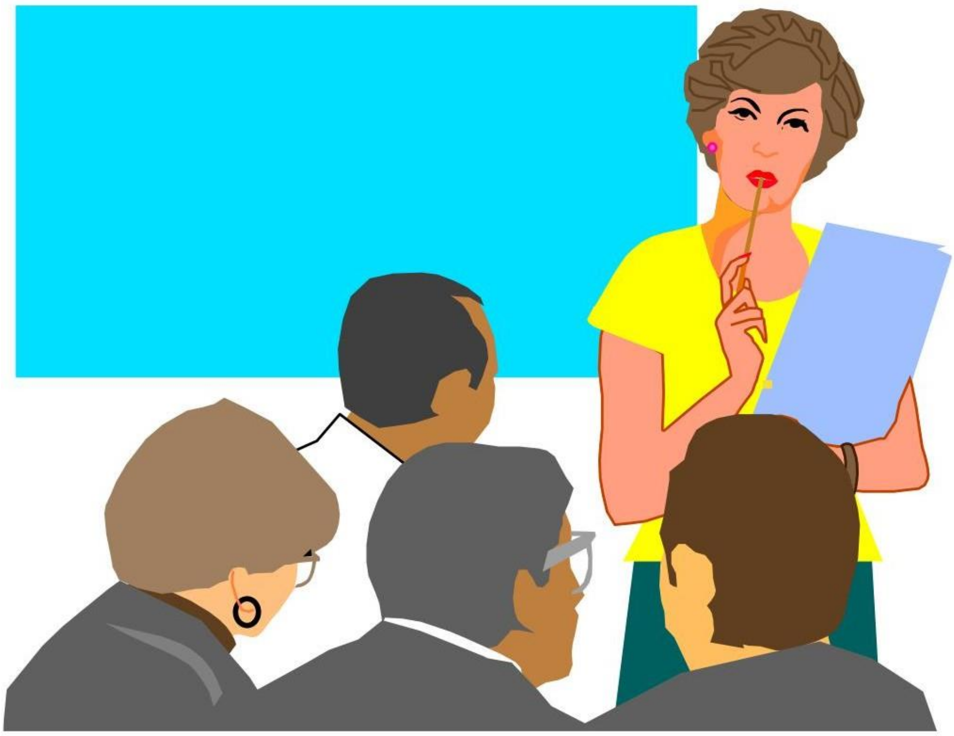
**HIGHER EDUCATION OF THE REPUBLIC OF UZBEKISTAN SCIENCE AND MINISTRY OF INNOVATION**

**NAMANGAN ENGINEERING AND CONSTRUCTION INSTITUTE**

***Department of Agricultural Mechanization***

# *"TRACTORS AND AUTOMOBILE"*

## *Text of lectures on the subject*



**Namangan -2024**

Sh. Akbarov, "Tractors and Automobiles" (problematic presentations on the structure text), NamMQI, Namangan 2024, 144 p.

Lecture texts Vocational education "Mechanization of agriculture"
It is based on the state standard and model curriculum in the field of education.

From the text of these problematic lectures, institute students and agricultural workers
Students of vocational colleges studying in the field of
possible.

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The texts of this problematic lecture are "Mechanization of Agriculture"

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## FOREWORD

These problematic lectures on the subject "The structure of tractors and automobiles" The text has been written by the authors for many years for students of the "Agroengineering" specialty. The text of these lectures is based on the lectures given by State Educational Standard and Model Curriculum in the Field of "Agroengineering" was prepared. The text of these problematic lectures was written from textbooks, study guides, written by Assoc. Prof. Sh. Akbarov on this subject The text of the lectures was used and today tractors and automobiles are The innovations introduced into the design were also taken into account.

The text of the problem lectures contains descriptions of parts and assemblies of tractors and automobiles. structure, principle of operation, differences in constructions, functions and what happens in them The following are the defects and methods for their elimination. In addition, The lectures should be easy to understand and present in a way that engages students independently. To develop their thinking, they should study the components and details of tractors and automobiles. Drawings and problem questions for each lecture are provided. Lectures The text is written in simple language that students can understand and assimilate well. It is written in such a way that it fully covers the knowledge and skills required in the subject. can provide an opportunity to acquire.

## Lecture 1: Introduction. Tractors and vehicles used in agriculture. Classification and general structure of tractors and vehicles.

*Plan:*

1. Problems of creation and development of energy vehicles in the conditions of market relations; 2. State decisions adopted on the development of tractor industry in Uzbekistan and its improvement and their implementation 3. Classification of tractors; 4. Classification of automobiles; 5. General structure of tractors and automobiles.

### 1. Problems of creating and developing energy vehicles in market conditions

In connection with the collapse of the former Soviet Union, the establishment of the Commonwealth of Independent States and the transition to a market economy, the issue of systematically providing agriculture with energy resources was somewhat disrupted. Because most of the parts, assemblies, and aggregates of all energy resources and other equipment produced in Uzbekistan were imported from foreign republics and assembled only at our own factories. In addition, ferrous metals for the manufacture of components manufactured at our own factories were imported only from Russian heavy metallurgical plants. The severance of ties and deterioration of relations between the republics at the beginning of the period of independence also led to the disruption of this supply.

After independence, over the years, the service life of the existing energy vehicles in agriculture has come to an end and they have gradually begun to fall into disrepair, the number of tractors in the company farms has sharply decreased, and those that are still in operation have become fuel and lubricants-intensive, requiring many spare parts. This, in turn, has led to the failure to complete agricultural work within the established agrotechnical deadlines, to an increase in operating costs per unit of work performed, and, in addition, to a slight increase in the cost of the product being produced. The share of manual labor in the value of manufactured products increased, and some technological operations (cotton picking, fertilizer preparation, etc.) began to be performed manually. Realizing this situation in time, the leadership of the Republic decided to conclude contracts with companies from developed foreign countries and import the necessary energy vehicles and agricultural machinery to Uzbekistan.

Therefore, "Magnium" tractors, grain harvesters, plows, and horizontal spindle cotton pickers were purchased from the American companies "Case" and "John Deere". These power tools and agricultural machinery were extensively tested in the soil and climatic conditions of Uzbekistan and were recommended for production.

The results of using imported energy vehicles and agricultural machinery in Uzbekistan showed that their worn-out parts and

Replacing the components was very expensive for farmers and cooperatives and caused a number of difficulties. Therefore, the State was tasked with solving the issues of manufacturing these parts and components at our existing factories, and in order to solve these problems, additional agreements were concluded with foreign companies, and their positive resolution was achieved.

## 2. The state of development of tractor industry in Uzbekistan and its improvemen State decisions adopted and their implementation

The development of tractor farming in Uzbekistan is directly related to the development of tractor farming in foreign countries. Therefore, it is more correct to study and look at the situation in this issue in two periods, namely the pre-independence and independence periods. Because the period of development of tractor farming before independence was based on certain plans, while during independence it is characterized by a period of transition to market relations.

In the years before independence, based on the decisions and plans of the former Union (in 1957), the Tashkent Tractor Assembly Plant was built, and plans for their production, development, and design improvement were determined by central bodies outside the Republic, and the necessary capital funds were allocated for their implementation. That is, it was a period when solving issues of developing tractor production in Uzbekistan depended solely on the center.

The development of tractor production during the period of independence was a difficult and complex period, determined by the capabilities of the young state and the requirements of its agriculture.

These periods are as different from each other as old and newly built families. Because the former Union had its own strength, raw materials, and the necessary metallurgical and tractor plants, while our Republic, which gained independence, was a young state that did not have the raw materials to develop and produce tractors and had only the Bekabad metallurgical plant, built during the former Union, which smelted metals. Therefore, we considered it appropriate to dwell separately on the stages of tractor development in both periods in order to compare them.

**The period before independence.** As a result of the tireless research and hard work of several generations of creative people towards a specific goal, tractors and automobiles were created. The merits of Russian inventors, scientists and engineers in this field are immense.

The creative inventor and farmer FA Blinov was the first in the world to demonstrate a steam-powered chain tractor at the Saratov Exhibition in 1889.

This steam-powered device, created at the end of the 19th century, was very heavy, slow, and inefficient. Therefore, as a result of the widespread use of oil refining in industry, a carburetor engine with a spark ignition of the working mixture, a carburetor engine, and a diesel engine with a compression ignition of air were created and began to be produced. The creation of such a lightweight and more economical engine made it possible to improve the design of tractors and automobiles.

The first spark-ignited gasoline internal combustion engine in Russia was built in 1889 by the design of I.O. Kostovich. In 1902, engineer G.V. Trinkler invented the fuel invented the diesel engine, which ignites by compressing a mixture.

Ya.V. Mamin, a student of FA Blinov, Russian tractor and engine builder occupies an honorable place in the development of the internal combustion engine. It was developed in 1893-1895 built a self-propelled "cart" with an engine. The first one was created in 1910 The wheeled tractor was also built by Ya.V. Mamin.

But the pre-revolutionary, which was extremely backward in socio-economic terms, In Russia, sufficient importance is attached to accelerating the development of science and technology. was not given and was not supported at all. That is why in 1917 the whole There are a total of 165 tractors in Russia, most of which are imported. was.

In the 1920s, agriculture was equipped with tractors and other machinery. Special attention was paid to ensuring.

In March 1918, designer Ya.V. Mamin built a new will be sent abroad to purchase equipment for the tractor factory under construction. Later, this plant was named "Karlik" based on the design of Ya.V. Mamin. Tractor production has begun.

By 1930, a number of other enterprises were adapted to the production of tractors, including "Mogul", FP, "Kolomits", "Zaporozhets", Bolshevik, "Kommunar" and others. Small-scale production of other similar tractors (about 500 in total) has been launched. However, this does not fully satisfy the needs of the agricultural sector. Therefore, by June 1930, special tractor factories were built and put into operation in Stalingrad (now Volgograd), and in October 1931 in Kharkov, with a capacity of Mass production of STZ-XTZ wheeled tractors with a capacity of 23.8 kW In the summer of 1933, a large machine-building plant was built in Chelyabinsk, where the production of chain tractors was launched. By 1937, this enterprise had diesel engines. The S-65 tractor began production and since then the tractor fleet has been The entire fleet began to be equipped with diesel engines.

Cotton growing at the Putilov (now Kirov) Tractor Plant since 1934 The famous "Universal" lawn tractors, which left a significant mark on the history of development mass production began, and at the same time, U-1, U-2, U-3 models are being produced here. Tractors were sent to life.

Thus, the number of tractors in Uzbekistan gradually increased (Table 1), and the former Soviet Union became the world leader in this field, that is, during the Great Patriotic War. On the eve of the 2016 elections, its tractor fleet consisted of 531,000 tractors.

Table 1

Dynamics of the number of tractors imported to Uzbekistan

| | Years | | | | |
|---|---|---|---|---|---|
| | 1925-1926 | 1926-1927 | 1927-1928 | 1928-1929 | 1929-1930 |
| Tractors number | 484 | 1063 | 1200 | 1525 | 2301 |

All sectors of the national economy primarily solve defense tasks. during the Great Patriotic War, when we were busy with issues aimed at

In the 1990s, new tractor factories such as ATZ, LTZ, and VTZ were built and put into operation. Restoration of enterprises destroyed in the post-war period (KhTZ, STZ),
Along with the modernization and expansion of the factories (ChTZ, LKZ), the current
The construction of tractor factories (such as MTZ, KTZ, TTZ) that meet the requirements of was taken on a large scale and with great intensity.

Starting in 1949, the Volgograd (VgTZ) and Kharkov (KhTZ) tractor plants were put into operation, and starting in 1952, the Altai (ATZ) tractor plant was put into operation, initially producing DT-54 and later the improved DT-54A tractors. This tractor
ahead of its time in terms of durability, serviceability and ease of management
was much superior to tractors. VgTZ has been further improved since 1963
DT-75, KhTZ produces the high-performance T-74 tractor, and ATZ produces the T-4 tractor.
In 1950-1955, the VTZ produced a U-4 pneumatic wheeled tractor.
The first SXM-48 cotton picker was also built on this tractor.
installed.

By 1955, the production of DT-24 tractors with diesel engines was mastered, replacing the kerosene-powered U-4 tractor. Since 1957, the Tashkent tractor factory
The assembly plant (now TTZ) in cooperation with VTZ produced the T-28X tractor.
So far, these two factories have jointly created and launched into mass production four models of this tractor (T-28X, T-28X3, T-28X4, T-28X4M).
These tractors are equipped with air-driven and crankshaft rotation
and engines of the D-30, D-37B, D-37E and D-144 models, which differ in power
installed.

The Minsk Tractor Plant (MTZ), launched in 1955, initially had a high profile.
MTZ-1, designed for cultivating rows of growing crops, since 1963
and began producing MTZ-50 tractors. Further improvements to this tractor
As a result, the unification level reaches 70%, with a D-240 engine
The MTZ-80 tractor has been launched. It meets the requirements of modern tractor construction in many respects, including its technical resource.
It was an energy source that provided.

MTZ-80X and MTZ-82 universal tillage tractors based on the MTZ-80 tractor
was created. The Tashkent Tractor Plant, in collaboration with MTZ, has been producing MTZ-80X tractors since 1977.

Thanks to the selfless work of the tractor industry, the former
The Union has become the world's leading producer of tractors. The Union
Tractors have been exported to more than 60 foreign countries. Among them are countries with highly developed economies such as the USA, France, England, and Canada.
was also.

The dynamics of the development of tractor industry during the former Soviet Union are presented in Table 2. This As can be seen from the table, the development of tractor production (taking into account the years 1944 and 1991) (if not) has been steadily increasing over the decades, especially during the war years (1944) and During the years of the collapse of the Soviet Union (1991), production decreased to a certain extent.

Table 2

| All models annual tractors production | During the decades of the Union's existence, thousands of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1924 | 1934 | 1944 | 1954 | 1964 | 1974 | 1984 | 1991 |
| | 74 | 115 | 20 | 150 | 330 | 531 600 500 | | |

**The period of independence.** On September 1, 1991, Uzbekistan declared its independence. During this period, the cotton farms of the Republic produced about 140 thousand sawmills, 30 thousand transport and 50 thousand driving tractors, 10 thousand tractor trailers and other The techniques were works. With the collapse of the Union, all communications between the Republics were severed. and the ongoing work in cooperation has stopped. Therefore, cotton farms systematically supplied tractors and other agricultural machinery production went out of control and stopped. The existing tractors on the farms As a result of their use, their service life gradually expired, and they were decommissioned. tractors were not replaced with new ones. This situation affected the machinery and tractor fleet in the companies. caused a sharp decrease in production processes on farms It became apparent that there was a shortage of tractors to complete the work, and the remaining tractor fleet was used to carry out the work. had to work non-stop for many shifts to complete the task. This situation In order to achieve this, the leadership of the Republic has taken measures to implement certain events. Among these, contracts with companies from developed foreign countries established, supplying the Republic with reliable and powerful "Magnium" tractors, "Keys" combines, horizontal spindle cotton pickers and other agricultural machinery machines were purchased. Assistance in the field of machinery for cotton farms "Machine and tractor parks (MTP)" were established in districts and regions to demonstrate. Because during this period, all joint-stock companies were in a very poor economic situation. and could not afford to buy new equipment.

As the years of independence passed, Uzbekistan began to develop in foreign countries. by establishing joint ventures with companies and producing TTZ-branded products in the factories of our Republic The production of tractors and some necessary parts was established, and ... of these tractors are currently in use at cotton farms and other enterprises He is working on the stove.

In our republic, along with other sectors, the agricultural sector has also consistently pursued policy Due to the implementation of the program, positive developments have occurred in most sectors of agricultural production, including cotton growing. Companies and farmers Strengthening the material and technical base of farms, improving the land reclamation economically justified improvement, mechanization of field work The measures are being implemented, namely the issue of purchasing equipment on a "Lease" basis. was established. This creates certain conditions for the development of companies and farms. to create and, depending on their capabilities, to purchase the necessary equipment It was the result of practical measures aimed at obtaining.

In addition, the purchase prices of agricultural products have increased significantly. The increase in the level of our farmers' livelihoods will change, albeit slightly. motivated to improve.

The agricultural products being grown are cheap and abundant. The development of tractor farming in the republic is of great importance. At the same time, complex mechanization of field work, application of advanced agrotechnical measures, Increasing the level of use of machinery in harvesting the crop is considered the most necessary condition.

Now, great importance is being attached to measures for the universal use of tractors, measures for using tractors with agricultural machinery that can combine several technological processes in one pass, in accordance with their power, work on creating wide-ranging, universal units, and the creation of machines capable of operating at high speeds (9-15 km/h).

The efforts made to industrialize agriculture are creating the basis for profound changes in the social and professional structure of the population, the nature of its labor, raising the level of spirituality and culture, and transforming agricultural labor into a type of industrial labor. At the same time, there are still serious shortcomings and untapped potential in accelerating scientific and technical progress in agriculture, introducing the latest achievements of science and technology and the experience of progressives into production.

In addition, in the context of the transition to market relations, it is necessary to increase the efficiency of using the machinery and tractor fleet of companies and farms, properly organize multi-shift work when using equipment, improve methods of organizing the labor of mechanized operators, create complex harvesting and transport detachments and increase the efficiency of their use, introduce communication and dispatching services within the farm, and improve methods of planning and accounting for the work of the machinery and tractor fleet.

## 3. Classification of tractors

1. Tractor - a wheeled or chained self-propelled machine, which can be towed or mounted with various machines and tools to perform agricultural work, road construction, and many other tasks. The tractor can drive various mechanisms of machines attached to it or mounted on it through a power take-off shaft. The tractor is equipped with a drive pulley to drive stationary (working in one place) machines. Tractors are divided into groups depending on their function, the structure of the running gear and base, the type of engine, and the traction force.

Depending on the purpose of the tractors, they are divided into agricultural tractors, industrial and land reclamation tractors. tractors. Depending on the work performed, agricultural tractors are divided into:

- general purpose tractors, universal tractors and special tractors

divided into tractors.

General purpose tractors are used for plowing, deep cultivation, planting, harvesting, and other tasks. Their base is not very high.

Universal tractors are mainly used for planting and cultivating row crops, they can also be used for transporting goods. The distance between the rear wheels can be expanded to match the distance between the rows of crops being cultivated: the base is raised above the ground. By changing the position of the tractor wheels, the base can be lowered, making it suitable for use in the garden, or raised above the ground to cultivate row crops. Sometimes such tractors are called garden tractors.

