free and compulsory
Stepped and stepless
Shock absorber and springs

No. 169 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

Types of drivetrain?
Asynchronous and synchronous
Asynchronous and synchronous
Synchronous
Asynchronous

No. 170 . Science chapter - 1 . Science department- 1 . 4 Level of difficulty - 1

The function of the air distributor ?
Serves to deliver air to the front or back spaces of the working cylinder.
Serves to deliver fuel to the front or back spaces of the working cylinder.
Serves for front delivery of air to the working cylinder.
Serves for delivery to back spaces.

No. 171 . Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

Brake mechanisms are evaluated by the following criteria ?
Efficiency, stability, balanced reversibility.
Effectiveness, balance and reversibility.
Balanced reversibility.
Efficiency, stability, balance

No. 172 . Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

Each brake system……..organized ?
From brake mechanisms and brake control
From brake mechanisms
From the brakes
From brake pads

No. 17 3. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

What are the parts of KSHM?
Movable and immovable
H is movable and rotatable
Piston, connecting rod and crankshaft
Connecting rod, crankshaft, flywheel

No. 17 4. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

At what angle are the connecting rod necks of the crankshaft located in 4-cylinder, 4-stroke engines?
90°
180°

120°
160°

No. 17 5. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

In which part of the piston is the gap between the piston and the cylinder the smallest?
At the bottom of the piston
In the referral section
In the head
It's going

No. 17 6. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

What kind of sleeves are called dry sleeves?
To the sleeve that is not connected to the coolant
For a non-lubricating sleeve
In a sleeve that does not introduce a combustible mixture
To the sleeve connected to the h avo

No. 17 7. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

At how many different heights in the same plane is the deflection of a cylinder measured?
Three (top, middle and bottom)
Two or three (top and middle or top, middle and bottom)
One (above or below)
Two (above and below)

No. 17 8. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

What happens if the mark on the connecting rod is not set correctly?
The engine does not run
Knocking occurs on a cold engine
Knocking occurs in a hot engine
It does not affect the working process of Digatel

No. 17 9. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

What helps the piston to come out of the extreme points?
Posangilar
Makhovik
Crankshaft
Crankshaft and connecting rod

No. 1 80. Science chapter - 6 . Science department- 6 . 1 Difficulty level - 1

chain is first installed on the piston?
Oil-absorbing brush
1-thickness putty
2-thickness putty
The limiting factor

No. 1 81. Science chapter -1. Science section-1.4 Difficulty level -2

h by mass ?
Crankshaft, flywheel, connecting rod
Piston and connecting rod
Piston, connecting rod, flywheel
Moving details

No. 1 82. Science chapter -1. Science section-1.4 Difficulty level -2

What details of KSHM are divided into groups according to their geometric dimensions ?
Piston, sleeve, piston rings , bearings, piston pin, crankshaft
Piston, connecting rod, crankshaft, cylinder, piston pin
Piston, sleeve, crankshaft, connecting rod

All answers are correct

No. 1 83. Science chapter -1. Science section-1.4 Difficulty level -2

In which type of GTM is it better to fill the cylinders with a combustible mixture or with air?
In GTM with valves above
In GTM with valves below
H am in both types
When GTM is properly configured

No. 1 84. Science chapter -1. Science section-1.4 Difficulty level -2

What engines have gas distribution phase?
In gasoline engines
In diesel engines
H am in both types
In jet engines

No. 1 85. Science chapter -1. Science section-1.4 Difficulty level -2

What engines have gas distribution phase?
In gasoline engines
In diesel engines
H am in both types
In jet engines

No. 1 86. Science chapter -1. Science section-1.4 Difficulty level -2

Can GTM details be interchanged?
Only fixed details
Only moving parts
Not interchangeable
Interchangeable

No. 1 87. Science chapter -1. Science section-1.4 Difficulty level -2

What is the difference between inlet and outlet valves?
In the diameter of the head
In the diameter and material of the head
In the diameter, material and length of the valve
It won't matter

No. 1 88. Science chapter -1. Science section-1.4 Difficulty level -2

Which car's GTM doesn't require a heat sink adjustment?
at NEXIA
at TICO
at VAZ
H is in amma

No. 1 89. Science chapter -1. Science section-1.4 Difficulty level -2

Why is the length of Koromislo's shoulders not made the same?
Ensuring linear movement of the valve guide bushing
Reduce the bite of the fists
The construction is mandatory
Reducing metal consumption

No. 1 90. Science chapter -1. Science section-1.4 Difficulty level -2

What bolts start the cylinder head release?
From the bolts in the middle
From external bolts
It doesn't matter
From left to ten

No. 1 91. Science chapter -1. Science section-1.4 Difficulty level -2

What is an envelope used for?
To open a groove

To shine
To smooth the hole surface
To expand the hole diameter

No. 1 92. Science chapter -1. Science section-1.4 Difficulty level -2

What materials are camshafts made of?
From steel
From steel or aluminum alloy
Cast iron or corrosion and heat resistant alloy
from hard alloy

No. 1 93. Science chapter -1. Science section-1.4 Difficulty level -2

When disassembling and reassembling the GTM, which parts should be replaced with new ones?
gaskets and sealing caps
Valves and sealing cap
Cylinder head gasket
Sealing caps

No. 1 94. Science chapter -1. Science section-1.4 Difficulty level -2

Which car has air cooling system
ZAZ-968
VAZ-2101
Tico
VAZ-210 7

No. 1 95. Science chapter -1. Science section-1.4 Difficulty level -2

boiling point of water depend on?
to pressure
to warm up the engine
to the thermostat
to the temperature

No. 1 96. Science chapter -1. Science section-1.4 Difficulty level -2

What happens if air gets into the cooling system ?
The liquid level increases
The liquid level decreases
The engine overheats
It doesn't change

No. 1 97. Science chapter -1. Science section-1.4 Difficulty level -2

exhaust valve located in the cooling system ?
On the radiator cover;
On the expander cover
In the thermostat
In the engine

No. 1 98. Science chapter -1. Science section-1.4 Difficulty level -2

Which car is not heated by the interior cooling system?
ZAZ-968
M-412
Tico
Damascus

No. 1 99. Science chapter -1. Science section-1.4 Difficulty level -2

What does the valve of the thermostat open for?
Pressure
Liquid
H arorate
In the thermostat

#200. Science chapter -1. Science section-1.4 Difficulty level -2

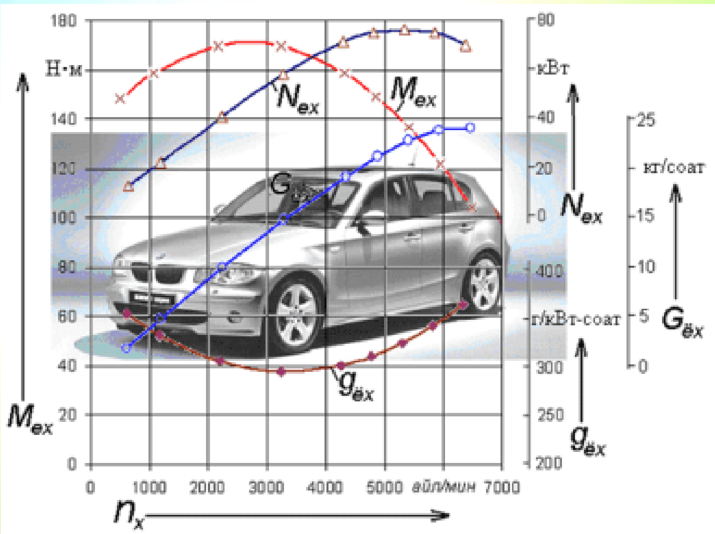
What kind of cooling system is called an open system?
The expander cover is open
The radiator cap is open
Air cooling system
In the thermostat

REPUBLIC OF UZBEKISTAN
HIGHER AND SECONDARY SPECIAL EDUCATION

NAMANGAN INSTITUTE OF ENGINEERING AND CONSTRUCTION

Ground Transport Systems

VEHICLES OF TRANSPORTATION CONSTRUCTION
in the method of rating students' knowledge of science



RATE MEZ O NI

Namangan-20 20

This evaluation criterion is part of the daytime **section** 5310600 Surface transportation systems and the **direction** of their operation was prepared based on the state educational standards, curriculum **and** programs.

Evaluation criteria for students of the day department **"** Vehicles " Construction " is intended for use **in** control and final assessment criteria and independent mastery **of** the **subject** .

Developers

Madrakhimov Alloberdi Makhmadaliyevych, senior teacher of the Department of Russian **Transport** Systems .

Azizov Zamon Akhmadbekovich, **teacher** of the Department of Earth Transport Systems .

Reviewer

Abdujalil Sattorovich Polvonov is an associate professor of the Department of Surface Transport Systems.

was reviewed and approved at the meeting of the Yerusti Transport Systems Department in ______ 2020 ___ - minutes of the meeting) **.**

It was considered at the ______.2020 meeting of the scientific-methodological council of the Faculty of Transport **(minutes of the meeting number __).**

The evaluation criterion was discussed and recommended for use at the meeting of the scientific and methodical council of the institute on ________, 2020 (list number #**____).**

Enter

On the measures of fundamental improvement of personnel training system in the field of transport The decision of the President of the Republic of Uzbekistan on May 4, 2020 was adopted.

In this decision, the system of training highly qualified personnel for the transport sector of the Republic is to be fundamentally improved based on advanced foreign experience and international standards, innovative forms and methods of teaching and modern pedagogical and information technologies are widely introduced into the educational process, as well as network education . examples of strengthening the material and technical base of institutions and further increasing their scientific potential were determined .

in the national program of personnel training are being implemented step by step, improving the quality of the trained personnel is considered one of the urgent tasks in the education system of our country. Of course, this indicator depends on several socio-economic conditions (educational and technical base, teacher's skills, time, etc.), but students from all subjects, including the Automotive network It is natural that it is considered one of the important factors to master the educational material thoroughly during the semester. Or, this subject is important in preparing students for their future professional activities, especially in forming their modern skills according to world standards. In order to harmonize and improve the system of assessment in science with the requirements of the educational system of advanced foreign countries, the size of the educational material to be mastered during the semester, the types of control, the content of assignments, and the distribution of points related to them in advance It is important to develop and inform students. Because, according to the world pedagogical practice, **"any educational reforms that do not take into account the improvement of the assessment system have not been successful." Because, at the same time, the assessment is the level of expression of the result of teaching in the students' behavior and activity, it also determines the quality of each training stage and its end.**

This evaluation criterion is based on the Decree of the President of the Republic of Uzbekistan dated June 5, 2018 No. in accordance with the decision of the Minister of Higher and Secondary Special Education of the Republic of Uzbekistan dated August 9, 2018 No. 19-2018 It was prepared on the basis of the Regulation on the rating system of monitoring and evaluating students' knowledge in higher education institutions. The goal of monitoring and evaluating students' knowledge through the rating system is to achieve competitive personnel training by managing the quality of education, to prevent the formation of gaps in students' learning of subjects, to identify and eliminate them.

Types of control and assessment criteria

1. Types of control

1. Monitoring of students' knowledge in higher education institutions is carried out by means of intermediate and final types of monitoring.

2. The mid-term supervision is conducted during the training sessions in order to assess the student's knowledge and practical skills after the completion of the relevant section of the work science program during the semester.

3. The type of intermediate control can be conducted up to 2 times for each subject depending on the nature of the subject.

The form and duration of the intermediate supervision is determined by the relevant department based on the nature of the subject and the hours allocated to the subject.

4. Assignments of the intermediate control type are developed by professors and teachers of the relevant department and approved by the head of the department.

5. During the semester, there is no intermediate control type for subjects that are less than 2 academic hours per week (4 academic hours in medical higher education institutions).

6. The student's performance of practical, seminar, laboratory exercises and independent educational tasks, as well as his activity in these exercises, will be evaluated by the science teacher. The evaluation is carried out based on the criteria provided for in Clause 15 of this Regulation .

When evaluating a student according to the type of interim control, the grades he received during the training sessions are taken into account.

7. The final type of control is conducted at the end of the semester (at the end of the subject in medical higher education institutions) in order to determine the level of mastering of theoretical knowledge and practical skills of the student in the relevant subject.

8. The form of conducting the final type of control is determined by the department of the relevant subject.

9. The type of final control is conducted according to the schedule of conducting types of final control, which is developed by the dean of the relevant faculty or the educational and methodological department of the higher education institution and approved by the vice-rector for academic affairs.

10. Intermediate and final control types in medical higher education institutions can be conducted in the form of an objectively structured clinical test or an objectively structured examination.

2. Criteria for evaluating student knowledge

1. Students' knowledge based on the following criteria:

a student makes independent conclusions and decisions, can think creatively, observes independently, can apply the acquired knowledge in practice, understands the essence of science (subject), knows, can express, tell, and is considered to have an idea about science (subject) — 5 (excellent) grade;

when the student conducts independent observation, can apply the acquired knowledge in practice, understands the essence of the science (topic), knows, can express, tell, and has an idea about the science (topic) - 4 (good) grade;

when the student is able to apply the acquired knowledge in practice, understands, knows, can express, tell the essence of science (topic) and has an idea about science (topic) - 3 (satisfactory) grade;

when it is considered that the student has not mastered the science program, does not understand the essence of the science (topic) and does not have an idea about the science (topic) - he is evaluated with a grade of 2 (unsatisfactory).