An aggregate is created by installing working elements of various agricultural machines on a self-propelled chassis belonging to universal tractors. Various self-propelled chassis

It can be widely used for transporting goods by installing agricultural machinery or installing a platform.

Special tractors are adapted to perform certain tasks (lifting loads, transporting timber, etc.) or to work in mountainous and swampy areas. These tasks can also be performed using additional equipment from ordinary tractors. Tractors are wheeled and tracked, depending on the structure of the undercarriage. Wheeled tractors were previously produced with steel wheels, but now they are equipped with pneumatic tires (balloons). Tractors are three-wheeled and four-wheeled, depending on the number of wheels. Often the rear wheels are leading, the front wheels are steering, and sometimes all four wheels are also leading. Wheeled tractors are light, simple, cheap, easy to repair and operate, and are used in gardens between rows of crops, for transporting goods; but the ground pressure of the wheels is higher than that of chain tractors ( up to 2 kg/cm2), so they slip more and work poorly on soft ground. Chain tractors have a lower ground pressure (0.2-0.5 kg/cm2), compact the soil less, slip less, and consume less energy for their movement, but are much heavier and more complex in structure.

Depending on the type of tractor, it is divided into frame, frameless, and semi-frame. The basis of frame tractors is the frame, on which all the mechanisms and parts of the tractor are mounted, which are easy to replace and repair.

The base of frameless tractors is formed by assembling the crankcases of the main units together. Frameless tractors are compact and lightweight, but to remove some mechanisms, the tractor must be disassembled. The base of semi-frame tractors consists of a short frame on which the engine is mounted and a transverse bridge body. Depending on the type of engine, tractors are equipped with an electric motor and a heat engine.

Although electric tractors have a number of advantages, they are not used due to their cumbersome design and the rapid failure of the expensive cable used. Heat-engine tractors are equipped with a steam engine or an internal combustion engine. Since the technical and economic performance of a tractor with a steam engine is low, tractors are now mainly produced with an internal combustion engine.

Industrial and land reclamation tractors are used in earthmoving, road construction, mining, hydraulic engineering, forestry, and especially for transporting heavy loads. These tractors are also divided into special industrial tractors used for various tasks, which are equipped with more powerful engines than agricultural tractors.

Tractor system. In order to technically mechanize the agricultural sector of our country and meet all the needs of industry, we need to have only the most necessary basic (base) types (models) of tractors. These models constitute a tractor and self-propelled chassis system. On this basis, tractors of the basic model are produced for certain sectors of agriculture. Tractors are divided into classes depending on the tractive effort in the hitch. This tractive effort is generated when the tractor operates at the lowest operating speed. Each class has approximately the same tractive characteristics, and the design belongs to a group of unified machines. In the plan for the production of tractors in 1966-1970, the nominal tractive effort of agricultural tractors was 0.6; 0.9; 1.4; 2; 3; 4 and 5t, power 10; 15; 25 t. Tractors of our industry

When used for heavy agricultural work, their nominal pulling force is 6.9 and 15 tons.

#### 4. Classification of vehicles

A vehicle is a wheeled vehicle that transports passengers and cargo or special equipment. Vehicles can be equipped with various devices (sprayers, dust collectors, cultivators, well-diggers, etc.) and used as special agricultural vehicles. Depending on the purpose of the vehicle, it is divided into transport vehicles and special vehicles. Transport vehicles transport cargo or passengers. Depending on the amount of cargo they can carry, trucks are divided into light (0.75-2.5 tons), medium (2.5-5 tons) and heavy (more than 5 tons) trucks. Depending on the type of cargo transported, trucks are: flatbed, self-dumping, and with a special body. Passenger vehicles are divided into cars and buses, depending on the structure and the number of passengers transported. Vehicles that can carry loads up to 0.75 tons are called light trucks. Special vehicles are used for special work, for which they are equipped with appropriate equipment. Fire trucks, ambulances, mobile workshops, truck cranes, and others are special vehicles.

Cars are designated by conditional numbers depending on the number of driving wheels (4 X 2; 4 X 4; 6 X 4; 6 X 6), where the first number indicates the number of wheels on the car, and the second number indicates the number of driven wheels. For example: 4 X 2 is understood as a single-axle driving or axle-driven car, 6X6 - a three-axle car with all axles driven. Cars are electric and heat engines depending on the type of engine. Cars with electric engines operate by receiving current from two wires suspended above (trolleybuses) or from a battery battery installed on them (electric cars). Cars use internal combustion engines as heat engines.
In addition to carburetor and diesel engines, gas engines (gas generator and gas cylinder engines) are also used in automobiles. In agriculture, mainly medium-duty trucks and 4X4 passenger cars are used.

***Stationary engines.*** Agricultural machinery used in one place, machinery used in the mechanization of livestock farming, and electric generators are driven by stationary engines. If such machinery (sowing machines, grain crushers, etc.) is moved from one place to another frequently, it is driven by the tractor's power take-off shaft and is towed to the tractor and moved from one place to another. In some farms, machinery (water pumps, fans), despite being used in one place, is driven by the tractor. This is not technically and economically justified, since only the tractor engine is used and its power is not fully utilized. Therefore, in such cases, it is preferable to use electric motors or special stationary motors.

In agriculture, internal combustion engines (carburetor and diesel) and wind turbines can be used as stationary engines, but electric motors are more commonly used on farms with electricity. Carburetor engines are lightweight, compact, and easy to use, and can be used to power electric generators, compressors, grain harvesters, and other power-intensive machines.

widely used in the production of gasoline engines. Carbureted stationary engines are often made with one or two cylinders, 2 or 4 strokes, and run on gasoline. The design and operating principle are similar to automobile engines.

Diesel engines are widely used in water pumps and repair shops, as well as in livestock farms to drive various machines, as well as electric generators. Stationary diesel engines are mainly 4-stroke and operate on the principle of diesel engines in tractors. Wind engines convert wind power into mechanical energy. They are installed in areas with strong winds and are used to drive machines that do not need to operate continuously. They can be used to supply pastures with water, grind grain and fertilizer, and other tasks.

Electric motors convert electrical energy into mechanical energy, which can be transmitted over long distances, transmitted to any network, and used for various purposes (lighting, heating, driving machines, etc.). Electrification of agriculture allows for increased labor productivity, easier working conditions, and improved cultural and household life of the population.

*4. General structure of tractors and automobiles.*

Tractors and automobiles are made up of several mechanisms that work in a certain way. The general structure of chain tractors and their main mechanisms are shown in Figure 1.

Tractor mechanisms can be divided into the following main parts: engine, transmission, running gear, steering mechanism, working and auxiliary equipment. The main parts and mechanisms of a wheeled tractor

are shown in Figure 2.

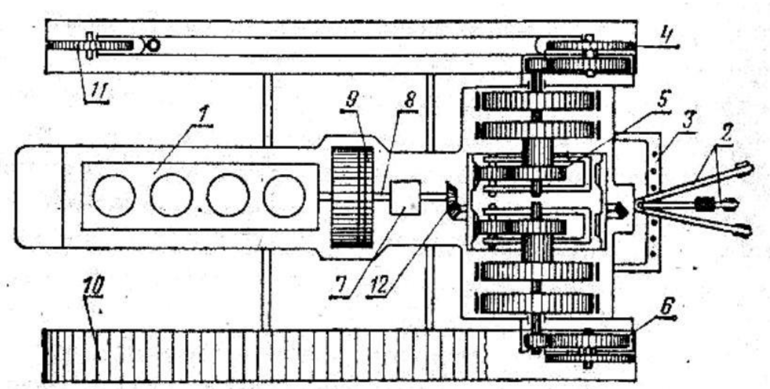


Figure 1. Layout of the main parts and mechanisms of the DT-75M tracked tractor. 1-engine; 2-lifting system; 3-

traction mechanism; 4-drive wheel; 5-planetary mechanism; 6-final drive; 7-gearbox; 8-coupling shaft; 9-clutch; 10-chain drive; 11-guide wheel; 12-main gear;

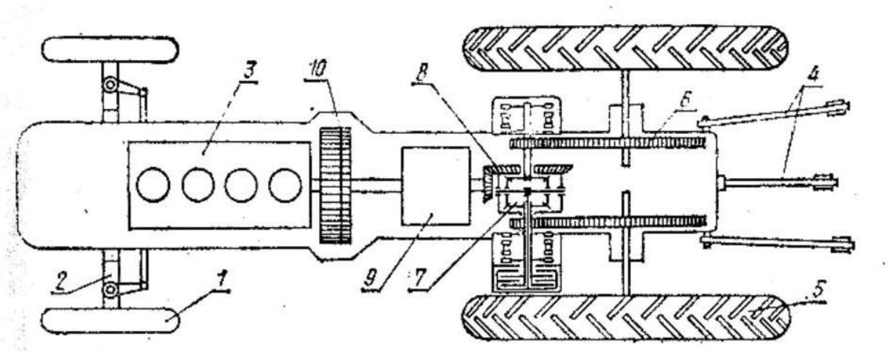


Figure 2. The main parts and mechanisms of the MTZ-80 wheeled tractor location. 1-steering wheel; 2-front axle; 3-engine; 4-lifting mechanism; 5-driving wheel; 6-final drive; 7-differential; 8-final drive; 9-transmission box; 10-clutch.

The location of the main parts and mechanisms of the car is shown in Figure 3.

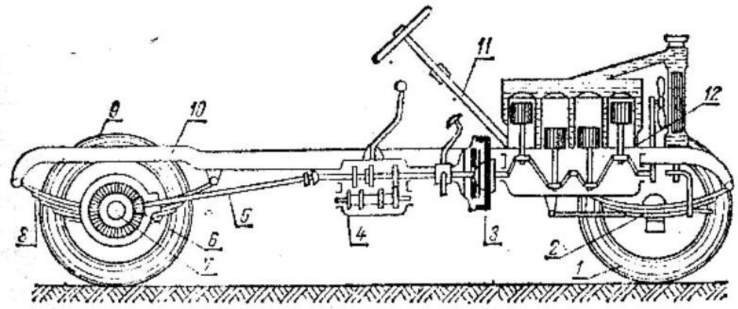


Figure 3. Location of the main parts and mechanisms of the car. 1-steering wheel; 2-front mounting mechanism; 3-clutch; 4-gearbox; 5-cardan transmission; 6-final drive; 7-differential; 8-rear mounting mechanism; 9-drive wheel; 10-frame; 11-steering gear; 12-engine;

The function, structure, and operation of tractor and automobile parts are very similar.

The car consists of the following parts: Engine, chassis, body. The chassis, in turn, consists of a power transmission, running gear, steering, and brakes. The engine converts the thermal energy generated by the combustion of fuel into mechanical energy, which is then transmitted from the crankshaft to the tractor's power transmission. The power transmission transmits the rotational motion of the engine crankshaft to the running gear of the tractor or car. It consists of a clutch, a connecting or cardan shaft, a gearbox, a final drive, a differential (in wheeled tractors and cars) or steering mechanisms (in chain tractors), and a final drive.

Running gear and steering mechanism. The running gear of a tractor and a car converts the rotational motion of the driving wheels into forward motion and supports the base. The running gear consists of the driving and guide wheels or the chain running gear and the frame. The

steering mechanisms of a wheeled tractor and car consist of the steering and brakes. The steering controls the front wheels of the tractor or car.

The steering mechanism and brakes of chain tractors slow down or stop the movement of a chain, turn the tractor in the required direction, and also brake it.

The working equipment serves to move the machines and tools attached to the tractor. The hitch is the mounting system consisting of a power take-off shaft and a drive pulley. The hood, cab, wings, lighting devices and other additional equipment of the tractor are.

The body of a car is designed for comfortable seating of passengers and the driver in passenger cars, while in trucks it consists of a loading platform and a driver's cabin.

*TEST QUESTIONS:*

1. What kind of machine is a tractor and how can it be used?
2. What groups are tractors divided into depending on their function and what are the differences in their structure? What are its unique characteristics?
3. What are the advantages and disadvantages of wheeled and tracked tractors?
4. What is the tractor system, and what classes are tractors divided into based on their tractive effort?
5. What types of vehicles are divided into based on their function and the number of driving wheels?
6. What stationary engines are used in agriculture and under what conditions are they used?
7. Explain the main parts of tractors and automobiles and their functions?
8. What are the components of a vehicle chassis and tractor working equipment?

## Lecture 2: General structure and operation of tractor and automobile engines

*Plan:*

1. Concept about the engine.
2. The structure of internal combustion engines.
3. The working process of a four-stroke carburetor engine.
4. The working process of a four-stroke diesel engine.
5. The structure and operation of a two-stroke carburetor engine.
6. Operation of multi-cylinder four-stroke engines.
7. General structure of an internal combustion engine.

### *1. Understanding the engine*

The difference between internal combustion engines used in tractors and automobiles and jet engines, gas turbines, and other engines where fuel burns in a special chamber of the engine, is that the force of the expanding gas acts on the piston of the engine and is transmitted to other parts of it, and the entire process occurs in a cylinder moving inside the cylinder.

This is done with a piston. Therefore, these engines are called piston internal combustion engines.

### *2. Structure of internal combustion engines*

Engines are divided into carburetor and gas engines, where the mixture is prepared outside the engine cylinder, and diesel engines, where the mixture is prepared inside the cylinder, depending on how the combustible mixture is prepared.

Engines are divided into spark-ignited (carburetor) and compression-ignited (diesel) engines, depending on how the mixture is ignited. Depending on how many strokes the piston makes, there are four-stroke and two-stroke engines. Depending on the number of cylinders, there are single-cylinder and multi-cylinder engines. Depending on the arrangement of the engine cylinders, the cylinders can be arranged vertically, horizontally, or in a V-shape. Depending on the cooling, there are water-cooled and air-cooled engines. In carburetor engines, a spark plug is installed in the cylinder head and ignites the working mixture. In diesel engines, an injector is installed in the head. From the injector, fuel is sprayed into the cylinder in the form of a finely divided mist. When the crankshaft is rotated, the piston moves back and forth in a straight line inside the cylinder. The point of the piston that is farthest from the crankshaft axis (the point where it rises up) is called the upper extreme point (UChN). The point of the piston that is closest to the shaft axis (the point where it falls down) is called the lower extreme point (PChN). The distance between the extreme points is called the piston stroke and is denoted by S.

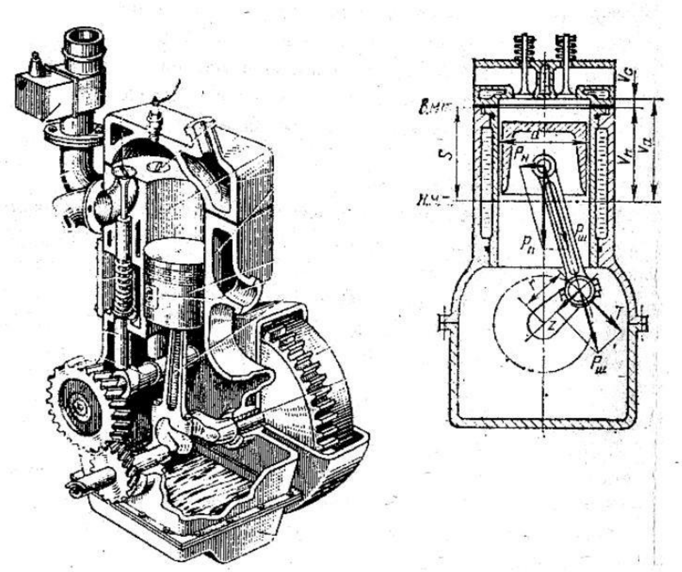

Figure 4. Main dimensions of a piston internal combustion engine

Each time the piston moves from one end point to the other, the shaft rotates through an angle of 1800. The process performed inside the cylinder during each stroke of the piston is called a stroke. The volume formed above the piston at the TDC is called the volume of the compression chamber and is denoted by Vc . The volume that the piston empties as it moves from the TDC to the PChN is called the working volume of the cylinder and is denoted by Vh . The working volume of the cylinder can be determined from the following formula.

$$V_h = \frac{\pi D^2}{4} \cdot S$$

where D is the cylinder diameter; S is the piston stroke; and S is the engine cylinder displacement.
The product of the volume and the number of cylinders is called the engine displacement. The piston standing in the PChN The volume above the bottom is called the total volume of the cylinder.

$$V_a = V_h + V_c$$

The ratio of the total volume of the cylinder to the volume of the compression chamber is the compression ratio of the engine. It is called (E).

$$E = \frac{\text{And}}{\text{Vc}}$$

The compression ratio carburetor in engines 4-8, in diesels is 13-20.

***3. The working process of a four-stroke carburetor engine.***

The working process is in four strokes of the piston, when the crankshaft rotates twice
The working process of a four-stroke engine is shown in Figure 5.
shown.

Intake (suction) stroke (Fig. 5, a). In this case, the combustible mixture is injected into cylinder 1
When the crankshaft rotates 10, the piston 4 begins to move below the TDC and
The volume above the piston expands, creating a rarefaction. At this time, the intake valve 6 opens and the cylinder tube 7 connects to the carburetor 8. In the combustion chamber, the previous
The gases remaining from the working cycle are mixed with the newly entering combustible mixture. Residual gases
The mixed combustible mixture is called the working mixture. During the intake stroke, the air in the cylinder
The pressure is 0.07...0.09 MPa, and the temperature of the working mixture is 330...390 K.

During the compression stroke (Fig. 5, b), the working mixture is prepared for combustion.

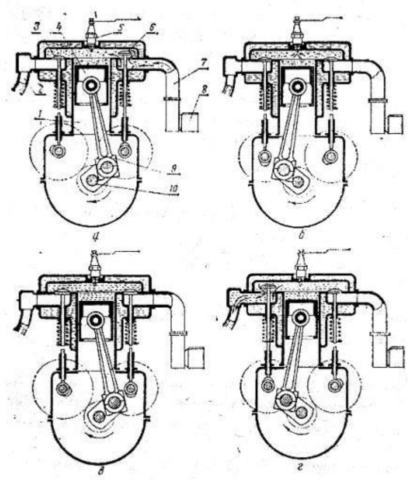

Figure 5. The working process of a four-stroke, single-cylinder carburetor engine.
a-intake; b-compression; c-expansion; d-exhaust; 1-cylinder; 2-exhaust pipe; 3-exhaust valve; 4-piston; 5-spark plug; 6-intake valve; 7-intake pipe; 8-carburetor; 9-connecting rod; 10-crank shaft.