2. The content of the tasks created for conducting the types of supervision must provide an opportunity to objectively and accurately assess the student's learning.

3. Assessment of student knowledge

1. Assessment of students' knowledge is carried out in a 5-grade system.

2. Conducting the intermediate control type and evaluating the student's knowledge on this type of control is carried out by the professor-teacher who conducted training sessions on the relevant subject.

Conducting the final type of control and evaluating the student's knowledge on this type of control is carried out by a professor who did not conduct the training.

A professor who has conducted training in the relevant subject is prohibited from participating in the final type of control.

Professors and teachers of other higher education institutions in the relevant subject can be involved in conducting the final type of supervision based on an agreement.

3. Conducting intermediate and final types of control in higher medical educational institutions, as well as evaluating students' knowledge is carried out by the commission organized by the head of the relevant department.

The composition of the commission is formed from professors and teachers of relevant subjects and experts in the field.

Experts from other organizations may be involved in the commission based on agreement.

4. The types of supervision in a higher educational institution are constantly studied by the educational quality control department of the relevant higher educational institution. In cases where it is determined that the procedure for conducting the types of control is violated, the results of the conducted types of control may be canceled and the corresponding type of control may be re-conducted.

5. The student must have passed the intermediate test before the final test for the relevant subject.

6. A student who has not passed the intermediate control type, and has been evaluated with a "2" (unsatisfactory) grade for this type of control, will not be included in the final control type.

A student who is not included or not included in the final control type, as well as evaluated with a grade of "2" (unsatisfactory) according to this type of control, is considered an academic debtor.

, it is allowed to resubmit the corresponding type of control based on the order of the dean of the faculty.

8. It is not allowed to hold more than 1 type of final control in one day. Final inspections should be scheduled at least 2 days apart.

9. Up to one month for non-graduating students who have academic debt from up to 3 subjects (subjects) according to the results of the autumn semester, up to one month for the student who has academic debt from up to 3 subjects (subjects) according to the results of the spring semester A period of 1 month is given to resubmit the intermediate and (or) final control types on (subjects) from the beginning of the new academic year.

Graduate students are allowed to retake the subject(s) they did not master based on the results of the spring semester until the start of the final state certification.

Students with an academic debt of 4 or more subjects are not allowed to retake and they are dropped from the course by order of the rector (head, branch director) of the higher education institution.

10. The number of re-submissions by the student should not be more than 2 times during the period given to the student to resubmit the intermediate and (or) final type of control.

If the student fails to pass the intermediate and (or) final type of control for the first time, a commission will be formed by the dean of the faculty . The composition of the commission is formed from professors and teachers of the relevant subject and experts in the field.

The commission will conduct the second intermediate and (or) final control and evaluate the student.

of the faculty informs the rector (head, branch director) of the higher education institution about the student who has not been able to pay the existing debt during the given period , and this student is ordered by the rector (head, branch director) will be dropped from the course based on i.

12. In cases where the student did not participate in the qualification practice without valid reasons, as well as in cases where the results of the qualification practice were evaluated with a grade of "2" (unsatisfactory), he is considered to be in academic debt and will be dropped from the course.

13. From the beginning of the semester in which the student has not mastered the subject(s), the student who is left in the course will continue to study according to the approved curriculum for the relevant semester of this academic year on a fee-contract basis.

14. Students who are dissatisfied with the evaluation result have the right to appeal to the Appeals Commission established by the dean of the faculty .

15. The chairman of the commission and at least four members from among professors and teachers of relevant subjects who did not participate in the evaluation of the student will be included in the appeal commission.

16. If the student is dissatisfied with the evaluation result, he can file an appeal within 24 hours from the time the evaluation result is announced. The appeal submitted by the student must be considered by the Appeals Commission within 2 days.

17. The student has the right to participate in the consideration of the student's appeal.

18. The Appeals Commission will review the student's appeal and make an appropriate decision on its outcome. The decision indicates whether the student mastered the relevant subject or failed to master it.

The appeals commission ensures that the relevant decision is delivered to the dean of the faculty and the student.

4. Recording of assessment results

is recorded by the professor-teacher of the relevant subject in the journal of students' mastery of subjects (hereinafter referred to as Journal). In addition, the professor-teacher can conduct the assessment of students' knowledge in the electronic system.

The professor-teacher records the marks given to the student in the Journal on the same day. If the evaluation of the student's knowledge was conducted in the form of a written work, then the professor-teacher should record the results of the students in the Journal within 3 days.

2. When the student's knowledge of the type of control is evaluated with a grade of "3" (satisfactory) or "4" (good) or "5" (excellent), it is not allowed to retake the type of control.

3. In cases where the student did not participate without good reason at the time of the inspection, "0" will be written in the Journal.

4. The journal is signed by the professor, head of the department, and the dean of the faculty who conducted training in the relevant subject and is kept in the dean 's office. The dean of the faculty is responsible for keeping the journal .

5. When students' grades for the final control type are recorded in the Journal, they should also be recorded in the student's Gradebook on the same day.

6. In cases where the student's knowledge is evaluated with a grade of "2" (unsatisfactory) according to the type of final control, or a mark of "0" is written in the Journal, this grade or mark is not recorded in the student's Assessment Book.

7. In order to keep the journal in a timely, correct and complete way, as well as not to make unreasonable changes to the grades and other information in it, the dean of the faculty and the professor-teacher of the relevant subject must is ul.

8. The student's higher education was evaluated with a grade of "3" (satisfactory) or "4" (good) or "5" (excellent) in the subjects of the working curriculum at the end of the relevant academic year. will be transferred to the next course based on the order of the rector (head, branch director) of the institution.

10. The evaluation results are regularly discussed at department meetings, faculty and higher education institution Councils, and appropriate decisions are made .

11. Comparative comparison of the evaluation system of students' mastery in the higher education institutions of the Republic of Uzbekistan with the 5-point or 100-point system and the evaluation system used in the higher education system of advanced foreign countries and their transfer to the appendix of this Regulation is carried out on the basis of appropriate tables.

VEHICLES OF TRANSPORTATION CONSTRUCTION ASSESSMENT CRITERIA FOR SCIENCE

in the 5th and 6th semesters according to the curriculum . Science is divided by direction as follows.

This subject is taught in the 1st semester according to the curriculum. Science is divided by direction as follows.

The name of the subject	**Course of Study**	**Course**	**Semesters**	**Lecture**	**Experience**	**Practical training**	**coursework**	**Independent education**	**Total**
Construction of vehicles	5310600-"Surface transport systems and their operation"	3	5 - 6	80	64	16	+	160	160

It is recommended that the distribution of ON and YaN grades be as follows, consisting of lecture (including problems, based on handouts), practical and seminar training hours.

Distribution by types of assessment

Semesters	**Assessment forms**								
	Intermediate assessment - 5 grades								**final- 5 marks**
	I-ON				**II-ON**				
	Lecture	**Practical**	**Laboratory**	**Independent education**	**Lecture**	**Practical**	**Laboratory**	**Independent education**	**5 marks (written)**
for the 5th semester	**1-9**	**-**	**1-7**	**1-12**	**10 -1 8**	**-**	**8-15**	**12-24**	
for the 6th semester	**1-4**	**1-8**	**-**	**25-37**	**5-9**	**-**	**1-8**	**38-48**	
Total :	**5 marks**				**5 marks**				**5 marks**

1- mid-term control tasks are recommended to be conducted orally after 18 hours of lectures and practical training in the 5th semester . Each student can answer the mid-term control tasks orally during the communication during the process of handing in the reports of the practical exercises. Independent work tasks set for mid-term control are performed in written form.

2- midterm control assignments are recommended to be given in the form of written assignments after 18 hours of lectures and practical training in the 1st semester . This paper consists of 3 questions. Each student can answer the mid-term control tasks orally during the communication during the process of handing in the reports of the practical exercises. Independent work tasks set for interim control are performed.

After intermediate controls are conducted and evaluated, the average arithmetic value of all evaluations is calculated. This obtained result determines the student's mastery rate.

Final control is recommended in written form.

The bank of intermediate and final questions will be made available to students at the beginning of the training sessions according to the application.

Assignments for the 1st and 2nd mid-term assessment of the 5th semester

1-Intermediate evaluation assignments (tests from these topics, control work in oral methods)

5 semester YeUTTUE course

1. Stages of development of a motor vehicle.

2. Establishment and development prospects of automotive industry in our republic.
3. Types and indexing and models of motor vehicles.
4. Impact of motor vehicles on the environment.
5. General structure of the vehicle.
6. The main units of the car, their main functions and location.
7. The main technical indicators of the vehicle.
8. Function and types of internal combustion engine (IYoD).
9. General structure of IYoD.
10. IYoD mechanisms, their functions and location.
11. IYoD systems, their functions and location.
12. The main indicators of IYoD.
13. The duty cycle of a four-stroke engine.
14. The duty cycle of a two-stroke engine.
15. Impact of IYoD on the environment.
16. The main technical indicators of IYoD.
17. Types of tasks and application of Krivoship connecting rod mechanism (KShM).
18. Structure and location of KShM.
19. Functions, structure, material and location of KShM parts.
20. The function, structure, operation, material and location of the flywheel.
21. The function, structure, material and location of the cylinder block, block cover, crankcase and crankcase base.
22. Design features of the KShM structure.
23. Types and application of gas distribution mechanism (GTM).
24. Structure of GTM.
25. Function, structure, material and location of GTM parts.
26. Construction features in the structure of GTM.
27. GAS distribution phases and operation of cylinders.
28. Function, types and application of the cooling system.
29. Cooling system fluids and their characteristics.
30. Structure, operation and location of the liquid cooling system.
31. The function of the acceleration pump is the structure and operation.
32. Types, structure and operation of gasoline air cleaners.
33. The structure and operation of the gasoline suction pump.
34. Structure, operation, application and location of the air adjuster of the frequency of revolutions of the crankshaft.
35. Function, types and structure of gas supply system of the engine.
36. Liquefied and compressed gases, their properties.
37. liquefied natural gas supply system.
38. Structure, operation and location of compressed gas balloon supply system.
39. The function, structure and operation of the two-stage reducer.
40. Structure and operation of vaporizer and gas mixer.
41. The function, structure and operation of the electromagnetic valve-cleaner.
42. Effects of combustion residues on the environment and measures to eliminate it.
43. The function, structure and location of the fuel supply system of a four-stroke

diesel engine.

44.Diesel fuel and its properties.

45.Structure, operation and location of the fuel suction pump.

46.Structure, operation and location of fuel coarse and fine cleaners.

47.Function, types, construction and operation of high pressure fuel pump.

48.Low and high pressure fuel pipes and their location.

49.The function, types, structure and operation of the nozzle.

50.Types, location and application of combustion units.

51.The function, types, structure and operation of an air purifier.

52.The formation of a combustible mixture in a diesel engine.

53.The function, structure, operation and location of the all-speed adjuster of the frequency of rotations of the crankshaft. The function, structure and operation of the acceleration pump.

54.Types, structure and operation of gasoline air cleaners.

55.The structure and operation of the gasoline suction pump.

56.Construction, operation, application and location of the air adjuster of the frequency of revolutions of the crankshaft.

57.Injector supply systems.

58.pumps of injector supply systems .

59.Function, types and structure of gas supply system of the engine.

60.Liquefied and compressed gases, their properties.

61.liquefied natural gas supply system.

62.Structure, operation and location of compressed gas balloon supply system.

63.The function, structure and operation of the two-stage reducer.

64.Structure and operation of vaporizer and gas mixer.

65.The function, structure and operation of the electromagnetic valve-cleaner.

66.Effects of combustion residues on the environment and measures to eliminate them.

67.The function, structure and location of the fuel supply system of a four-stroke diesel engine.

68.Diesel fuel and its properties.

69.Structure, operation and location of the fuel suction pump.

70.Structure, operation and location of fuel coarse and fine cleaners.

71.Function, types, construction and operation of high pressure fuel pump.

72.Low and high pressure fuel tubes and their location.

73.The function, types, structure and operation of the nozzle.

74.Types, location and application of combustion units.

75.The function, types, structure and operation of an air purifier.

76.The formation of a combustible mixture in a diesel engine.

77.Development of diesel engines.

2 -intermediate control assignments EUTTUE direction

2nd interim control is oral based on lecture materials (test) is conducted in the form. 5 marks for the 2nd midterm 5 grades are allotted for the independent work assignment .

No	Type of activity 2- Intermediate	price
1	1st oral control for the test	**2,3,5**
2	For doing and defending **independent work**	**2,3,5**
	Average	**2,3,5**

2- intermediate control assignments
5 semester YeUTTUE course

1. Types and structure of power transmission function.
2. Types of mechanical power transmission, mechanisms and their location.
3. Structure, operation and application of hydromechanical power transmission.
4. Structure, operation and application of electromechanical power transmission.
5. The function, types and location of the clutch.
6. Form, structure, operation and application of single disc clutch.
7. Form, structure, operation and application of double disc clutch.
8. Form, structure, operation and application of hydraulic coupling.
9. The structure of the mechanical operation of the clutch control.
10. The structure of the hydraulic mechanism of the clutch control.
11. The function, types and location of the gearbox in the car.
12. Structure, operation and application of a step-by-step manual transmission.
13. Structure, operation and application of stepless manual transmission.
14. Function, structure, operation and location of the synchronizer.
15. The structure and operation of the mechanism for adding and removing extensions.
16. Function, location, construction, operation and application of the distribution box.
17. The function, types, structure and location of the cardan transmission in the car.
18. Cardan joints with different and uniform angular velocities and their application.
19. Methods of eliminating the unevenness of rotation of the propeller shaft in the transmission of rotary motion.
20. The function, types and location of the main gear in the car.
21. Structure, operation and application of single main gear.
22. Form, structure, operation and application of double main gear.
23. Adjusting the gap between the main gear teeth.
24. Structure, operation and application of split main gear.
25. Types of functions of the differential and its location in the car.
26. The structure and operation of the differential.
27. Structure, operation and application of symmetric differential.
28. Structure, operation and application of the inter-axle differential.
29. Structure, operation of a self-locking differential.
30. Semi-axles and methods of unloading them.
31. Rama's function, types and structure.
32. Functions and types of bridges.
33. Structure and application of split and non-split leading bridge.