When the piston moves from the upper to the lower cylinder, the working mixture entering the cylinder is compresses. Since the inlet 6 and outlet 3 valves are closed, the volume of the mixture
The engine's compression ratio increases as the pressure and temperature in the cylinder increase.
The volume of the mixture decreases depending on the degree of compression. At the end of the compression stroke, the pressure is 0.9 ... 1.2 MPa, and the temperature is 500 ... 700 K.

Expansion stroke (Fig. 5, c). The thermal energy of the burned mixture is converted into mechanical
At this time, the inlet and outlet ports are closed with valves.
The gases expand and push the piston down. The piston movement is transmitted to the crankshaft by means of the connecting rod 3, forcing it to rotate. The expansion stroke
The final pressure is 0.3 ... 0.4 MPa, and the temperature is 1200 ... 1500 K.

The exhaust stroke (Fig. 5, g) purifies the cylinders from spent gases. Piston
Moving from PChN to YuChN, the spent gases are discharged through a pipe from the exhaust hole.
is released into the atmosphere. At the end of the exhaust stroke, the gas pressure is 0.11. 0.12 MPa, and the temperature is 700 - 1100 K.

*4. The working process of a four-stroke diesel engine.*

The working process of a four-stroke diesel engine is shown in Figure 6. Diesel
The working process of an engine is the formation of a mixture and the ignition of the mixture.
It differs from carburetor engines only in terms of stroke, piston movement,
The direction and opening and closing of the valves are similar to those of a carburetor engine.
Intake stroke (Fig. 6, a). The piston moves from the top of the cylinder to the bottom of the cylinder.
The intake valve opens and air is drawn into the cylinder through the air cleaner.
Cleaned air enters. During the intake stroke, the pressure in the cylinder is 0.08.....0.09 MPa, and the temperature is 320 ... It will be 340 K.

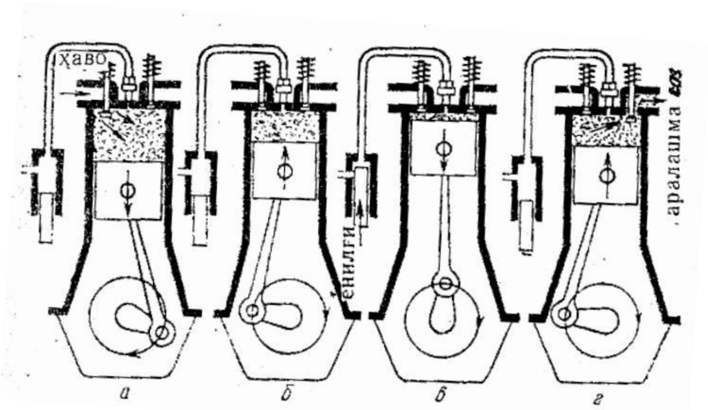


Figure 6. The working process of a four-stroke single-cylinder diesel engine.
a - insertion stroke; b - compression stroke; c - expansion stroke; d - extraction stroke;

Compression stroke (Fig. 6, b). The piston moves from BDC to TDC. Both
The air in the cylinder moves because the valve is closed. Excessive compression of the air
As a result, the air pressure in the cylinder at the end of the compression stroke is 3.5. 4.0 MPa, and its temperature is 750. 950 K.

At the end of the compression stroke, as the piston approaches TDC, it is above the injector.
The fuel is sprayed under pressure. The fuel, which consists of very small particles, is heated
It exchanges heat with air, heats up, and after a while ignites. When the mixture burns
The pressure in the cylinder is 5.5 ... 9.0 MPa, the temperature is 1900...... It will be 2400 K.

Expansion stroke (Fig. 6, v). In diesel engines, the mixture does not burn completely during the compression stroke, but continues to burn for a while during the expansion stroke. Both valves are closed
Due to this, the piston moves from the upper cylinder to the lower cylinder under the influence of gas pressure. Expansion
At the end of the stroke, the pressure in the cylinder is 0.2.....0.3 MPa, and the temperature is 900.....1200 K.

The exhaust stroke (Fig. 6, g) is the same as the exhaust stroke in carburetor engines, as it is in diesel engines. The pressure of the exhaust gases at the end of the stroke is 0.11 ... 0.12 MPa, and the temperature is 650...900 K.

Diesel engines consume 20-25% less fuel than carburetor engines. Diesel fuel is cheaper and safer to use.

### *5. Structure and operation of a two-stroke carburetor engine*

The working process of a two-stroke engine is that the piston rotates in two strokes or the crankshaft rotates in one stroke. The structure and operation of a two-stroke gasoline engine are shown in Figure 7. shown.

When the crankshaft rotates and the piston 3 moves from the upper and lower cylinder heads to the lower and upper cylinder heads (Fig. 7, a), rarefaction occurs in the crankcase chamber and the piston skirt closes the inlet hole. When it opens, the combustible mixture is sucked into the crankcase from the carburetor. The piston compresses the mixture entering the cylinder, first closing the intake and then the exhaust ports. The piston When approaching the ignition coil, a spark is emitted from the electrodes of the spark plug 5. The gas pressure is up to 20 kg/cm2 and the temperature is 18,000 °C. rises.

When the piston descends from the upper cylinder to the lower cylinder (Fig. 7, b) first closes the inlet hole, stops the mixture from entering the crankcase from the carburetor, and The piston begins to compress the mixture in the crankcase. Then the piston opens the exhaust port opens, the used gases begin to escape from the cylinder through this hole, as a result The pressure in the cylinder decreases rapidly, then the piston opens the blow-off port.

In this case, the compressed mixture from the carburetor enters the cylinder through the injection channel. Since the inlet and outlet ports are open, the fuel enters the cylinder from the crankcase. The mixture expels the used gases (Fig. 7, v)

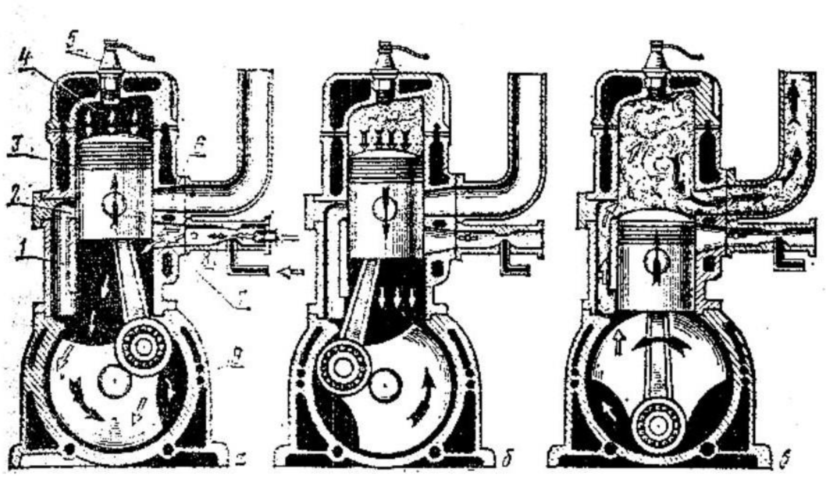

Figure 7. The working process of a two-stroke carburetor engine. 1-channel; 2-blow channel; 3-piston; 4-cylinder; 5-spark plug; 6-intake; 7-exhaust; 8-carburetor; 9-chamber.

*6. Operation of multi-cylinder four-stroke engines.*

The operation of a single-cylinder four-stroke engine can be expressed in a table. (1-table)

Table 1

*The working process of a single-cylinder four-stroke engine*

| Crankshaft time | Piston movement direction | Cycle | Input valve | Release valve |
|---|---|---|---|---|
| First half Downward rotation | | Input | Open | Closed |
| Second half rotation | To the top | Compression | Closed | Closed |
| Third half rotation | Down | Expansion | Closed | Closed |
| Fourth half rotation | To the top | Release | Closed | Open |

So, in a single-cylinder four-stroke engine, only one of the four piston strokes The working stroke is the stroke, and the remaining three are auxiliary strokes. The engine is cranked. The flywheel attached to the end of the shaft accumulates energy in the course of its work and transfers it spends on performing auxiliary strokes. In a four-cylinder engine (Fig. 8), the crankshaft The second and third elbows of the shaft are placed in the same plane, and the first and fourth The elbows form an angle of 180ÿ with respect to the second and third. The engine When working, the pistons of cylinders 1 and IV move downwards (Fig. 8, a), while cylinders II and III cylinders the piston moves up. If at this time in cylinder 1 - working stroke, II - Exhaust strokes are occurring in cylinder 1, compression in cylinder 3, and intake strokes in cylinder 4. The rest of the pictures work in order.

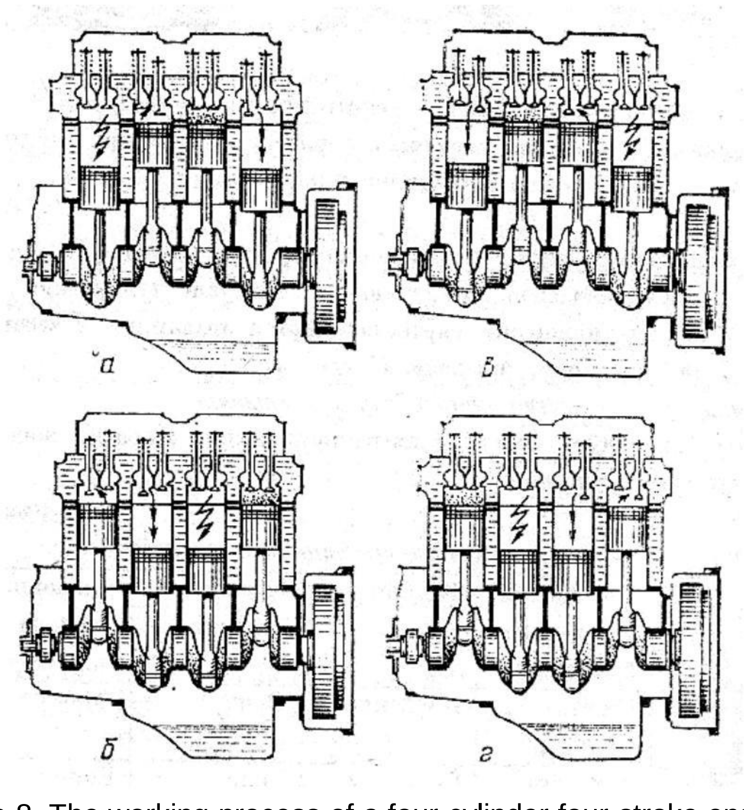


Figure 8. The working process of a four-cylinder four-stroke engine

Table 2

*The working process of a four-cylinder four-stroke engine.*

| Crankshaft rotation | Crankshaft turn corners | Cylinders | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| First half rotation | 0-1800 | Work path | Release | Compression | Input |
| Second half rotation | 1800 -3600 | Release | Input | Work path | Compression |
| Third half rotation | 3600 -5400 | Input | Compression | Exit Work path | |
| Fourth half a turn | 5400 -7200 | Compression | Work path | Input Output | |

Also, the working process of a four-cylinder, four-stroke engine can be expressed in a table. possible. (Table 2). So, the working path is the first half-revolution of the crankshaft. in the cylinder, second half-cycle in the third cylinder, third half-cycle in the fourth cylinder and in the fourth half-cycle in the second cylinder, i.e. The engine cylinders operate in the order 1-3-4-2. Then the whole process repeats.

### 6. *General structure of an internal combustion engine*

The engine consists of a crankshaft and connecting rod and gas distribution mechanisms, as well as supply, lubrication, cooling, combustion and propulsion systems. ensures engine operation.

The crank-rod mechanism receives the pressure of the gases, the piston is straight converts linear reciprocating motion into rotational motion of the crankshaft and It performs work in conjunction with other mechanisms and systems of the engine. Gas The timing mechanism injects a combustible mixture or air into the engine cylinders at the right time and exhausts the spent gases.

The supply system prepares a combustible mixture in carburetor engines and supplies it to the It delivers air and fuel to the cylinders, while in diesel engines it delivers air and fuel to the cylinders, where the work is done. prepares a mixture.

The lubrication system continuously lubricates all the rubbing parts of the engine. It lubricates and reduces their friction, heating, and wear.

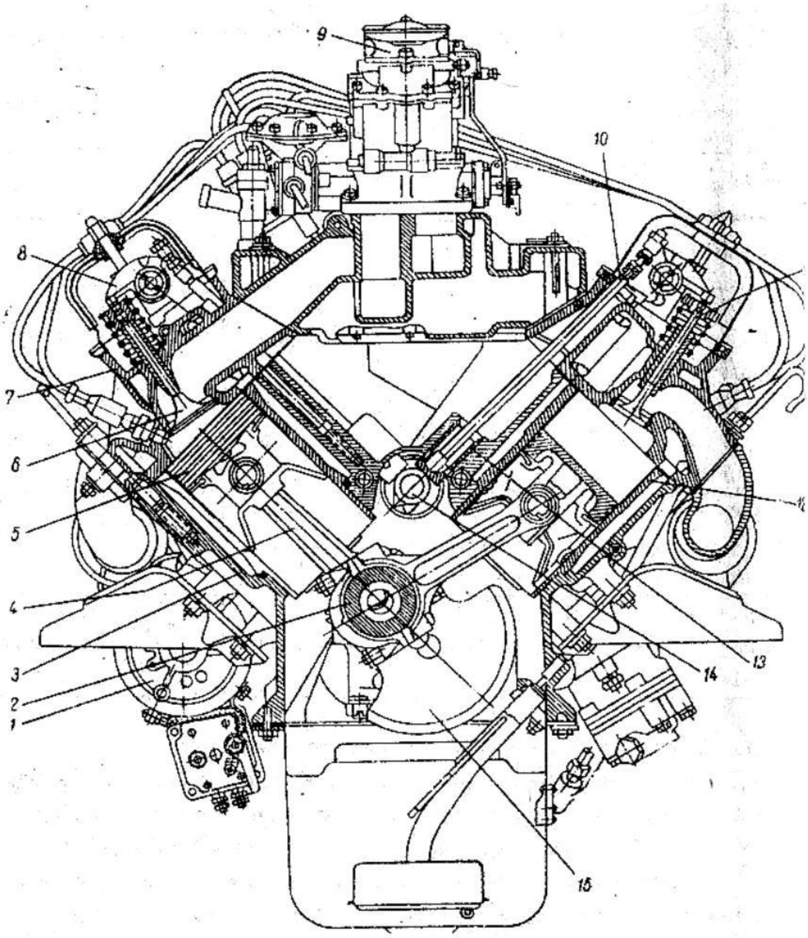


Figure 9. Cross-section of a carburetor engine with V-shaped cylinders. 1-starter; 2-crankshaft; 3-cylinder block; 4-connecting rod; 5-piston; 6-intake valve; 7-cylinder head; 8-rocker; 9-carburetor; 10-rod; 11-exhaust valve; 12-cylinder liner; 13-tappet; 14-distributor shaft; 15-crankshaft and camshaft.

The cooling system cools the engine's hot parts and prevents them from overheating.

The ignition system of carburetor engines uses an electric motor to ignite the fuel-air mixture in the cylinder. It ignites with a spark. The propulsion system propels the engine.

The location of engine mechanism parts and some systems is shown in Figure 9.

*TEST QUESTIONS:* 1.

What is an engine? What types of engines do you know?

2. What is the difference between cylinder displacement, combustion chamber size, and compression ratio of an engine? How does compression ratio affect engine power and fuel economy?

3. How does a four-stroke carburetor engine work?
4. How does the working process of a four-stroke diesel engine differ from that of a carburetor engine?
5. How is a two-stroke carburetor engine constructed and how does it work?
6. Compare carburetor and diesel engines, as well as four-stroke and two-stroke engines, and describe their advantages and disadvantages?

7. What is the operating mode of an engine? How do 2, 4 and 6 cylinder engines work?

8. What are the engine's rated power, effective power, mechanical efficiency, and effective fuel consumption?
9. What mechanisms and systems does an internal combustion engine consist of, and what functions do they perform?

## Lecture 3: Lever-link mechanism

*Plan:*

1. The structure of the lever-link mechanism.
2. Control of the crank-rod mechanism.

1. The structure of the crank-and-connecting

mechanism The crank-and-connecting mechanism of the engine converts the rectilinear motion of the piston into the rotary motion of the crankshaft. This mechanism consists of a cylinder, piston, piston pin, connecting rod, crankshaft, and flywheel. These parts are located inside the engine block crankcase.

The block-crankcase is the main base part of the engine, where all the mechanisms and systems are mounted, and is often made of cast iron and aluminum alloy. The block-crankcase is the base of the engine, and the part where the cylinders are located is called the cylinder block. It has holes for the crankshaft and camshaft. The lower part is called the engine crankcase, and it is closed from below with a bottom. The mechanisms and devices of the engine are mounted inside and on the surface of the block-crankcase.
The cylinders of single-cylinder engines and air-cooled engines are made separately, with cooling fins. They are fastened to the crankcase by placing a gasket under the cylinder flange. The top of the block is closed with a cylinder head.

The block crankcase of the SMD-14 diesel engine is shown (Figure 10).

The cylinders of most automobile engines, as well as the cylinders of the traction engine, are installed together with the block-crankcase. Some automobile cylinders have a special cast-iron liner that is resistant to wear, either completely or only on the top, and such liners are called "dry liners". In water-cooled tractor engines, cast liners are mainly used.

There is a gap between the block wall and the cylinders through which cooling water passes, which is why such cases are called "wet cases." To prevent water from passing from the water jacket into the crankcase, a sealing rubber ring is installed on the lower part of the case where it touches the block.