34.the structure of the lead bridge.
35.Osma's function, types and location in the car.
36.Structure, operation and application of independent suspension.
37.Structure, operation and application of independent suspension.
38.The function, structure and application of the balance suspension of the middle and rear axles.
39.The function, types, structure and operation of the shock absorber.
40.Function, structure, operation and application of transverse stabilizer.
41.The function, types and structure of wheels.
42.The function, types, structure and operation of tires.
43.Tire sizes, markings and models.
44.Centralized tire pressure adjustment system.
45. Steering wheel mounting angles.
46.The function of the steering wheel, its location in the car and the structure of the car.
47.The shape, structure and operation of the steering wheel.
48.The function, types, structure and operation of the steering mechanism.
49.Function, types, structure and operation of the steering wheel.
50.Structure, operation and application of hydraulic power steering.
51.The structure and application of the hydraulic split steering mechanism.
52.Function, types and location of the brake control.
53.Function, types, structure and operation of the brake mechanism.
54.The function, types, structure and operation of the brake system.
55.The function, structure and operation of the hydrothinning amplifier.
56.function, types and structure of car and bus bodies.
57.Types, structure and equipment of bodies and cabins of trucks.
58.Structure and operation of heating, frontal cleaning and ventilation devices of body and cabins.
59.Purpose, types, advantages and disadvantages of specialized vehicles.
60.Types of one- and two-axle trailers.
61.Construction structures, heavy and long-sized cargo vehicles.
62.The structure and operation of the lifting mechanism of the body of the dump truck and the train.

FINAL CONTROL.

For the final control, there will be a total of 5 marks, and it will be conducted in the form of a written work based on basic words and phrases or in the form of a test.

FINAL CONTROL ASSIGNMENT IQS

1. Stages of development of a motor vehicle.
2. Establishment and development prospects of automotive industry in our republic.
3. Types and indexing and models of motor vehicles.
4. Impact of motor vehicles on the environment.
5. General structure of the vehicle.

6. The main units of the car, their main functions and location.
7. The main technical indicators of the vehicle.
8. Function and types of internal combustion engine (IYoD).
9. General structure of IYoD.
10. IYoD mechanisms, their functions and location.
11. IYoD systems, their functions and location.
12. The main indicators of IYoD.
13. The duty cycle of a four-stroke engine.
14. The duty cycle of a two-stroke engine.
15. Impact of IYoD on the environment.
16. The main technical indicators of IYoD.
17. Types of tasks and application of Krivoship connecting rod mechanism (KShM).
18. Structure and location of KShM.
19. Functions, structure, material and location of KShM parts.
20. The function, structure, operation, material and location of the flywheel.
21. The function, structure, material and location of the cylinder block, block cover, crankcase and crankcase base.
22. Design features of the KShM structure.
23. Types and application of gas distribution mechanism (GTM).
24. Structure of GTM.
25. Function, structure, material and location of GTM parts.
26. Construction features in the structure of GTM.
27. GAS distribution phases and operation of cylinders.
28. Function, types and application of the cooling system.
29. Cooling system fluids and their characteristics.
30. Structure, operation and location of the liquid cooling system.
31. The function of the acceleration pump is the structure and operation.
32. Types, structure and operation of gasoline air cleaners.
33. The structure and operation of the gasoline suction pump.
34. Structure, operation, application and location of the air adjuster of the frequency of revolutions of the crankshaft.
35. Function, types and structure of gas supply system of the engine.
36. Liquefied and compressed gases, their properties.
37. liquefied natural gas supply system.
38. Structure, operation and location of compressed gas balloon supply system.
39. The function, structure and operation of the two-stage reducer.
40. Structure and operation of vaporizer and gas mixer.
41. The function, structure and operation of the electromagnetic valve-cleaner.
42. Impact of burning residues on the environment and measures to eliminate it.
43. The function, structure and location of the fuel supply system of a four-stroke diesel engine.
44. Diesel fuel and its properties.
45. Structure, operation and location of the fuel suction pump.
46. Structure, operation and location of fuel coarse and fine cleaners.
47. Function, types, construction and operation of high pressure fuel pump.

48. Low and high pressure fuel pipes and their location.
49. The function, types, structure and operation of the nozzle.
50. Types, location and application of combustion units.
51. The function, types, structure and operation of an air purifier.
52. The formation of a combustible mixture in a diesel engine.
53. The function, structure, operation and location of the all-speed adjuster of the frequency of rotations of the crankshaft. The function, structure and operation of the acceleration pump.
54. Types, structure and operation of gasoline air cleaners.
55. The structure and operation of the gasoline suction pump.
56. Construction, operation, application and location of the air adjuster of the frequency of revolutions of the crankshaft.
57. Injector supply systems.
58. pumps of injector supply systems .
59. Function, types and structure of gas supply system of the engine.
60. Liquefied and compressed gases, their properties.
61. liquefied natural gas supply system.
62. Structure, operation and location of compressed gas balloon supply system.
63. The function, structure and operation of the two-stage reducer.
64. Structure and operation of vaporizer and gas mixer.
65. The function, structure and operation of the electromagnetic valve-cleaner.
66. Effects of combustion residues on the environment and measures to eliminate it.
67. The function, structure and location of the fuel supply system of a four-stroke diesel engine.
68. Diesel fuel and its properties.
69. Structure, operation and location of the fuel suction pump.
70. Structure, operation and location of fuel coarse and fine cleaners.
71. Function, types, construction and operation of high pressure fuel pump.
72. Low and high pressure fuel pipes and their location.
73. The function, types, structure and operation of the nozzle.
74. Types, location and application of combustion units.
75. The function, types, structure and operation of an air purifier.
76. The formation of a combustible mixture in a diesel engine.
77. Development of diesel engines.
78. Types and structure of power transmission function.
79. Types of mechanical power transmission, mechanisms and their location.
80. Structure, operation and application of hydromechanical power transmission.
81. Structure, operation and application of electromechanical power transmission.
82. The function, types and location of the clutch.
83. Form, structure, operation and application of single disc clutch.
84. Form, structure, operation and application of double disc clutch.
85. Form, structure, operation and application of hydraulic coupling.
86. The structure of the mechanical operation of the clutch control.
87. The structure of the hydraulic mechanism of the clutch control.
88. The function, types and location of the gearbox in the car.
89. Structure, operation and application of a step-by-step manual transmission.