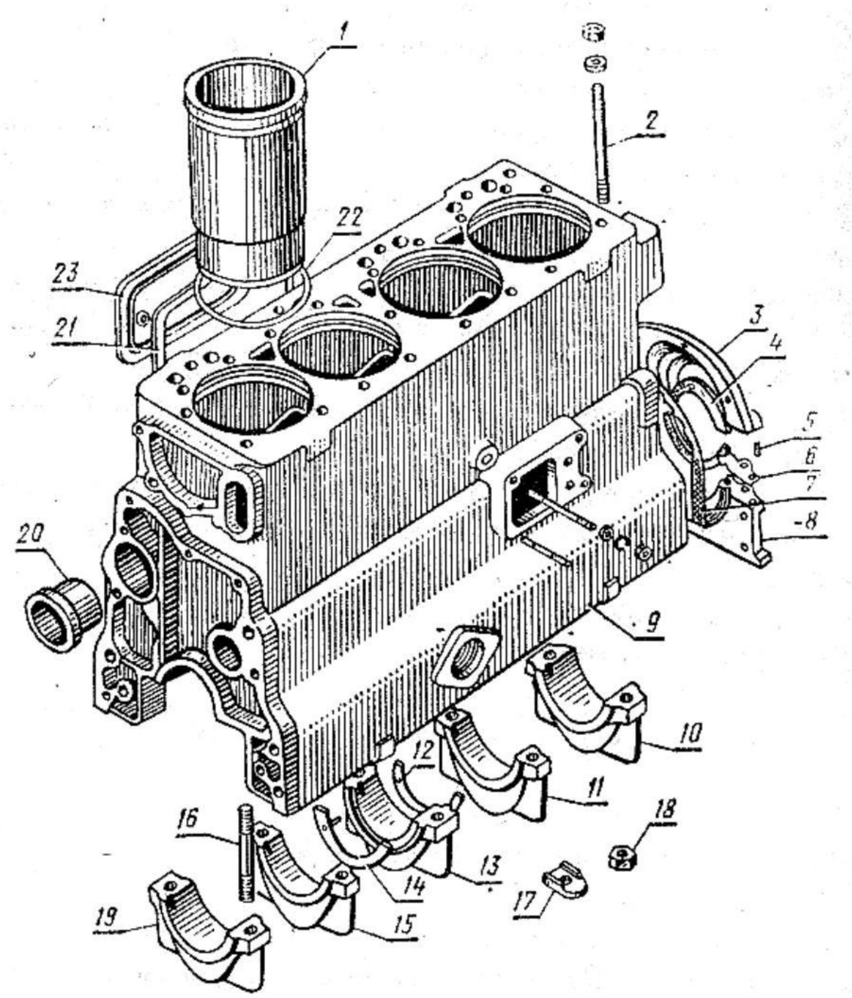

Figure 10. Block-crankcase of the
SMD-14 engine 1-cylinder liner; 2-pin; 3-upper housing fastener; 4-socket; 5-pin; 6 and 7-gasket; 8-lower housing fastener; 9-block crankcase; 10,11,13,15 and 19-main bearing cap; 12 and 14-half rings; 16-pin; 17-washer; 18-nut; 20-distribution shaft bushing bearing; 21-side cover gasket; 22-cylinder sealing ring; 23-side cover.

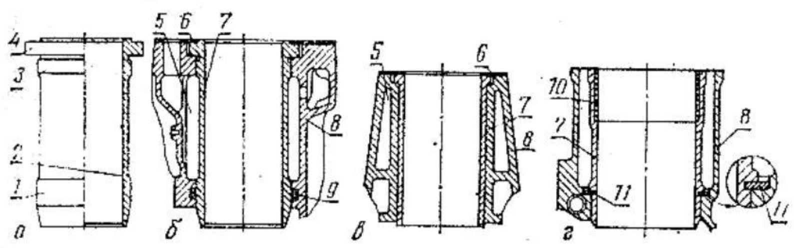

Figure 11. Cylinder liner
a)- D-240 engine cylinder liner; b) - "wet liner" of the D - 240 engine cylinder; c) - dry cylinder liner of the block-crankcase; d) - "dry liner" of the 24 - D engine cylinder liner Installation of liners 1 and 3; 2-cylinder mirror; 4-bumper; 5-block crankcase water jacket; 6-cylinder head gasket; 7-cylinder liner; 8-block crankcase; 9-sealing rubber ring; 10-insert; 11-sealing copper ring.

The cylinder head is a cover that covers the top of the cylinders, and is often made as a single unit for all cylinders, sometimes to make the head heavier.

A separate head for every two or three cylinders of a 4-6 cylinder engine to avoid
In air-cooled engines, each cylinder head is
will be.

In the head of engines with overhead valves (Fig. 12), the intake 4 and exhaust 2 valve seats and the intake and exhaust ports 8, the reciprocating motion
generating diffuser 10, mixing chamber 11, channel 3 and push rods
There are 6 water inlet holes. 5 water inlet holes are for nozzles.
The hole is also placed in the 9-hole head.

The valve seat opening is closed by the valve 12.

The combustion chamber of an engine is often located in the head. The valves are located at the bottom.
In engines with a built-in valve train, the valves are located in the block, so the head is not
There are no exhaust ports. Each row of cylinders in V-shaped engines has
A separate header is made.

The cylinder head is cast from special cast iron or aluminum alloy.
In water-cooled engines, the wall of the head is made of two layers.
There will be a gap between them through which the cooling water will pass. The head is mounted on the block
The surface is machined smooth. A metal-asbestos gasket is poured between the block and the head.
The head is secured to the block with studs and nuts.

Piston - receives the pressure of gases expanding during the stroke and moves the finger and
It transmits power to the crankshaft through the connecting rod, and also performs auxiliary strokes, in which
The crankshaft drives the piston with connecting rods and pins. (Figure 13)

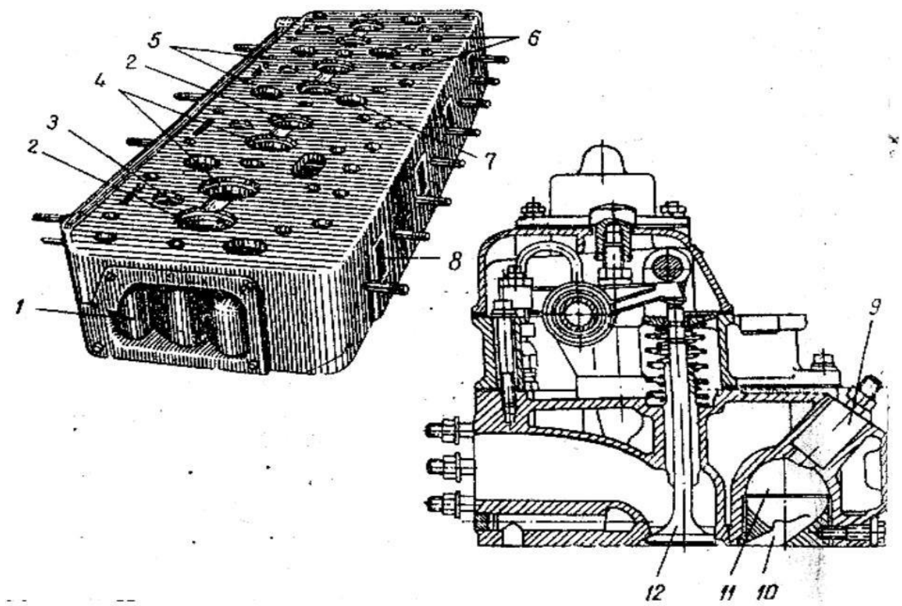


Figure 12. Cylinder head

1 and 7-water holes; 2-exhaust valve housing; 3-compression chamber channel; 4-inlet valve housing; 5-head mounting screw hole; 6-tappet
rod hole; 8-exhaust valves; 9-nozzle mounting hole; 10-diffuser; 11-combustion chamber; 12-valve.

The piston is cast from an aluminum alloy, sometimes from cast iron. Aluminum
The piston is light, conducts heat well, and has less friction.

Each piston has a bottom, a sealing part with ring grooves, a guide part - a skirt, and a protrusion for mounting the piston pin.

The bottom of the piston is flat or convex, sometimes the combustion chamber is recessed into the piston. placed, special grooves for valves on the piston bottom, groove under the diffuser Sometimes a tube is inserted into the tube to increase its strength and distribute heat. The piston is ribbed. Holes are made in the groove where the oil seal ring is installed. will be done.

When the engine is running, the top of the piston heats up more than the skirt, so the diameter of the compression part is made smaller than the skirt and the cylinder Piston rings are installed in special grooves in the wall to ensure that the plaster touches it.

Some pistons have an elliptical skirt, meaning the piston pin is pointed in the direction of the axis. The relatively steep slope is larger, which also ensures a tighter fit of the piston and Reduces friction. 0.18-0.30 millimeters between the cylinder and the piston skirt There should be a gap. In pistons with an elliptical or cut-out skirt, this gap is 0.05-0.10 millimeters.

In addition to the fact that pistons are selectively installed in cylinders by diameter, their weight is also selected and installed.

Piston rings - ensure tight contact of the piston with the cylinder and seal the gases It does not transfer heat from the cylinder to the crankcase and partially transfers the heat of the piston to the cylinder. Piston rings are made of special cast iron. The rings are pressed into the cylinder When not inserted, their diameter is larger than the cylinder diameter and is cut off. The distance between the ends is 10-15 mm.

A gas-tight seal installed on the top of the piston The rings that do this are called compression rings.

There are also holes in the groove where the oil seals are installed. When the engine is running, the oil scraper rings scrape the oil from the cylinder walls and return it to the crankcase through the piston holes.

The piston pin pivotally connects the piston to the upper head of the connecting rod.

The piston pin is of the type that can be rotated in the bosses and the connecting rod bushing. will be done.

The connecting rod-piston is connected to the connecting rod neck of the crankshaft, and the working stroke is transmits force from the piston to the crankshaft. The direction of the gas pressure on the connecting rod is The variable inertia force also affects. Special steel stamping with connecting rod It is made like this.

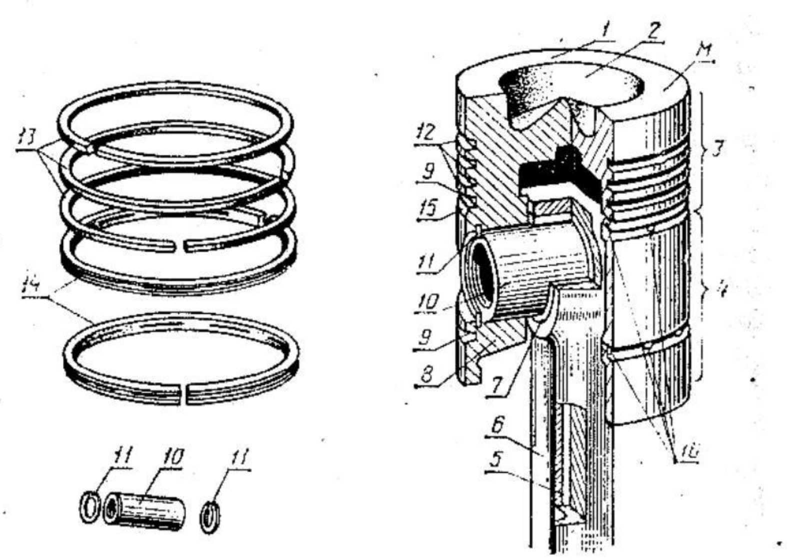

Figure 13. Piston, piston rings and piston pin 1-tube; 2-combustion chamber; 3-compression part; 4-guide part; 5-groove in the connecting rod; 6-connecting rod; 7-connecting rod bushing; 8-bump; 9-oil seal ring groove; 10-piston ring; 11-ring; 12-groove for compression ring; 13-compression ring; 14-oil seal ring; 15-circular groove; 16-oil passage hole.

The connecting rod consists of an upper head, a lower head, and a rod. The upper head of the connecting rod is attached to the piston pin, and the lower head is attached to the connecting rod journal of the crankshaft.

A connecting rod bearing is mounted on the lower head of the connecting rod. Most connecting rods use plain bearings. Such bearings are made of thin steel inserts with aluminum alloy, babbitt, or lead bronze.

If the crankshaft is made to be separable, the lower head of the connecting rod is made integral and has rolling bearings installed on it.

The crankshaft converts the linear motion received from the pistons through the connecting rods into rotary motion, and the pressure force into torque, which is transmitted to the power transmission parts through the flywheel. The gas distribution mechanism, water, oil and fuel pumps, fans, generators, and others are also driven by the crankshaft.

Crankshaft journal or support journal, connecting rod or crankpin journal
It has jaws, a flange or tail on which the flywheel is attached, and sometimes a shank.

The crankshaft is an important, high-pressure part of the engine, and is made of steel. It is made by stamping or casting from a special base.

The shaft necks are heated with high-frequency current, polished, and
It is trimmed to size.

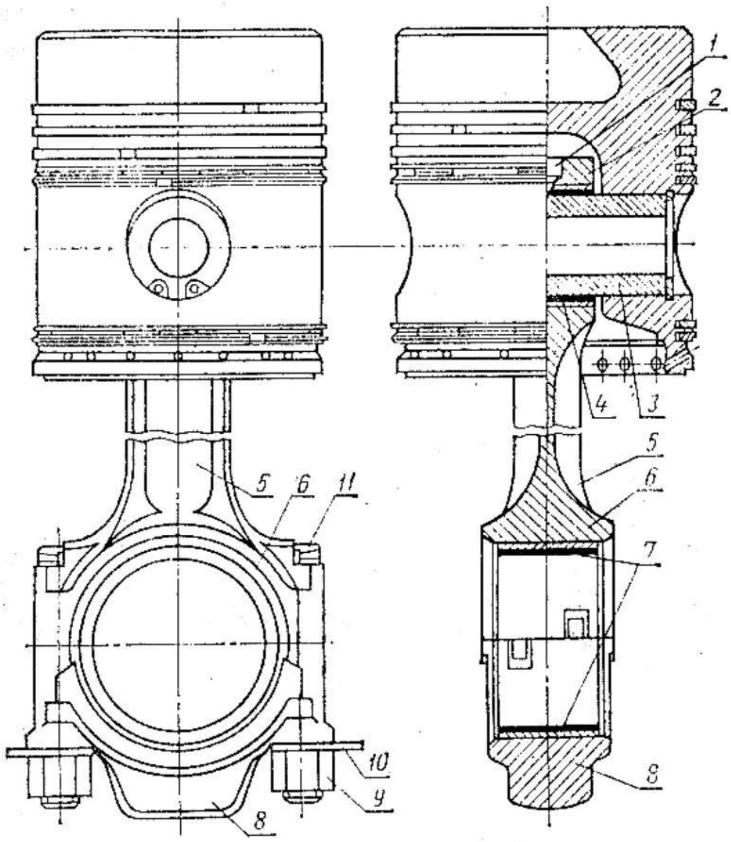


Figure 14. With connecting rod piston (diesel-D-240)

1-upper head hole; 2-upper head; 3-piston pin; 4-sleeve; 5-rod; 6-lower head; 7-inner insert; 8-lower head cover; 9-nut; 10-washer; 11-bolt;

In inline engines, the number of connecting rod journals on the crankshaft is equal to the number of cylinders. In two- and four-cylinder engines, The connecting rod journals of the shaft are 1800 relative to each other., and in the case of octahedral cylinders, the angle is 1200 is placed with.

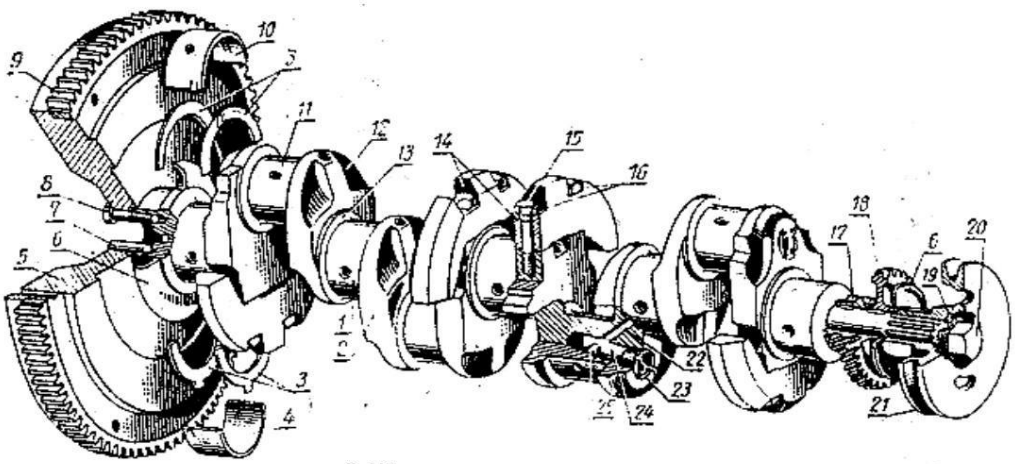

Figure 15. Crankshaft of the D-240 diesel

1-shaft neck; 2 and 12 - neck; 3-half ring; 4-lower inner bearing of the shaft; 5-flywheel; 6-oil return washer; 7-installation pin; 8-bolt; 9-flywheel tooth; 10-upper inner bearing; 11-connecting rod; 13-bolt; 14-lower; 15-
16-washer; 17-crankshaft gear; 18-oil pump gear; 19-

washer; 20-bolt; 21-pulley; 22-connecting rod groove; 23-cap; 24-connecting rod; 25-pipe for clean oil.

One- and two-cylinder engines have journal bearings at only two ends of the crankshaft.

Four-cylinder engines often have five, but sometimes two, three, or four, camshafts. Six-cylinder engines have four or seven camshafts.

The bearings of a crankshaft balance the centrifugal forces acting on the main bearings. The bearings are made integral with the shaft or separately and are bolted to the shaft flange.

The drive gear of the distribution mechanism is mounted on the front end of the crankshaft, from which the fuel pump, oil pump, etc. are driven. Often, a pulley that drives the fan and generator, as well as a ratchet into which the end of the handle is inserted when the shaft is turned manually, is mounted on the end of the shaft. When the engine is running, the crankshaft heats up and can move along its axis. To limit the axial movement of the shaft, one of the main bearings is made with a bearing. For example, the fifth main bearing is made with a bearing surface that is recessed into the supporting surface of the shaft journal and the groove of the oil return screw.

The main bearings of the crankshaft are often designed in the same way as the connecting rod bearings, but their thin-walled inserts are made larger, the upper inserts are installed in the housing in the block, and the lower ones in the cover. The cover is fastened to the block with bolts. There are channels drilled in the shaft body to transfer oil from the main bearings to the connecting rod bearings. Clean oil flows through the tube and lubricates the bearing. The main bearings of crankshafts with two main journals are often made of ball, sometimes roller.

The flywheel is a heavy cast iron disk that ensures smooth engine operation, moves the crankshaft and connecting rod mechanism at fixed points, and facilitates the start of a tractor or automobile. When the engine is started, the gear of the starter or starter motor gear meshes with the flywheel's gear ring, turning the crankshaft.

Engine crankcase and sump - the lower part of the engine that is attached to the block
It is called the crankcase, and the crankshaft and other parts are placed inside it.

When an engine is running, a small amount of gas passes between the piston and the cylinder and into the crankcase during the compression and power strokes. As the cylinders and rings wear, the passage of gases increases.

A soap dish is installed in the engine to prevent the pressure inside the crankcase from increasing. The soap removes excess gases and traps oil, and when the engine cools, it allows air from the outside into the crankcase, preventing dust from entering.

The sump consists of a housing and a wire mesh or plug placed inside it. The sump is installed in the crankcase or cylinder head. For the sump to work properly, it is necessary to remove the plug during maintenance, wash it in kerosene, moisten it with oil, and then replace it. In automobile engines, the sump is often made together with the crankcase ventilation system.

***2. Control of the lever mechanism of the crane***

The details of the engine crankcase - connecting rod mechanism are exposed to high temperatures, strong It operates in harsh conditions, where pressure and inertia forces act.

This is necessary for the machine to function for a long time without damage to the parts of the mechanism. It is necessary to follow the rules of use. An engine with worn connecting rod mechanism details will be difficult to start, its power will decrease, and oil and fuel consumption will increase.
It's getting hot, smoke is coming out of the soap, and the engine is running with a knocking sound.

During work, constantly monitor the readings of control instruments, as well as check for fuel, oil and water leaks, as well as gas leaks due to leaks.
should not be allowed.

If the oil pressure drops, the engine starts to stall, knock, or run unevenly.
If it works, it is necessary to immediately determine the cause and eliminate the shortcomings.

Of the details of the crank mechanism, the piston rings wear out faster, the gap in their lock and in the piston groove increases. The movement of the rings in the cylinders
The upper part of the piston rod is mostly worn away, forming a cone and an ellipse. Piston finger
When the bearing hole and the connecting rod bushing wear out, the distance between them widens.
When crankshaft bearings and journals are worn, the gap increases and the journal of the shaft
The ellipse remains. As the engine parts wear out, the gap between them increases and becomes
It makes a characteristic knocking sound, which can be detected with a stethoscope. Piston
When the rings, pins, connecting rod bushings, liners, and pistons are worn, replace them with new ones.
When the cylinder is worn out, it is expanded and a larger piston is installed, or
The clay pot is renewed.

*TEST QUESTIONS*

1. What is the function of the lever mechanism and what are its main parts?
structured?
2. How is the cylinder block constructed?
3. How is the cylinder head designed in carburetor and diesel engines?
4. How the piston and its rings are constructed. Compression and oil seal
how rings work, why the gap in their lock is needed, and how
measured?
5. Why is a piston pin needed and how is it fastened?
6. Describe the structure and function of a connecting rod?
7. How are the crankshaft and its main bearings constructed?
8. Why is a flywheel needed and how is it attached to the shaft?
9. How is the engine crankcase and sump constructed and what is its function?

## Lecture 4: Gas distribution and decompression mechanism

*Plan:*

1. The structure of the gas distribution mechanism.
2. Structure of the decompression mechanism.
3. Control of the gas distribution mechanism and decompression mechanism
to do.

### *1. Structure of the gas distribution mechanism*

For engines to operate, it is necessary to introduce a combustible mixture or air into the cylinders and to expel exhaust gases from the cylinders. The gas distribution mechanism opens and closes the holes through which this mixture or air enters and through which the exhaust gases are expelled in a timely manner.

There are two types of valve timing mechanisms used in modern engines.

The overhead camshaft is used in all tractor engines and some automobile engines (Figure 16). This mechanism consists of intake and exhaust valves, valve guide bushings, valve springs, shims, rocker arms, rocker arm shafts, adjusting screws with nuts, rods, pushers, camshaft with cams, and a timing gear.

The gas distribution mechanism works as follows: When the engine is running and the camshaft sprockets rotate the camshaft, the valve spring closes the hole when the camshaft cam is facing down.

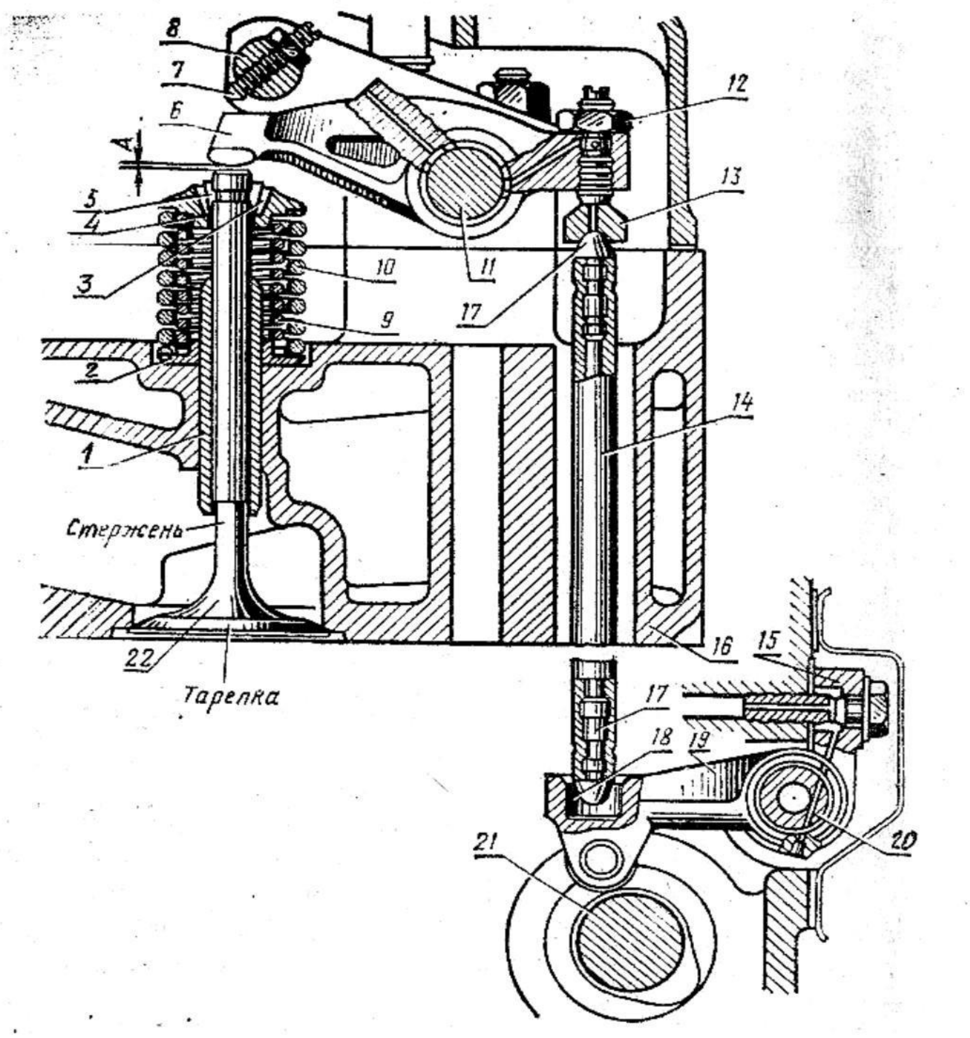


Figure 16. Gas distribution mechanism. (A-41 and A01M diesel).

1-guide bushing; 2-lower washer; 3-bush; 4-upper washer; 5-cracker; 6- rocker arm; 7-decompression mechanism adjusting screw; 8-roller; 9-inner spring; 10-outer spring; 11-rocker arm shaft; 12,13-adjusting screw; 14-rod; 15-tappet shaft base; 16-cylinder head; 17-rod; 18-tappet seat; 19-tappet; 20-tappet shaft; 21-distributor shaft; 22-valve.

When the camshaft cam is pushed against the pushrod, it rises. The push rod and the adjusting screw lift one end of the rocker arm, and the other end presses the valve stem. In this case, the spring is compressed, and the valve is pushed down, that is, it opens the inlet or outlet hole. When the knob is turned under the wheel, the spring is compressed, and the valve is tightly closed. The gas distribution mechanism with valves located below is mainly used in automobile engines (Fig. 17).

This mechanism has a much more compact design due to the fewer transmission parts. When the camshaft rotates, the cam lobe lifts it when it rests under the tappet. The tappet lifts the valve with the help of a setting bolt. When the valves are placed in the head, the engine compression chamber is made compact, the working mixture burns faster, and the engine compression ratio can be increased, that is, more use can be made of the thermal energy of the fuel. When the valves are placed in the block, the mechanism becomes more compact and the engine weight is reduced.

Valve opening and closing times. To fill the engine cylinders with a combustible mixture or air, as well as to release spent gases, the intake and exhaust valves must open earlier and close later, before the piston reaches its extreme points.

The structure of the details of the gas distribution mechanism. Valve. consists of a plate and a rod, opens the inlet and outlet holes at the right time and closes them tightly. To withstand high temperatures, high pressure and chemical effects of the gas, the inlet valves are made of chromium-nickel or chromium steel, and the exhaust valve is made of special fire-resistant silicon chromium steel. Sometimes a wear-resistant cast iron bush is installed in the valve housing.

The guide bushing guides the movement of the valve and ensures that it closes its seat properly. This bushing is made of cast iron and is press-fitted into the cylinder head or block.

The valve spring closes the valve and ensures that the valve seat is tightly closed. The spring is made of special steel. Sometimes two springs are installed on each valve. One end of the spring is attached to the block or head. The other end is attached to the support washer. The support washer is attached to the valve stem with screws. To prevent pressure from being applied to the valve stem and guide bushing, a cup is sometimes installed on the valve spring.

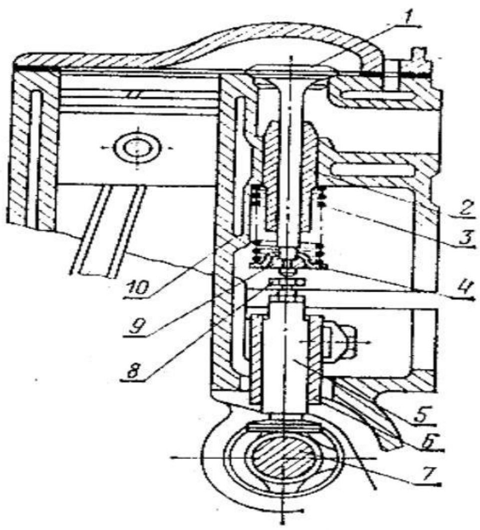

Figure 17. Gas distribution mechanism with side-mounted valves. 1-valve; 2-valve guide bushing; 3-spring; 4-washer; 5-tappet; 6-tappet bushing; 7-distribution shaft; 8-adjusting bolt; 9-cracker; 10-block-crankcase.

The lever is mounted on a shaft and a set screw is screwed onto the short arm. When this arm is raised with a barbell, the end of the long arm presses and opens the valve.
The crankshaft is drilled, and the oil from it lubricates the crankshaft bushing and the head of the adjusting screw. The crankshaft is secured to the head supports.

The barbell is made of tubular steel to make it lightweight. The lower end of the barbell, where the push rod is attached, is spherical in shape, and the upper end is pressed into a spherical groove. The barbell is made of steel or aluminum alloy.

The tappet lifts the rod or valve when the cam is rotated. The tappet is made of steel, and the friction surface is case-hardened and hardened. The tappet of some diesel engines has a rocker arm with a hanging roller. The roller rolls on the camshaft cam, which reduces friction and wear. The tappet plate rotates around its axis in addition to moving up and down in a guide bushing to ensure uniform wear.

The camshaft opens and closes the valves in time, rotating in bushings or ball bearings mounted in the block crankcase. The camshaft has support journals, twice as many pistons as there are cylinders, and a journal on which the gear is mounted.

The axial displacement of the camshaft (0.08-0.25 mm) is limited in various ways.
To do this, a supporting flange or a supporting bolt is installed on the shaft neck. By turning them, you can limit the movement of the shaft. The distribution gears transmit movement from the crankshaft to the distribution shaft, fuel pump, oil pump, hydraulic pump, generator and other mechanisms.

### *2. Structure of the decompression mechanism*

When starting and servicing diesel engines with high compression ratios, it is much more difficult to turn the crankshaft, since a lot of force is required to overcome the frictional resistance of the parts and compress the air in the cylinders. To prevent the engine or electric starter from having to start the diesel engine, the air introduced into the cylinder is returned without compression. When the engine warms up a little, the frictional resistance decreases and the crankshaft begins to rotate smoothly, the air introduced into the cylinder begins to compress without being returned. Fuel is sprayed into the air heated by compression, the diesel ignites and runs.

The decompression mechanism allows the air in the cylinders to return to the combustion chamber without compressing it by leaving the intake valves partially open. This mechanism is designed together with the gas distribution mechanism and is used for engine start-up and maintenance. In addition to the camshaft cams, the decompression mechanism also opens the valves slightly by lifting the tappets or by pressing the long shoulder of the rocker arm or by lifting the short shoulder of the rocker arm. The decompression mechanism, which opens the valve by lifting the tappet, is shown in Figure 18.

This mechanism consists of four rollers 3 installed in holes on the right side of the engine crankcase, the tapered ends of which enter the annular groove of the intake valve tappets 4. Levers 2 are attached to the ends of the rollers, which are connected to each other by a rail. The rollers are held by a cover 5. The lever is connected to the rail by a finger 1.

The decompression mechanism works as follows. Before starting the engine, the rail is pushed back. In this case, the tips of the rollers lift the tappets, open the intake valves and hold them open. The air drawn into the cylinder is released uncompressed, which means that the crankshaft rotates more easily. When starting the engine, the rail is pushed forward. The rollers are turned so that the cams are facing up, the intake valves close their seats, and the gas distribution mechanism begins to operate normally. This means that the air is compressed and heated, fuel is sprayed, and the engine starts.

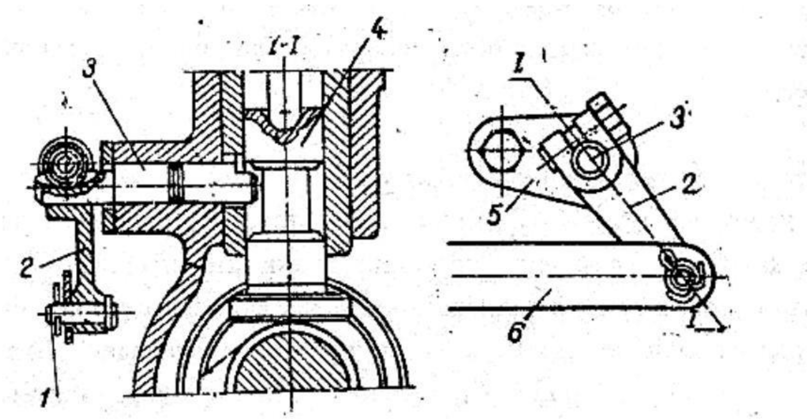


Figure 18. Diagram of the decompression mechanism. 1-finger; 2-lever; 3-roller; 4- pusher; 5-cap; 6-rail.

In all decompression mechanisms, the valves must not be opened more than specified, otherwise the valve plate will hit the piston bottom and cause an accident. In engines with valves located in the head, the gas distribution mechanism is covered with caps to protect it from contamination.

***3. Checking the gas distribution mechanism and decompression mechanism.*** The details of the gas distribution mechanism also work in difficult conditions, withstanding high temperatures and friction. Inspection of the gas distribution mechanism details consists of checking and adjusting the valve clearances, and in diesel engines, the clearances of the decompression mechanism and the movement of the camshaft along the axis, as well as ensuring the tight closure of the valves.

As a result of wear of the camshaft cam, valve seat and other parts, loosening of nuts, and compression of gaskets, the gap between the valve stem and the cam or tappet changes. If the gap decreases, the valve does not close its seat tightly, air or gas passes through the valve slot, reducing compression in the engine and quickly burning the valve seats and cams. If the gap increases, the valve opens less and for a shorter time, as a result, less air or mixture enters the cylinder, the combustion gases are not cleaned well, the valves knock and wear out quickly.

To adjust the valve clearance, the engine is cleaned of dust, the cylinder head and rocker arm nuts are tightened. The valve clearance is checked after the engine has warmed up.

In diesel engines, a decompression mechanism is used to facilitate crankshaft rotation, but when measuring the gap, the decompression mechanism is disconnected.

*TEST QUESTIONS* 1.

Describe the types of gas distribution mechanisms, their function, structure, and operation?

2. What does the gas distribution diagram show, explain the reasons for the early opening and late closing of the valves?
3. Describe the function, structure, and operation of the decompression mechanism?
4. What work is performed to control the gas distribution mechanism?
5. Why is clearance needed in valves and how is it adjusted?

## Lecture 5: Tractor and automobile engine supply systems and regulators

*Plan:*

1. Fuel and its main properties.
2. The composition of the combustible mixture and its effect on engine performance.
3. Air purifiers.
4. Inlet and outlet pipes, muffler and spark arrester.
5. Check the air cleaner, intake and exhaust pipes.

### *1. Fuel and its main properties*

Tractor and automobile engines use liquid fuels that burn with a lot of heat. These fuels are obtained by boiling oil. Most automobiles and diesel propulsion engines use light fuel gasoline, which quickly turns into vapor.

Modern tractors and large trucks run on diesel fuel.

The main properties of fuel are as follows:

**Specific gravity** - (weight in grams of one cubic centimeter of fuel) - the specific gravity of automobile gasoline at a temperature of 200 is 0.730-0.770 g/cm3 ; that of tractor kerosene - 0.820 g/cm3 ; that of diesel fuel - 0.825 - 0.870 g/cm3 ; The specific gravity of fuel is determined with a hydrometer.

**Heat capacity** - the amount of heat released by the complete combustion of 1 kg of fuel - is measured in calories and is equal to 10,000 - 10,500 kcal/kg for fuels derived from petroleum.

**Vaporization** - the conversion of fuel from a liquid state to vapor is one of the main indicators determining its quality. Automobile gasoline is 40 - 2050, tractor kerosene is 110-300

It boils and turns into steam.

**The freezing point is** the temperature at which the level of the fuel poured into a test tube does not change for one minute when the test tube is tilted 450 to the horizontal.

The pour point of diesel fuels of the DL, DZ and DA brands is -10, -45 and -60.

**Viscosity** - internal friction depends on the composition of the fuel and affects the formation of a mixture and combustion. Diesel fuel must have a certain viscosity. If the viscosity of the fuel is higher than the specified, it does not pass through the filters well and is not cleaned well, if it is lower - the pump and injectors wear out quickly.
The viscosity of diesel fuel should not be less than 2.2 sst at 200 and not more than 8 sst.