90. Structure, operation and application of stepless manual transmission.
91. Function, structure, operation and location of the synchronizer.
92. The structure and operation of the mechanism for adding and removing extensions.
93. Function, location, construction, operation and application of the distribution box.
94. The function, types, structure and location of the cardan transmission in the car.
95. Cardan joints with different and uniform angular velocities and their application.
96. Methods of eliminating the unevenness of rotation of the propeller shaft in the transmission of rotary motion.
97. The function, types and location of the main gear in the car.
98. Structure, operation and application of single main gear.
99. Form, structure, operation and application of double main gear.
100. Adjusting the gap between the main gear teeth.
101. Structure, operation and application of split main gear.
102. Types of functions of the differential and its location in the car.
103. The structure and operation of the differential.
104. Structure, operation and application of symmetric differential.
105. Structure, operation and application of the inter-axle differential.
106. Structure, operation of a self-locking differential.
107. Semi-axles and methods of unloading them.
108. Rama's function, types and structure.
109. Functions and types of bridges.
110. Structure and application of split and non-split leading bridge.
111. the structure of the lead bridge.
112. Osma's function, types and location in the car.
113. Structure, operation and application of independent suspension.
114. Structure, operation and application of independent suspension.
115. The function, structure and application of the balance suspension of the middle and rear axles.
116. The function, types, structure and operation of the shock absorber.
117. Function, construction, operation and application of transverse stabilizer.
118. The function, types and structure of wheels.
119. The function, types, structure and operation of tires.
120. Tire sizes, markings and designs.
121. Centralized tire pressure adjustment system.
122. Steering wheel mounting angles.
123. The function of the steering wheel, its location in the car and the structure of the car.
124. The shape, structure and operation of the steering wheel.
125. The function, types, structure and operation of the steering mechanism.
126. Function, types, structure and operation of the steering wheel.
127. Structure, operation and application of hydraulic power steering.
128. The structure and application of the hydraulic split steering mechanism.
129. Function, types and location of the brake control.

130. Function, types, structure and operation of the brake mechanism.
131. The function, types, structure and operation of the brake system.
132. The function, structure and operation of the hydrothinning amplifier.
133. Purpose, types and structure of bodies of passenger cars and buses.
134. Types, structure and equipment of bodies and cabins of trucks.
135. Structure and operation of heating, frontal cleaning and ventilation devices of body and cabins.
136. Purpose, types, advantages and disadvantages of specialized vehicles.
137. Types of one- and two-axle trailers.
138. Construction structures, heavy and long-sized cargo vehicles.
139. The structure and operation of the lifting mechanism of the body of the dump truck and the train.

Tasks for the 1st and 2nd mid-term assessment of the 6th semester

1-Midterm assessment tasks

1. The creation of the theory of operational features of the car and its importance.
2. Operating characteristics of the car.
3. Obtaining the description of the external speed of the engine by the laboratory method.
4. Obtaining the description of the external speed of the engine by calculation.
5. Vehicle driving force and moments.
6. Forces resisting the motion of the car.
7. Forces and moments acting on the front wheel of the car.
8. Forces and moments acting on the driving wheel.
9. Traction and description of the vehicle.
10. The force resisting the rolling of clay d irak.
11. The force that resists the car's ascent.
12. Road resistance.
13. Air resistance.
14. The force of resistance (inertia) to the acceleration of the car.
15. Reactive forces.
16. The bite force between the wheel and the road surface.
17. General equation of motion of a car.
18. The car's force balance equation.
19. Solving the force balance equation graphically.
20. The car's power balance equation.
21. Solving the power balance equation graphically.
22. Dynamic factor of the car.
23. Description and analysis of the dynamic factor of the car.
24. Car speaker passport and its description.
25. Solving exploitation issues using a dynamic passport.
26. Determining the power of the engine by the desired number of revolutions of the crankshaft.

27. Determination of the torque of the engine crankshaft for the desired number of revolutions.
28. Determination of hourly fuel consumption by the desired number of revolutions of the engine crankshaft.
29. Determination of relative fuel consumption for the desired number of revolutions of the engine crankshaft.
30. Determination of the maximum power of the engine when the car is running at maximum speed.
31. Determination of wheel turning radius.
32. Determination of FIK of power transmission
33. Graphing and interpreting the motor external speed characteristic.
34. Determining the number of transmission gears.
35. Determining the number of transmissions of the main gear.
36. Determining the vehicle's center of gravity
37. Reaction forces acting on car wheels.
38. Determining the number of transmissions waiting for extensions
39. Speed when moving the car in different gears.
40. Traction force on the wheel of a car .
41. Annotate the vehicle dynamic factor graph.
42. Effective engine power
43. Effective engine torque
44. Laboratory determination of hourly fuel consumption of a car.
45. Laboratory determination of vehicle speed.
46. Determination of the cross-sectional area of the car.
47. Determining the intervals of the number of revolutions of the crankshaft.
48. Torque applied to the wheel.
49. Anti-roll coefficient of the wheel.
50. The power of resistance in climbing.
51. Reactive forces.
52. car .
53. The force of biting the wheel between the road.
54. Vehicle condition.
55. The power delivered to the wheels of the car.

2-Midterm assessment assignments

1. Vehicle acceleration and description.
2. Dimensions of car acceleration.
3. Determining acceleration time graphically.
4. Determining the path of acceleration graphically.
5. Influence of operational factors on traction-speed characteristics.
6. Car braking process.
7. Forces acting on the wheel when braking.
8. The car when braking to him effect doer forces .
9. Braking acceleration of the car.
10. Braking time and path.