**Detonation resistance** is the property of the fuel-air mixture to burn without detonation in the engine cylinders. When a combustible mixture burns without detonation, its burning speed is 20-30 m/sec. For certain reasons, the mixture burns by forming a shock wave, the burning speed of which reaches 2000-2500 m/sec. The engine makes a knocking sound, the engine power decreases, black smoke comes out of the exhaust pipe, and it overheats. Such explosive combustion of the combustible mixture in the engine cylinders is called detonation. When a detonation event occurs, engine parts are quickly worn out, or even broken and fail.

The mixture can overheat or ignite spontaneously due to contact with hot engine parts even if there is no spark, in which case the engine can run for some time even if the ignition system is turned off. Detonation, on the other hand, begins after the spark is applied and the engine stops immediately when the ignition system is disconnected.
This is the difference between detonation and spontaneous combustion. The resistance of a fuel to detonation is determined by its octane number. The octane number indicates how much isooctane a fuel has compared to a certain amount of a mixture of heptane and isooctane hydrocarbons. The industry mainly produces gasolines of the A-66, A-72, A-74, A-76 brands. The numbers indicate the octane number of the gasoline.

### *2. The composition of the combustible mixture and its effect on engine performance*

The chemical reaction of fuel elements with oxygen to produce heat is called combustion. The mixture of fuel vapors and formed droplets with air is called a combustible mixture. The combustible mixture mixes with the gases remaining from the previous cycle in the cylinder to form a working mixture. The ratio of fuel to air in the mixture is called the composition of the mixture. Fuel obtained from petroleum consists of approximately 85 carbon and 25 hydrogen, while air contains 23 oxygen. Considering the molecular weights of these elements in the formation of chemical compounds, theoretically 15 kg of air is required for the complete combustion of 1 kg of fuel. If there is less air in the combustible mixture, it is called a condensed mixture, and if there is much less, it is called a dense mixture. On the contrary, if there is more air, if it is much more liquid, it is called a liquid mixture. The ratio of the actual amount of air consumed Lx to the theoretical amount of fuel required for combustion Ln is called the air excess coefficient ÿ. This coefficient clearly shows the composition of the combustible mixture:

$$ÿ \quad ÿ \quad \frac{L}{L}$$

The amount of air actually consumed in a normal mixture is the theoretically required amount. Since the amount of air is equal to the amount of air, the excess coefficient of air is ÿÿ1. This coefficient In liquid mixtures, it is greater than one, and in dense mixtures, it is less than 1: if ÿÿ1.0-1.1, it is called a liquefied mixture, if ÿ>1.1, it is called a liquid mixture, if ÿÿ0.8-1.0, it is called a dense mixture, if ÿ<0.8, it is called a dense mixture. Combustible
If the mixture is too thick or too liquid, it will not burn.

If the air excess coefficient is less than ÿ-0.5 or more than ÿÿ1.35, the mixture will not burn, therefore these values are called the lower and upper limits of flammability.
is called the limit.

The composition of the combustible mixture has a large impact on the power and economical operation of the engine. The engine produces near maximum power when operating on a normal mixture, and the relative fuel consumption does not exceed the norm. A lean mixture burns faster
ignites, the engine produces maximum power, but the relative fuel consumption increases slightly. The engine is most economical when running on a liquid mixture, but its power is slightly reduced. decreases. Whether the engine is running on a rich mixture or a liquid mixture
power decreases and relative fuel consumption increases. The engine runs on a rich mixture
Black smoke comes out of the exhaust pipe when working. When working in a liquid mixture
the smooth operation of the engine is disrupted, the carburetor starts to "sneeze" and
The engine overheats due to the slow combustion of the mixture. The engine operates in different conditions requires a different mix to work.

### *3. Air purifiers*

Tractors and automobiles often operate in dusty conditions. Engine cylinders
air supply system to clean the incoming air from dust and dirt
A cleaner is installed. If dust enters the engine cylinders with the air, the piston, cylinder, valves, and other parts will wear out quickly, and the oil in the crankcase will become contaminated prematurely. Modern engines are mostly equipped with combined air cleaners,
The air entering the cylinders is cleaned by two or three of them. The air cleaner consists of a head, a housing, a central tube, a centrifugal dry dust separator, removable and non-removable wire mesh cassettes, and a bottom. The bottom is inserted into the housing and equipped with bolts and cap nuts. Crankcase oil is poured into the bottom up to the ring level.

Air sucked in through the cleaner due to rarefaction in the engine cylinders
The dust enters through the holes in the upper dust separator, hits the guide vanes, and is blown away by the screw. The large particles in it are thrown out of the center.
Under the force of the impact, 60% of the dust in the air is blown against the walls of the dust separator. It comes out through the lower slits. A side is cleaned and put into a compact motion.
The incoming air flows through the central pipe to the bottom of the air cleaner and hits the oil in it. The speed of the air slows down and its direction changes. As a result, the air
Part of the dust moves by inertia and sinks to the bottom of the oil bath. Air
It hits the oil, foams it up, and the oil droplets hit the wire mesh in the air cleaner housing.
The air is cleaned three more times after passing through the cassettes. The air that has passed through the wire mesh filter is The cleaner enters the engine's intake manifold through a short pipe in the head.
Air cleaners for most tractor engines sometimes work on this principle.
Sometimes a lint-free gauze tape is applied to the upper cassettes of the air purifier.
and the air is cleaned even better.

Air enters the air cleaner of automobile engines between the housing and the cover. enters through the resulting gap (Figure 20)

The air entering at high speed hits the oil bath in the housing, leaving large particles in the oil, hits the guide ring and changes direction. Then, attracting oil droplets, it rises and passes through a filter made of nylon fibers. Oil droplets and dust remain in this filter. The cleaned air enters the carburetor through the central pipe.

The engine crankcase is equipped with tubes to allow fresh air to enter and circulate. The annular cavity of the housing, connected to the cavity of the central tube of the air cleaner, reduces the noise generated during air intake. Later, some tractors began to use cyclone air cleaners, which clean the air thoroughly, although they only clean it twice.

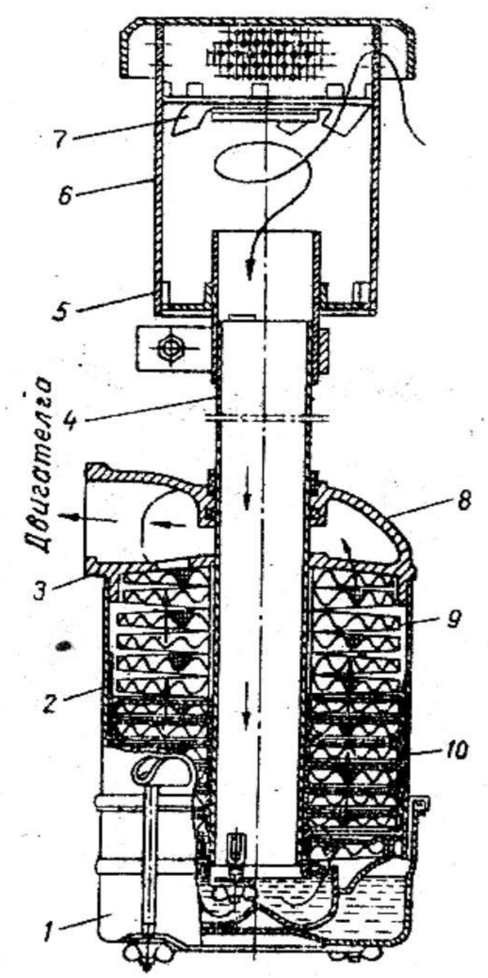


Figure 19 Air cleaner used in tractors 1. Air cleaner base, 2. Housing, 3. Short tube, 4. Central tube, 5. Lower slot, 6. Dust separator, 7. Guide vanes, 8. Head, 9. Non-removable wire mesh, 10. Removable wire mesh

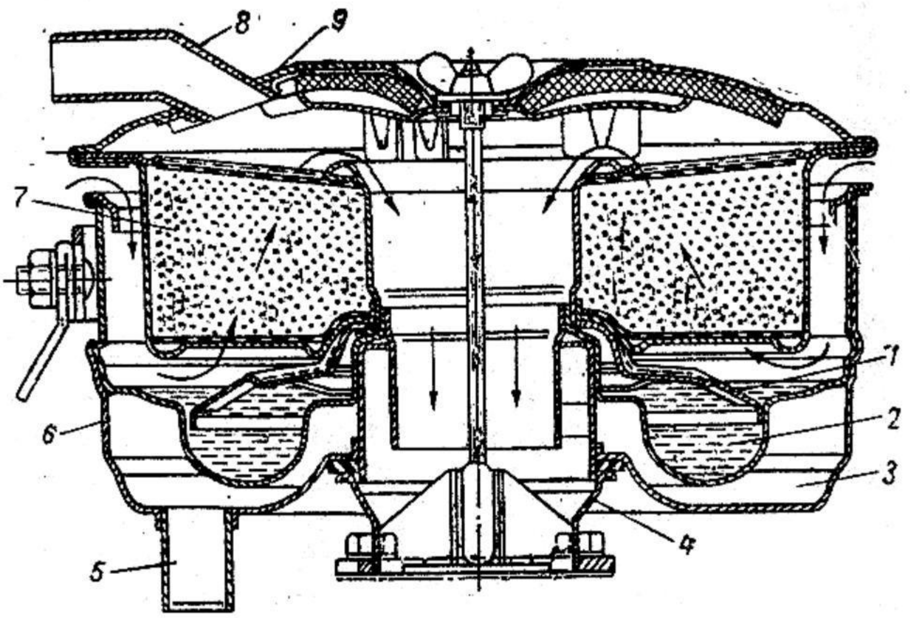


Figure 20: Air purifier used in cars.
1-guide ring; 2-oil pan; 3-annular cavity; 4-central groove; 5 and 8-engine crankcase ventilation pipes; 6-housing; 7-elephant element; 9-cover

The cyclonic air cleaner has nine cyclones inside, and consists of a casing covered by a head and a base, and two wire mesh cassettes placed inside the head. The head is connected to the engine intake pipe by means of a short pipe.
The dust collection hopper at the bottom of the air cleaner is connected to the ejector via a suction pipe and to the spark arrester at the end of the engine exhaust pipe. While conventional oil bath air cleaners remove 97-97.5% of the dust, this air cleaner removes up to 99%.

***4. Intake and exhaust pipes, muffler and spark arrester*** In carburetor engines, a combustible mixture enters the cylinders from the carburetor through the intake pipe, while in diesel engines, exhaust gases are removed from the cylinders through the intake pipe from the air cleaner. Each of the intake and exhaust pipes is made individually or in combination from cast iron or aluminum alloy. A metal-asbestos gasket is cast under the flange of the pipes and fastened to the cylinder head or block with bolts and nuts. In carburetor engines, when the combustible mixture passes through the intake pipe, small droplets of fuel can adhere to the pipe walls, forming a fuel film: This fuel can enter the cylinder and cause soot in it, or it can enter the crankcase and dilute the oil, as a result of which engine parts wear out quickly, engine power decreases, and fuel consumption increases. In the intake pipes, the pipe is heated with gases used to convert fuel droplets into vapor (sometimes with a stream of water from the cooling system). The degree of heating the mixture and converting fuel into vapor is changed manually or automatically using a special valve (valve). Sometimes it is made non-returnable. The intake and exhaust pipes are shown, in which the combustible mixture is heated by the flo
The valve opens or closes when the sector is switched to summer or winter mode.

That is, the exhaust gases exiting the exhaust pipe exit directly without touching the intake pipe or heat it up. It is also not good to overheat the mixture, because the weight of the mixture entering the cylinder may decrease, which may reduce the engine's power. In diesel engines that are ignited by a propulsion engine, sometimes the exhaust turbine of the propulsion engine is passed through the diesel intake pipe, heating the air drawn into the cylinder. To muffle the noise of the exhaust gases, a muffler is installed at the end of the exhaust turbine in automobiles.

The muffler consists of a chamber and a casing with many holes and separated from each other by barriers. As the spent gases repeatedly pass from the internal turbine of the muffler to the chambers and exit into the atmosphere, they expand, their speed, temperature and pressure decrease, as a result of which the noise of the exhaust gases decreases. A muffler and often a spark arrester are installed on the exhaust pipe of the engines. In multi-stage engines, a double-cone wire mesh muffler is installed at the end of the exhaust turbine. Later engines are equipped with an ejector and a cone-shaped composite spark arrester. This spark arrester consists of a fixed vane and a cone body, which is fastened to the engine exhaust pipe with a yoke. The spent gases pass through the blades and are set in motion by the stack. The spark particles rub against the walls of the cone and burn out faster in the stack flow. To prevent water from falling when the tractor is parked in the open, a special annular groove is made in the wall of the exhaust turbine. Water droplets fall to the ground through the holes in the annular groove. Sometimes a special hole is made in the muffler bowl.

Some exhaust pipes are closed with a cap. When the engine is running, the pressure of the exhaust gases opens the cap, and when the engine stops, the cap remains closed. Some engines have a whistle installed in the exhaust pipe.
When the tractor or trailer driver pulls the wire attached to the whistle lever, gases from the pipe partially pass through to the whistle and are blown.

***5. Checking the air cleaner, inlet and outlet pipes.*** This includes ensuring that all parts of the air cleaner are securely attached, timely changing the oil in the pipe, and washing the cassette mesh.
The dust outlet slots of the inertial dust separators are inspected and cleaned if necessary. The bottom of the air cleaner, up to the level of the annular cement belt, is cleaned or used oil is passed through a filter. If there is little oil, the air is not cleaned well, if there is a lot of oil, the valves are clogged with soot and the diesel engine runs, sometimes causing the engine to overheat. The air cleaner oil is replaced after 10-60 hours of engine operation, depending on operating conditions. When changing the oil, the wire mesh of the cassette is inspected and, if necessary, washed in diesel fuel or kerosene. The cap nuts of the cyclone air cleaner are tightened every shift, the wire mesh of the air inlet pipe is cleaned, and the ejector is checked for proper attachment to the air cleaner and exhaust pipe.

After the engine has been running for 60 hours, the air cleaner's air intake pipe, ejector pipe, and the key in which the cassettes are located are removed, and the cassettes with wire plugs are removed. The cassettes are washed in diesel fuel, dried, and soaked in diesel oil, then shaken off the oil and replaced when no more oil drips. The cassettes are allowed to dry out.

It should not be allowed when the engine is operating in very dusty conditions and temperatures above 400, 10-15% solids are added to the oil due to the moisture in the cassettes. In dusty conditions, these operations are repeated after every 20-30 hours of engine operation. The head and cyclones are wiped clean, any remaining oil and dirt are removed. For this, the cyclones are washed in gasoline. When assembling and using air cleaners, special attention must be paid to the tightness of the parts. Checking the intake and exhaust pipes consists of periodically tightening the bolts and nuts in their attachment and fastening places to ensure that air is not sucked in from the outside and gas is not released. If the gaskets are worn (burned), they are replaced. During repairs, exhaust pipes and spark arresters are cleaned of soot by burning or other methods.

*TEST QUESTIONS.*

1. What fuels are used in tractor and car engines?
2. What do the octane number and cetane number of a fuel mean?
3. Why is gasoline ethylated?
4. What is a combustible mixture, what are the mixtures?
5. Explain the function, types, structure and operation of air purifiers?
6. Describe the function and structure of the inlet and outlet pipes?
7. Explain the function and structure of a fire extinguisher and spark arrester?

## Lecture 6: Fuel supply system of carburetor engines

*Plan:*

1. General structure and operation of the fuel supply system.
2. Simple carburetor and its operation.
3. Additional carburetor components. 4.
Structure and operation of carburetors.
5. Checking carburetors.

### *1. General structure and operation scheme of the supply system*

The fuel supply system of a carburetor engine prepares a combustible mixture of the required composition, sends it to the engine cylinders in a specified amount, and exhausts the spent gases into the atmosphere. The fuel supply system (Figure 21) consists of a fuel tank, fuel filter, fuel pump, carburetor, air cleaner, intake and exhaust pipes, muffler, fuel level indicator, level sensor, and supply system control equipment.

The fuel pump pumps fuel through a filter and into the carburetor. During the intake stroke, a rarefaction occurs in the cylinder, and air is drawn in through the air cleaner and fuel is drawn in from the carburetor's plenum chamber and mixed.

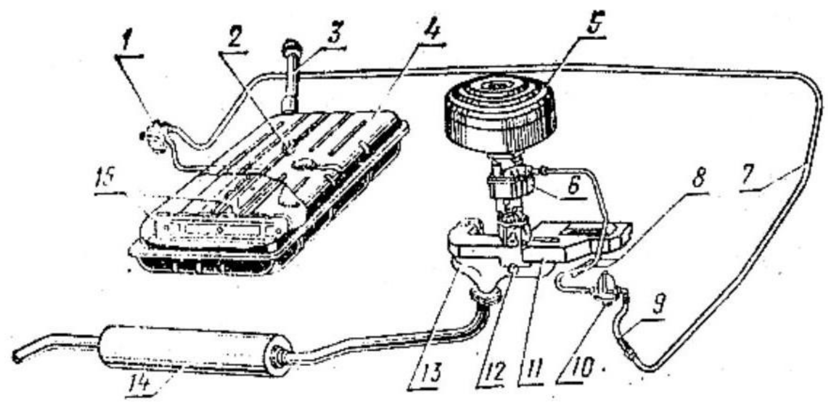


Figure 21. General diagram of the fuel supply system of a carburetor engine. 1-fil tr; 2-crane; 3-fuel tap; 4-tank; 5-air cleaner; 6-carburetor; 7-fuel pipe; 8-barrier; 9-hose; 10-fuel pump; 11-inlet pipe; 12-mixture adjustment device; 13-exhaust pipe; 14-exhaust gas silencer; 15-tank protective barrier;

The resulting combustible mixture passes through the intake manifold and intake valve and enters the engine cylinders. After the mixture is compressed, ignited, and the work is done, It is released to the atmosphere through an exhaust valve, exhaust pipe, and muffler.

### *2. A simple carburetor and its operation*

The carburetor mixes fuel with air to form a combustible mixture. The carburetor's operation is based on the principle of a money changer.

A simple carburetor has two main parts: a chamber with a flap and a mixing valve. The chamber consists of a valve and a plunger. The mixing chamber is equipped with a diffuser, a jet straightener and a throttle valve. There is a lid (Figure 22).

If the fuel in the float chamber is below the specified level, the float is low. falls, the plunger on its lever opens the fuel inlet and fuel enters the chamber.

Since the float is light, it floats to the surface of the fuel and the fuel When a certain level is reached, the valve rises and closes the fuel inlet. Thus, the fuel level in the chamber is kept constant.

From the diffuser throat of the carburetor pipe to the throttle valve cover axis The space in which the mixture is mixed is called the mixing chamber. The nozzle is placed at the throat of the diffuser. It is placed in the fuel outlet of the cleaner.

A nozzle is installed at the end of the cleaning pipe that extends into the hooded chamber. A calibrated hole that restricts the passage of fuel or air is called a nozzle.

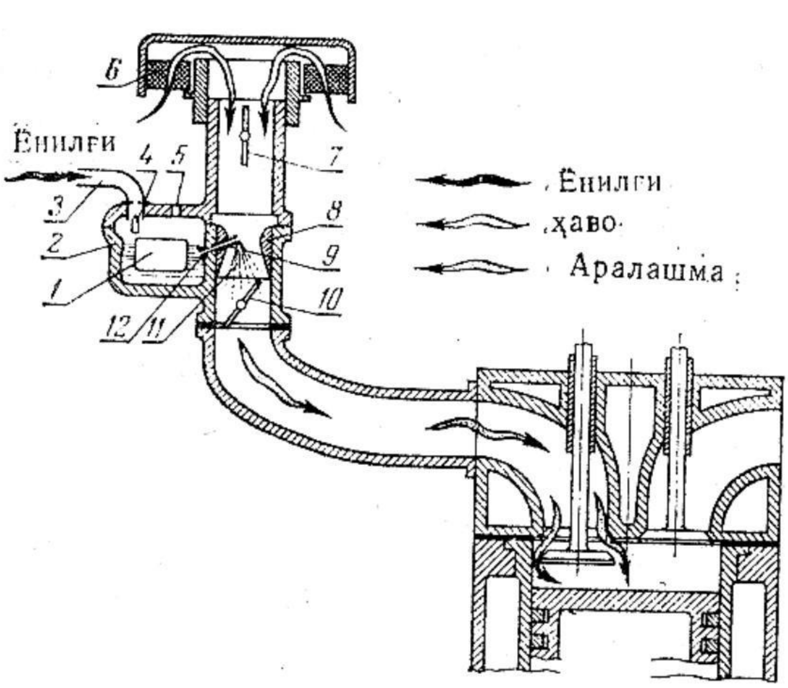


Figure 22. Diagram of the operation of a simple carburetor. 1-poppet; 2-poppet chamber; 3-fuel line; 4-nozzle; 5-chamber hole; 6-air cleaner; 7-air valve; 8-diffuser; 9-rectifier; 10-throttle valve; 11-chamber; 12-nozzle;

The throttle valve controls the amount of mixture entering the cylinders. It serves to change, it is controlled from the driver's cabin.

The carburetor works as follows: the rarefaction formed in the engine cylinder passes through the inlet port and the inlet pipe into the carburetor mixing chamber, and air is drawn into the cylinder through the chamber. The air velocity increases in the throat of the diffuser, where the atomizer is located. At this time, since the diaphragm chamber is at atmospheric pressure, and the mixing chamber is under rarefaction, fuel flows through the atomizer pipe and is atomized by the air flow. The fuel particles are sprayed with air, turning into vapor and mixing with air,

forming a combustible mixture. In a conventional carburetor, as the throttle valve is opened, more of the mixture enters the cylinder and it becomes thicker, because as the rarefaction increases, the amount of fuel relative to air increases. When the throttle valve is closed, the mixture liquefies and the engine stalls.

Carburetors are divided into types with a mixture flow direction from bottom to top, top to bottom, and horizontal, depending on the direction of the combustible mixture flow. Carburetors with a mixture flow direction from top to bottom produce a high-quality mixture, fill the cylinders with the mixture better, and save fuel, which is why carburetors are used more often.

***3. Additional carburetor devices*** To prepare a

combustible mixture suitable for operation in various engine modes, a simple carburetor drive system is equipped with a main metering system, an economizer, and an accelerator pump (Figure 23).

When the engine is running, the crankshaft rotates slowly, resulting in less rarefaction in the mixing chamber and less fuel coming out of the injector nozzle.

When the engine is cold, a thickened mixture is formed and a propelling device is installed, which mainly consists of an air damper. When the engine is ignited, the air damper is closed, the rarefaction in the mixing chamber increases, and fuel flows out of the main metering and injection system nozzles. Air enters the mixture mainly through the gap in the damper.

**The system of salt operation** (Fig. 24). When the engine is salt operated, a small amount of mixture must be injected into the cylinders, so the throttle valve is almost closed. Due to the reduced rarefaction in the mixing chamber, fuel does not leak from the nozzles.

For smooth operation of the engine, the carburetor is equipped with a smooth operation system, which consists of a fuel nozzle 2, an air nozzle 3, an adjusting screw 8, a channel 4, and holes 5 and 7. The salt working system is located so that the fuel and air flow to the surface of the throttle valve, that is, to the area where it is sufficiently rarefied, and it works as follows.

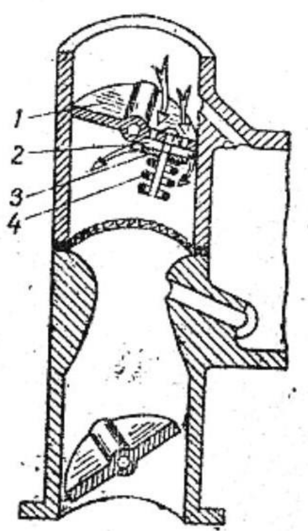


Figure 23. Drive mechanism. 1-air barrier cover; 2-hole; 3-valve; 4-spring;

To prevent the mixture from thickening too much even after the engine starts, an automatic valve 3 is installed on the air barrier cover. Air overcomes the force of the spring 4, opens the valve 3, and more air enters the mixing chamber through the hole 2, reducing the rarefaction in the diffuser.

When the carburetor throttle valve 6 is closed, the rarefaction passes through the hole 7 and channel 4 of the single-acting system to the single-acting fuel nozzle 2 and fuel begins to flow from it, since fuel does not flow from the main nozzle 1. Air enters this fuel first through the nozzle 3 and then through the additional hole 5 above the throttle valve cover, forming an emulsion. The emulsion flows out through the hole under the throttle and is mixed with air coming out of the slot on the edge of the throttle.

The amount and composition of the mixture in the salt process is changed with the adjusting screw 8.

**Economizer.** The main metering systems of carburetors prepare a liquefied mixture. In order for the engine to produce maximum power, it is necessary to introduce more and thicker mixture into the cylinder. The economizer sends additional fuel into the mixing chamber, thickening the mixture. The economizer is driven by the throttle valve shaft (mechanically) or by rarefaction in the mixing chamber (pneumatically).

The mechanically actuated economizer (Fig. 25, a) When the throttle valve is opened more than 80%, the economizer valve 5, lever 1, link 4, block 6 and plate 7 opens, and additional fuel is supplied to the main metering system's injector 8 from the economizer nozzle 2. The additional valve 5, lever 1, link 4, block 6 and plate 7 opens, and additional fuel is supplied to the main metering system's injector 8 from the economizer nozzle 2.

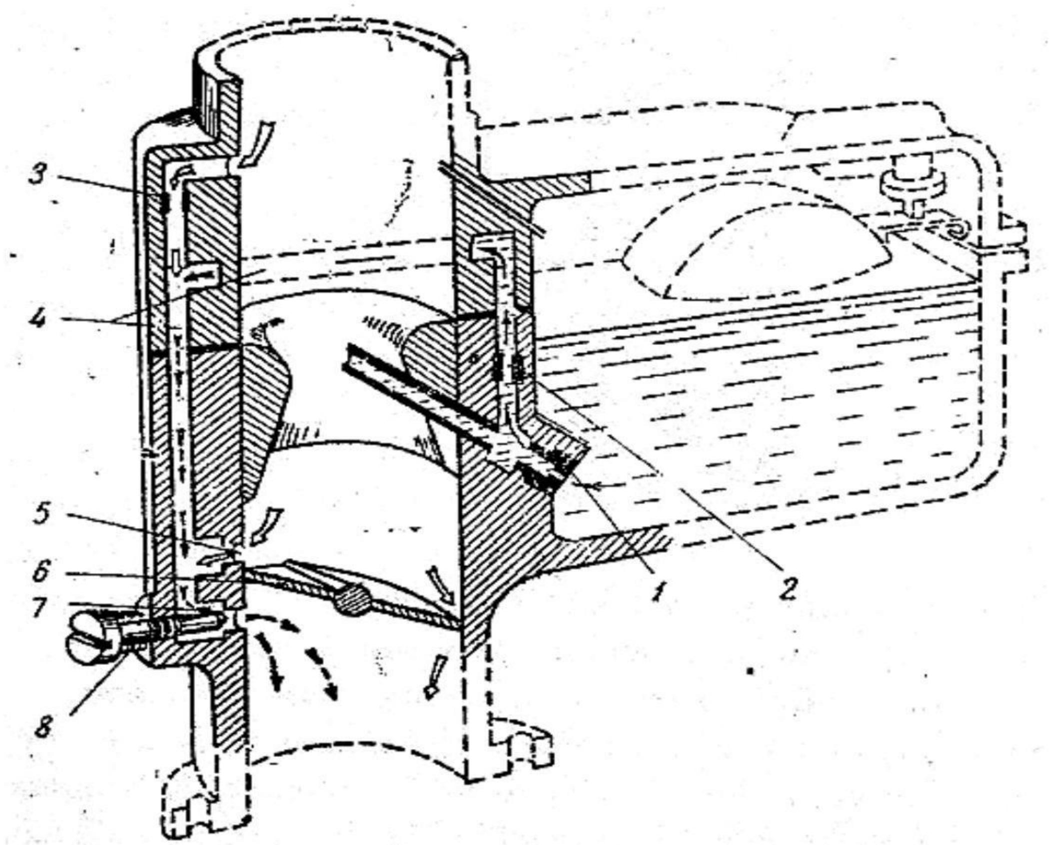


Figure 24. Salt processing plant

1- Main jet; 2-Quick-run fuel jet; 3-Air jet; 4-Channel; 5 and 7-holes; 6-Throttle; 8-Adjusting screw; Since there is a gap between the plate 7
and the economizer valve 5, when the throttle valve cover is opened more, it overcomes the force of the spring 3 and opens the valve. Only then does the engine start to produce full power.

Pneumatically driven economizer (Figure 25, b)

The opening of the valve 5 is due to the rarefaction on the surface of the throttle valve. If the throttle valve is closed, the rarefaction on its surface is transmitted through the hole 11 and the channel 10 to the lower part of the piston 12 and, overcoming the force of the spring 9, pushes the piston down. In this case, the economizer valve 5 remains closed.

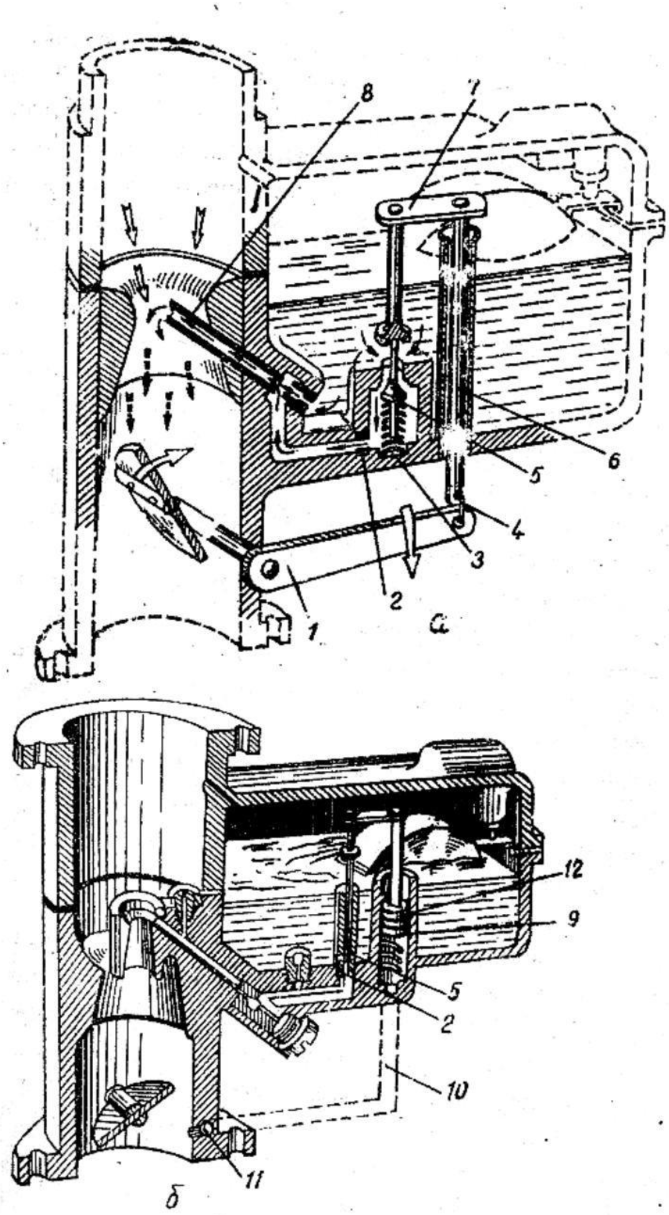


Figure 25. Economizer scheme.
a) mechanically driven; b) pneumatically driven;
1-lever; 2-economizer nozzle; 3 and 9-spring; 4-link; 5-economizer valve; 6-plate; 7-plate; 8-main metering system damper; 10-channel; 11-hole; 12-piston; As the throttle valve

opens, the rarefaction on its surface, i.e., in hole 11 and channel 10, decreases, the piston rises under the influence of spring 9, the economizer valve connected to its plate opens, and additional fuel flows from its nozzle 2 to the main metering system.

When the throttle valve opening is changed, the engine speed decreases, but the rarity decreases and the economizer starts to operate.

***4. Structure and operation*** of the

carburetor A diagram of a carburetor with a horizontally directed mixture flow, fuel and air brake is shown (Fig. 26). The carburetor has a flap chamber 3, a mixing chamber 17, an air damper 8, a throttle valve 15, a fuel

The main dosing system consists of a channel 4, a main nozzle 5 and a filter 6: there is a single-acting system consisting of channels 18, 9, 12, a single-acting nozzle 10, a adjusting screw 11 and holes 13, 14 near the throttle valve cover.

The camera with a pop-up channel is connected to the main dosing system and the salt processing system via 4 channels. and the balancer is connected to a short pipe through which air passes through channel 16.

Fuel from the tank enters the chamber with a flap through a nozzle 1. The flap 2 maintains the fuel level in the chamber unchanged. The carburetor's drive system consists of an air damper 8 and a flap plunger.

When starting the engine, the air valve is almost closed and the throttle valve is slightly open. To make it easier to start the engine, the fuel level in the carburetor dipstick is increased by pressing the button. The fuel is pushed through the main metering system, forming a rich mixture.

When the engine is idling, the throttle valve is slightly open, so that fuel is drawn in through the intake port and nozzle, as there is also a rarefaction in the diffuser.

When the engine is running under load, the throttle valve is fully opened, the rarefaction in the diffuser increases, and the fuel exits the main jet's nozzle and mixes with the air flow.

Multi-chamber carburetors are now used in most cars. In them, the mixture is distributed evenly throughout the cylinder and enters more deeply.

As a result, the car's power increases and it works well in various conditions. Multi-chamber carburetors have one poppet chamber, but two or four mixing chambers. The chambers operate in parallel or in series.

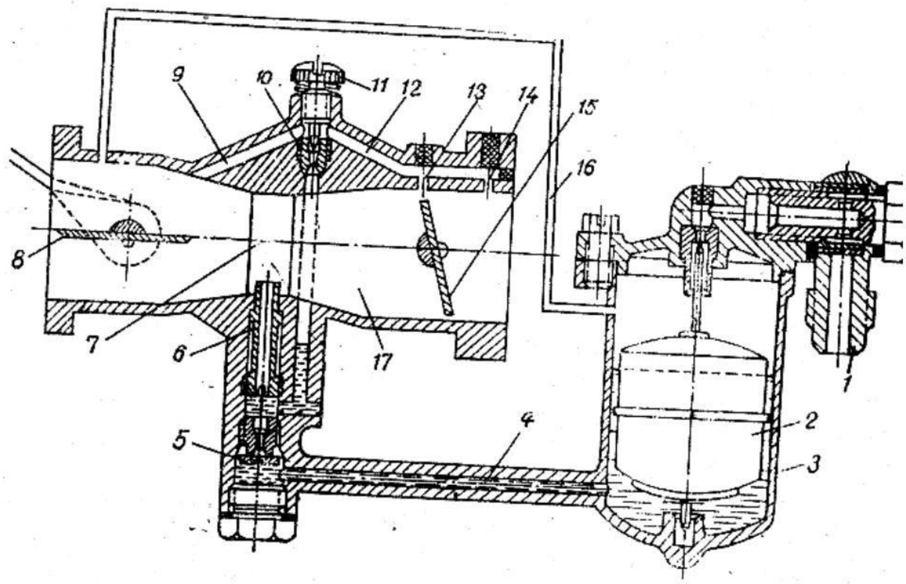


Figure 26. Diagram of a carburetor with a horizontal mixture flow. 1-nozzle; 2-poppet; 3-poppet chamber; 4-fuel channel; 5-main nozzle; 6-filter; 7-diffuser; 8-air baffle cover; 9,12 and 18-channels; 10-nozzle; 11-adjusting screw; 13,14-hole near the throttle baffle cover; 15-throttle baffle cover; 16-balancing channel; 17-mixing chamber;

When operating in parallel, each chamber sends a mixture to certain cylinders and the throttle valve opens simultaneously, while when operating in series, one opens first and the other opens when the engine is running at full load.

When starting a cold engine, the choke is closed, the throttle is slightly opened, and the accelerator pump is given a break once or twice. An automatic choke valve is installed to prevent the mixture from thickening when the engine is started.

When the engine is idling, the rarefaction that occurs in the push tube passes through holes and channels into the mixing chamber, and the fuel passes through the main jets and exits the idling jets.