11.Descriptions of braking time and distance and their changes.
12.Car braking graph.
13.Braking of strength car arrows between distribution .
14.Influence of factors occurring in operation on braking characteristics.
15.of simple savings.
16.Factors affecting fuel economy.
17.Distance fuel consumption standards of cars .100 km
18.Economic description of the car.
19.Effect of operating factors on fuel economy.
20.Measurements and indicators of controllability of vehicles.
21.Controllability condition and factors affecting it.
22.Car roll when there is lateral tire slip.
23.Cycles of the turning process of the car.
24.Forces affecting the turning of the car.
25.Speed limited by turning.
26.The connection between the turning angles of the wheel.
27.Types of stagnation loss and its dimensions.
28.Stability of a vehicle climbing a longitudinal incline.
29.Stability of a car going down a longitudinal incline.
30.Stability of a car moving on a transverse inclined plane.
31.Stability and limited speed of the car when turning on an inclined plane.
32.The influence of factors encountered in operation on vehicle stability.
33.Measurements and indicators of vehicles passing through road obstacles.
34.Geometric indicators of permeability.
35.front wheel over the road block.
36.road block.
37.Abutment-bite dimensions of permeability.
38.Effect of design and operational factors on permeability.
39.Driving smoothness and dimensions of the car.
40.Vibration of a one-mass system with one degree of freedom and its differential equation.
41.Dimensions of harmonic free vibration: V, j, j^1, T, n, and f_{cm} their determination.
42.Vibration systems of the car.
43.Crushing (deformation) of the car's vibration systems and the general failure of the suspensions.
44.Resilience factor of the car.
45.Car vibration.
46.The efficiency of suspension and shock absorbers.
47.The influence of factors encountered in operation on the smoothness of driving a car.
48.Which indicators of the external speed description of the internal combustion engines of the vehicle are determined by the laboratory.
49.Determine the operational characteristics of the vehicle.
50.Define the theory of operational characteristics of the vehicle.
51.It is determined by calculating which indicators of the external speed

description of internal combustion engines of the vehicle.
52.Determine the mobility of the vehicle.
53.motion of the vehicle .
54.Determine the balance of forces acting on the vehicle.
55.Determine the balance of forces acting on the vehicle.
56.Determine the condition for the idler wheel E.
57.Define the dynamic factor of the vehicle.
58.Determine the driving ability of the vehicle according to the dynamic factor.
59.Define the dynamic passport of the vehicle.
60.determine the dynamics of the car.
61.Determine the dimensions of the acceleration of the car.
62.Determine the traction force of the vehicle.
63.Determine the car's braking dimensions.
64.Determine whether the braking device is decelerating and braking effectively.
65.Define vehicle traction dynamics.
66.Determine the fuel consumption of the car engine in one hour.
67.Determine the amount of fuel consumed by the vehicle .100 km
68.Determine the amount of fuel used by the car when pulling one ton of cargo .1 km
69.Determine the definition of a controlled property of a vehicle.
70.Determine vehicle handling dimensions.
71.Determine the connection between the turning angles of the front wheels.
72.Determine the lateral stability of the vehicle on an inclined road.
73.Determine the stability of the vehicle on a longitudinal slope .
74.Define vehicle stagnation.
75.Define a vehicle's ability to avoid roadblocks.
76.Determine the condition of the vehicle to pass the road block.
77.Determine the geometric dimensions of the turbidity.
78.In first gear, determine the road resistance and the condition for the leading wheel to be able to move without wobble.
79.Determine how many degrees of freedom the car body and cabin vibrate in space.
80.Determine the dimensions of the smoothness of the running part of the vehicle.
81.Determine which expression determines the number of gears for each gear of the gearbox.
82.From the given expressions, determine the condition for overcoming the total road resistance of the car when the first gear is added.
83.Determine the fuel consumption of a car engine in one hour .
84.Determine the amount of fuel consumed by the vehicle .100 km
85.Determine the amount of fuel used by the car when transporting one ton of cargo over a distance.1 km
86.Determine the lateral stability of the vehicle on an inclined road.
87.Determine the stability of the vehicle on a longitudinal slope .
88.Determine the moment that resists the turning of the car.
89.Determine how many degrees of freedom the car body and cabin vibrate in space.

Final assessment assignments.

1. The creation of the theory of operational features of the car and its importance.
2. Operating characteristics of the car.
3. Obtaining the description of the external speed of the engine by the laboratory method.
4. Obtaining the description of the external speed of the engine by calculation.
5. Vehicle driving force and moments.
6. Forces resisting the motion of the car.
7. Forces and moments acting on the front wheel of the car.
8. Forces and moments acting on the driving wheel.
9. Traction and description of the vehicle.
10. The force resisting the rolling of clay d irak.
11. The force that resists the car's ascent.
12. Road resistance.
13. Air resistance.
14. The force of resistance (inertia) to the acceleration of the car.
15. Reactive forces.
16. The bite force between the wheel and the road surface.
17. General equation of motion of a car.
18. The car's force balance equation.
19. Solving the force balance equation graphically.
20. The car's power balance equation.
21. Solving the power balance equation graphically.
22. Dynamic factor of the car.
23. Description and analysis of the dynamic factor of the car.
24. Car speaker passport and its description.
25. Solving exploitation issues using a dynamic passport.
26. Determining the power of the engine by the desired number of revolutions of the crankshaft.
27. Determination of the torque of the engine crankshaft for the desired number of revolutions.
28. Determination of hourly fuel consumption for the desired number of revolutions of the engine crankshaft.
29. Determination of relative fuel consumption for the desired number of revolutions of the engine crankshaft.
30. Determination of the maximum power of the engine when the car is running at maximum speed.
31. Determination of wheel turning radius.
32. Determination of FIK of power transmission
33. Graphing and interpreting the motor external speed characteristic.
34. Determining the number of transmission gears.
35. Determining the number of transmissions of the main gear.
36. Determining the vehicle's center of gravity
37. Reaction forces acting on car wheels.
38. Determining the number of transmissions waiting for extensions

39.Speed when moving the car in different gears.
40.Traction force on the leading wheel of a car.
41.Annotate the vehicle dynamic factor graph.
42.Effective engine power
43.Effective engine torque
44.Laboratory determination of hourly fuel consumption of a car.
45.Laboratory determination of vehicle speed.
46.Determination of the cross-sectional area of the car.
47.Determining the intervals of the number of revolutions of the crankshaft.
48.Torque applied to the wheel.
49.Anti-roll coefficient of the wheel.
50.The power of resistance in climbing.
51.Reactive forces.
52.the height of the center of gravity of the car.
53.The force of biting the wheel between the road.
54.Vehicle condition.
55.The power delivered to the wheel of the car.
56.Vehicle acceleration and description.
57.Dimensions of car acceleration.
58.Determining acceleration time graphically.
59.Determining the path of acceleration graphically.
60.Influence of operational factors on traction-speed characteristics.
61.The braking process of the car.
62.Forces acting on the wheel when braking.
63.The car when braking to him effect doer forces .
64.Braking acceleration of the car.
65.Braking time and path.
66.Descriptions of braking time and distance and their changes.
67.Car braking graph.
68.Braking of strength car arrows between distribution .
69.Influence of factors occurring in operation on braking characteristics.
70.of simple savings.
71.Factors affecting fuel economy.
72.Distance fuel consumption standards of cars .100 km
73.Economic description of the car.
74.Effect of operating factors on fuel economy.
75.Measurements and indicators of controllability of vehicles.
76.Controllability condition and factors affecting it.
77.Vehicle roll when there is lateral tire slip.
78.Cycles of the turning process of the car.
79.Forces affecting the turning of the car.
80.Speed limited by turning.
81.The connection between the turning angles of the wheel.
82.Types of stagnation loss and its dimensions.
83.Stability of a car climbing a longitudinal inclined plane.
84.Stability of a car going down a longitudinal incline.

85. Stability of a car moving on a transverse inclined plane.
86. Stability and limited speed of the car when turning on an inclined plane.
87. The influence of factors encountered in operation on vehicle stability.
88. Measurements and indicators of vehicles passing through road obstacles.
89. Geometric indicators of permeability.
90. Passage of the leading front wheel over the road barrier.
91. Passage of the leading axle wheel over the road barrier.
92. Abutment-bite dimensions of permeability.
93. Effect of design and operational factors on permeability.
94. Driving smoothness and dimensions of the car.
95. Vibration of a one-mass system with one degree of freedom and its differential equation.
96. Dimensions of harmonic free vibration: V, j, j^1, T, n, and f_{cm} their determination.
97. Vibration systems of the car.
98. Crushing (deformation) of the car's vibration systems and the general failure of the suspensions.
99. Resilience factor of the car.
100. Car vibration.
101. The efficiency of suspension and shock absorbers.
102. The influence of factors encountered in operation on the smoothness of driving a car.
103. Which indicators of the external speed description of the internal combustion engines of the vehicle are determined by the laboratory.
104. Determine the operational characteristics of the vehicle.
105. Define the theory of operational characteristics of the vehicle.
106. It is determined by calculating which indicators of the external speed description of internal combustion engines of the vehicle.
107. Determine the mobility of the vehicle.
108. motion of the vehicle .
109. Determine the balance of forces acting on the vehicle.
110. Determine the balance of forces acting on the vehicle.
111. Determine the condition for the idler wheel E.
112. Define the dynamic factor of the vehicle.
113. Determine the driving ability of the vehicle according to the dynamic factor.
114. Define the dynamic passport of the vehicle.
115. determine the dynamics of the car.
116. Determine the dimensions of the acceleration of the car.
117. Determine the traction force of the vehicle.
118. Determine the car's braking dimensions.
119. Determine whether the braking device is decelerating and braking effectively.
120. Define vehicle traction dynamics.
121. Determine the fuel consumption of the car engine in one hour.
122. Determine the amount of fuel consumed by the vehicle .100 km
123. Determine the amount of fuel used by the car when pulling one ton of cargo .1 km

124. Determine the definition of a controlled property of a vehicle.
125. Determine vehicle handling dimensions.
126. Determine the relationship between the turning angles of the front wheels.
127. Determine the lateral stability of the vehicle on an inclined road.
128. Determine the stability of the vehicle on a longitudinal slope .
129. Define vehicle stagnation.
130. Define a vehicle's ability to avoid road obstacles.
131. Determine the condition of the vehicle to pass the road block.
132. Determine the geometric dimensions of the turbidity.
133. In first gear, determine the road resistance and the condition for the leading wheel to be able to move without wobble.
134. Determine how many degrees of freedom the car body and cabin vibrate in space.
135. Determine the dimensions of the smoothness of the running part of the vehicle.
136. Determine which expression determines the number of gears for each gear of the gearbox.
137. From the given expressions, determine the condition for overcoming the total road resistance of the car when the first gear is added.
138. Determine the fuel consumption of a car engine in one hour .
139. Determine the amount of fuel consumed by the vehicle .100 km
140. Determine the amount of fuel used by the car when transporting one ton of cargo over a distance.1 km
141. Determine the lateral stability of the vehicle on a slope.
142. Determine the stability of the vehicle on a longitudinal slope .
143. Determine the moment that resists the turning of the car.
144. Determine how many degrees of freedom the car body and cabin vibrate in space.
145. Conditions for overturning a car.

Recommended reading list
Basic literature

21. A. Mukhitdinov and others. Cars. Basics of construction. "Light of Independence" publishing house. T.: 2015, 332 pages.
22. A. Mukhitdinov, B. Sattivaldiev, SH. Khakimov "Design of vehicles" "Educational publishing house" TASHKENT-2014 y 158 p.
23. Faizullayev EZ Structure and theory of transport vehicles. Textbook. 1st part.-T.: " Generation of the new century ", 2006. -375 b.
24. Mamatov.X Cars (Fundamentals of car construction). Part 1. Tashkent, "Teacher", 1995.
25. Mamatov.X Automobiles (Fundamentals of automobile construction). Part 2. Tashkent, "Teacher", 1998.

Additional literature

40. Vakhlamov. V.K. "Car: Espluatatsionnie svoystva M: Izdatelsky tsentr" "Akademiya" 2004-528 p.
41. Sidiqnazarov K.M and dr. Motor transport is located in the surrounding area. T: 2007-188 p.
42. Ivanov. A.M. i dr. Osnovi konstruktsii avtomobilya, M.OOO. "Knijnoe izdatelstvo" "Zarulem", 2005-336 p.
43. Vakhlamov. V.K. "Tenika avtomobilnogo transporta: Podvizhnoy sostov i ekspluatatsionnie svoystva M: Izdatelskiy tsentr" "Akademiya" 2004-528 p.
44. MOQodirkhanov. B. Rasulov. a collection of problems on the subject of the theory of automobiles. Tashkent. Teacher. 1992
45. Mamatov.Kh, Turdiev.Yu, Kadirkhanov.M Fundamentals of automobile design and theory. Tashkent. "Teacher" 1982.
46. SM Kadyrov. MOQodirkhanov. Theory of engines and cars. Tashkent. Teacher. 1982
47. Kadyrov. SM Tiko car structure, troubleshooting and repair. Tashkent, "Teacher", 2001.
48. Kadirkhanov.MO Car processes and accounting Tashkent. "Teacher" 2003.
49. Carroll E. Goering, Marvin L. Stone, David W. Smith, Paul K. Turnquist. " Off-Road vehicle Engineering principles " , American Society of Agricultural Engineers, 2006.
50. David A. Crolla. "Automotive Engineering Powertrain, Chassis System and Vehicle Body", Amsterdam, Butterworth-Heinemann is an imprint of Elsevier, 2009.
51. Engineering Principles of Agricultural Machines Ajit K. Srivastava Michigan State University Carroll E. Goering University of Illinois Roger P. Rohrbach North Carolina State University Dennis R. Buckmaster The Pennsylvania State University Copyright 2006 by the American Society of Agricultural and Biological Engineers All rights reserved.
52. Sites where Internet information can be obtained: http://ru.wikipedia.org/wiki/'Avtotransportnoe_predpriyatie