When the engine is running at medium load, the throttle valve is partially open, more air passes through the main channels, and the rarefaction in the small diffuser increases, and the main carburetor metering system begins to operate.

### *5. Checking carburetors*

If there is a defect in the carburetor, the composition of the mixture may change, becoming thinner or thicker. If the mixture is thick, a rattling sound will be heard in the carburetor, the engine will overheat, and fuel consumption will increase.

If the fuel level in the plenum chamber drops, the carburetor is not adjusted properly, the filter, jets, and channels become clogged, insufficient fuel is delivered, and air is sucked in from the outside through the carburetor flanges, the mixture becomes liquefied.

If the fuel level in the poppet chamber is high, the carburetor is not adjusted properly, the fuel jets are worn and enlarged, the economizer and accelerator pump valves are not tightly closed, and the air intake flap is not fully open, the mixture will thicken.

Carburetor maintenance consists of daily cleaning of dust, elimination of fuel leaks and air intake from the outside, periodic adjustment of the mixture composition, checking and adjusting the fuel level in the plenum chamber, washing the filters, cleaning the jets by blowing them out, checking the fuel flow of the jets, and checking the condition of the main jet nozzle. Also, during maintenance, all parts are checked for tightness, and any loose parts are tightened.

When disassembling the carburetor, be careful not to tear the gaskets, and clean the nozzles and channels with compressed air.

The fuel level is adjusted by manually opening the valve lever plate or by changing the thickness of the gasket under the throttle valve seat.

*TEST QUESTIONS.*

1. What is the function of the fuel supply system in carburetor engines and its causes?
2. How do the components of the fuel system work together? 3. What are the main parts of a simple carburetor and how does it work?
4. When and how do the additional features of carburetors (salt treatment system, main metering system, economizer) work?
5. How does the mixture flow work in different modes of a horizontally oriented carburetor engine?

6. What are the advantages of a multi-chamber carburetor and how does it work?
7. What are the steps involved in inspecting carburetors?
8. How is the carburetor checked and adjusted?

## Lecture 7: Diesel engine supply systems.

***Plan:***

1. General scheme of the supply system.
2. Methods of mixture formation in diesel engines.
3. Fuel injection timing and its effect on engine performance. 4. Fuel tanks, filters and fuel pumps.
5. Structure and operation of a multi-plunger fuel pump.
6. Injectors and fuel pipes.
7. Control of the diesel supply system.

***1. General scheme of the supply system*** The diesel supply system cleans the fuel and sprays it into the combustion chamber at high pressure, also cleans the air entering the cylinders and prepares a combustible mixture of fuel and air.

The diesel fuel supply system (Fig. 27) consists of a fuel tank 1, a coarse filter 12, and a fine filter 4, a fuel injection pump 11, a fuel pump 5, injectors 7, a low-pressure pipe 13, a high-pressure pipe 6, an air cleaner 10, inlet and outlet pipes, a speed regulator 15, and control and inspection devices for the supply system.

Fuel from tank 1 flows through tap 14 and pipe 13 to coarse filter 12. In the filter, the fuel, cleaned of large impurities, is sucked by pump 11 and pumped to filter 4. The fuel is cleaned of water in the fine filter, and then sent to fuel pump 5.

The fuel pump sends a portion of the fuel at high pressure through pipe 6 to injector 7. The portion of the fuel not sent to the injector is returned to the pump.

The injector finely atomizes the fuel and sprays it into the combustion chamber 8. The fuel mixes with the compressed and heated air in the chamber to form a combustible mixture, and is ignited by its heat.

The air entering the cylinder is cleaned of dust by passing through the air cleaner 10 and is sucked out through the pipe 9.

The pressure gauge shows the pressure of the fuel flowing from the 3-way filter to the fuel pump. The pressure gauge is not mounted directly on the pipe, but is attached through a pressure equalizing tank in the pipe.

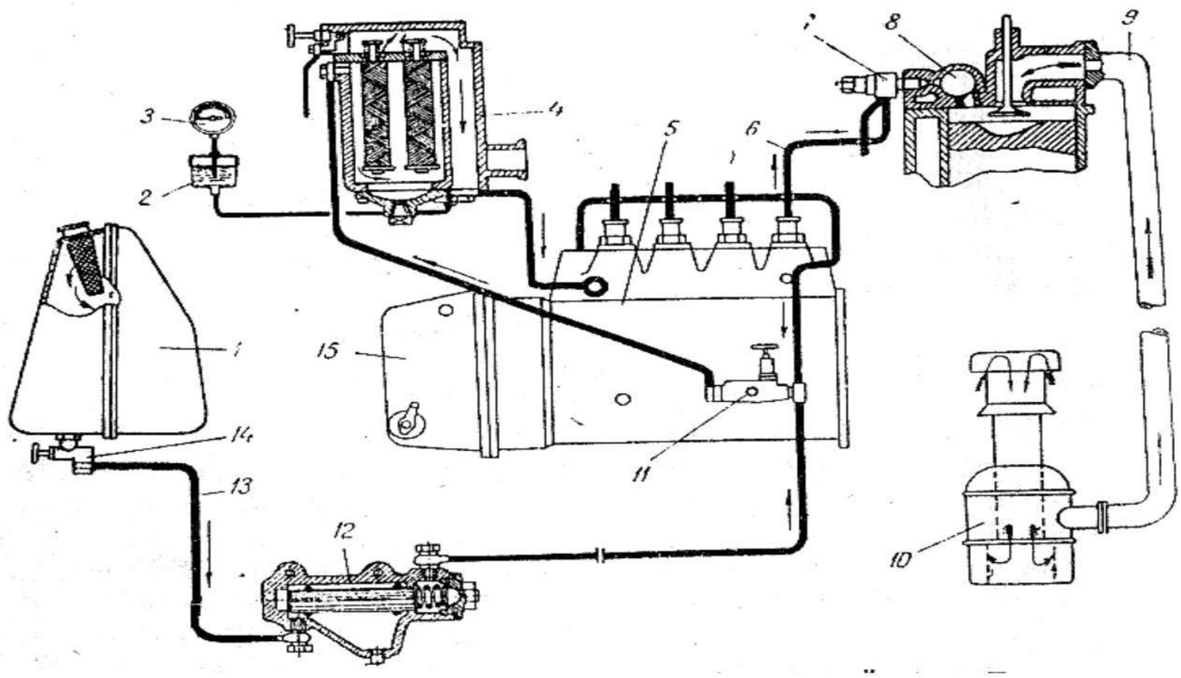


Figure 27. General scheme of the diesel engine supply system. 1-fuel tank; 2-tank; 3-manometer; 4-fine oil pipe; 5-fuel pump; 6-high pressure pipe; 7-injector; 8-combustion chamber; 9-pipe; 10-air cleaner; 11-fuel drive pump; 12 - coarse oil pipe; 13 - low pressure pipe; 14-crane; 15-speed regulator;

***2. Mixture formation in diesel engines***

Depending on the method of mixture formation, diesel engines are divided into single-chamber and multi-chamber types.

In single-chamber diesels (Fig. 28, a), fuel is sprayed directly into the cylinder, that is, into the combustion chamber 2 above the piston 1, using the injector 3, to form a mixture.

The fuel is finely atomized under high pressure and mixes well with the heated air, burning. The combustion chamber is hemispherical or round in the middle, with a deeper edge. For better atomization of the fuel, the fuel spray holes of the nozzle are very small (0.1-0.25 mm) and are made in several pieces. The fuel is sprayed from it with a pressure of 300-400 kg/cm2.

In such diesels, the combustion chamber is compact, which allows for better use of thermal energy. The fuel consumption is relatively low, and the engine is easier to start.

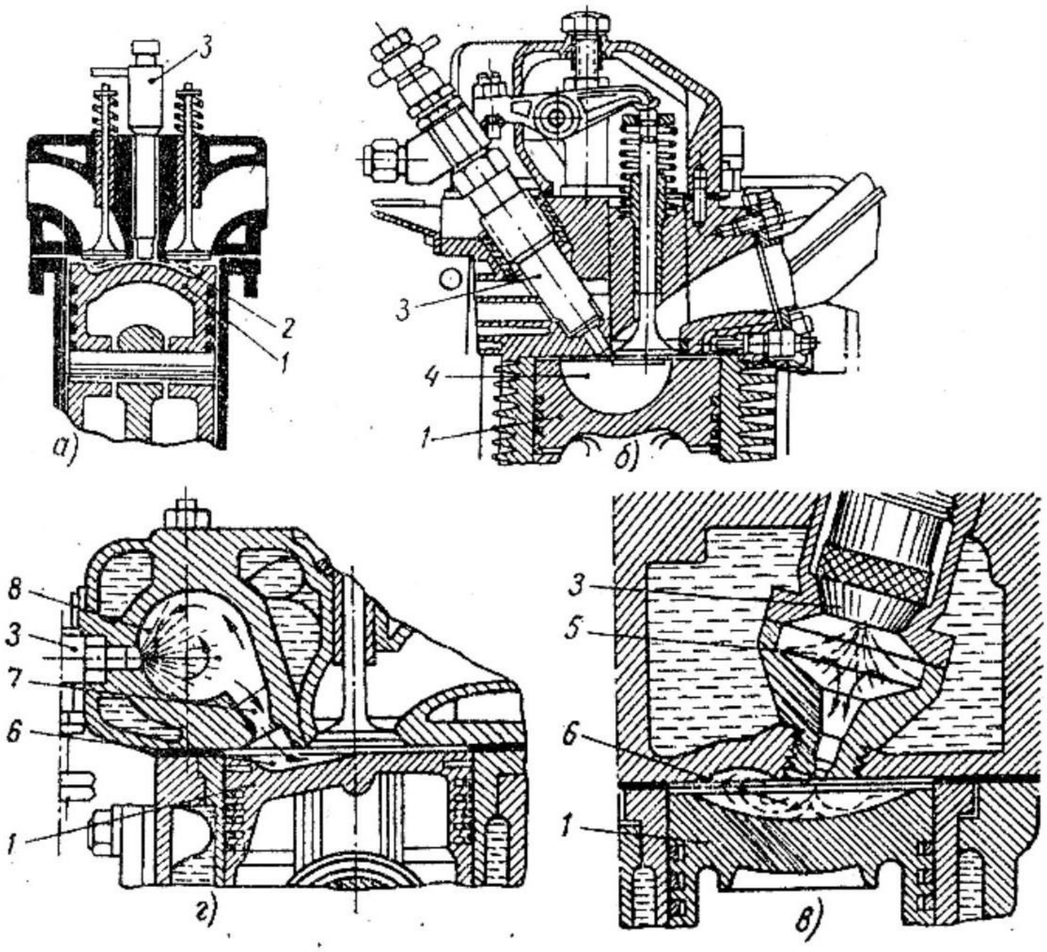


Figure 28. Shapes of the combustion chamber of diesel engines.
a- single-chamber; b- piston-mounted chamber; v- front-chamber; g- stack-chamber; 1-piston; 2-combustion chamber; 3-injector; 4- piston-mounted chamber; 5- front
camera; 6- main camera; 7- diffuser channel; 8- stacking camera.

In diesel engines with a chamber mounted on the piston (Fig. 28, b), about 70% of the combustion chamber is a spherical or ellipsoidal chamber located at the bottom of the piston 1.
It consists of 4, the rest of which is placed between the piston and the head.

In front-chamber diesels (Fig. 28, c), the combustion chamber is located at the bottom of the piston.
The main chamber 6 located in the cylinder head and the front chamber 5 located in the cylinder head
During the compression stroke, air passes into the front chamber, where it moves and heats up. Front
The volume of the chamber is about 25-40% of the volume of the combustion chamber, and the injector 3 is installed in it.

In diesel engines with a combustion chamber (Fig. 28, g), the combustion chamber consists of two parts:
The main chamber, which accounts for about 20-40% of its volume, is equipped with 6 piston bottoms.
located between the cylinder head.

The remaining part is made up of a spherically shaped combustion chamber 8 in the cylinder head.
placed.

### *3. Fuel injection timing and its effect on engine performance*

In carburetor engines, the fuel mixture is prepared mainly in the carburetor.
It begins in the intake manifold of the engine and continues during the intake and compression strokes.

It is ignited by the spark plug at the end of the compression stroke and burns until the combustion process begins.

In diesel engines, the fuel, which does not disperse well and is difficult to vaporize, is sent from the pump through a pipe to the injector at the end of the compression stroke. The fuel is sprayed from the injector into the combustion chamber at a speed of 150-400 m/s, forming a mixture.

This process occurs 40-50 times faster than in carburetor engines. Therefore, 25-65% more air is introduced into the cylinders of diesel engines than is necessary to form a normal mixture.

The timing of fuel injection affects the power, fuel economy, and
It has a great impact on other indicators.

In modern tractor diesels, fuel is injected from the pump 15-40 seconds before the piston reaches top dead center during the compression stroke. Fuel is sprayed from the injector 6-10 seconds before the piston reaches top dead$^0$ center.

If the fuel is injected too early, the air may not be hot enough at this point. In this case, the fuel sticks to the walls of the combustion chamber, burns poorly, and the diesel engine runs rough. If the fuel is injected too late, most of it burns during the power stroke, when the cylinder volume increases, so the pressure in the cylinder decreases at the beginning of the power stroke.

To ensure mixture formation and complete combustion of fuel in diesel engines, it is necessary to properly install the fuel pump, periodically adjust the pump and injectors, and fully utilize the engine's power.

***4. Fuel tanks, filters and drive pumps*** Fuel tanks. The

fuel tank contains a fuel zone and can hold enough fuel for at least 10 hours of engine operation in tractors and 300-400 km in cars. Fuel tanks are installed behind the cab or under the driver's seat in tractors. In cars, fuel tanks are attached to brackets on the frame with clamps.

Fuel filters. It is necessary to filter and clean the fuel to reduce wear on engine and fuel system parts and to prevent clogging of the small holes in carburetors and injectors.

In carburetor engines, in addition to cleaning the fuel tank, the filter is also cleaned in the filter. Mechanical impurities and water settle in the filter. The filtered fuel is passed through a wire mesh filter.

In diesel engines, the fuel must be extremely clean to prevent corrosion of the highly precise parts of the fuel system, such as the pump plunger, injector nozzle, and injector nozzle. Therefore, before being poured into the tank, the fuel must be filtered and passed through a special filter, and in the engine itself, it is passed through coarse and fine filters, where it is thoroughly cleaned of all impurities.

Coarse filters clean the fuel from large mechanical impurities. In diesel engines, coarse filters with metal strips and metal plate slots are used.

Soft elephant (Figure 30) captures small mechanical attachments that the rough elephant cannot capture. It continuously cleans the fuel.

Fuel injection pumps. In cars, the fuel tank is located below the carburetors. A special injection pump is installed to force fuel from the tank to the carburetor. In diesel engines, fuel from the tank is pumped through a soft filter under pressure.

The so-called driving pump is used to send the fluid to the main pump.
An auxiliary pump is installed.

Diaphragm, piston, gear and rotary pumps in the fuel delivery system is applied.

Piston drive pump (Fig. 31) cast iron housing 11, piston 13 with spring 2, rod 7 and roller pusher 8 with spring 10, spring-loaded inlet valve 5 and drive valve Consists of 1.

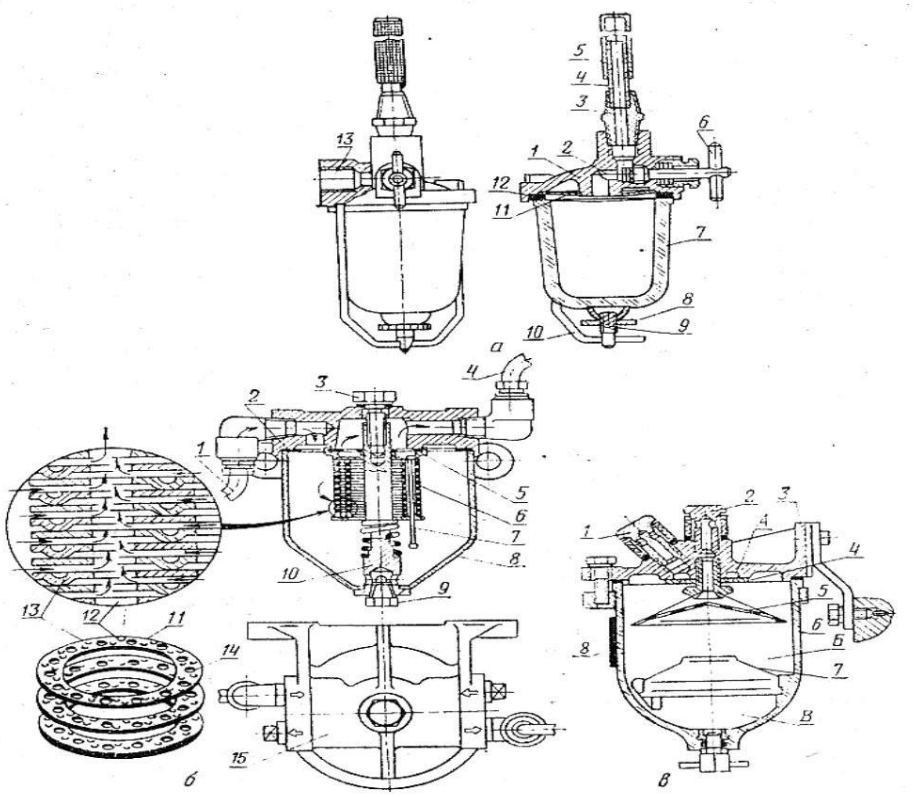

Figure 29. Fuel elephant trees.

a) elephant trunk; 1-housing; 2-ditch in the housing; 3-fitting; 4-pipe; 5-elephant trap; 6-tap; 7-cup; 8-nut; 9-screw; 10-bent wire; 11-elephant trap; 12-gasket; 13-hole for the nozzle; b)-elephant trunk with a slotted metal plate. 1-pipe; 2-housing gasket; 3-bolt; 4-pipe to the fuel pump; 5-gasket; 6-elephant trap element; 7-rack; 8-housing; 9-cover; 10-rod; 11-elephant trap element plate; 12-hole in the plate; 13- bulge in the plate; 14-hole in the plate; 15-filtre head; c) coarse filter. 1 and 2-

bolt; 3-body; 4-distributor; 5-elephant-shaped element; 6-glass; 7-calmator; 8-explanatory table.

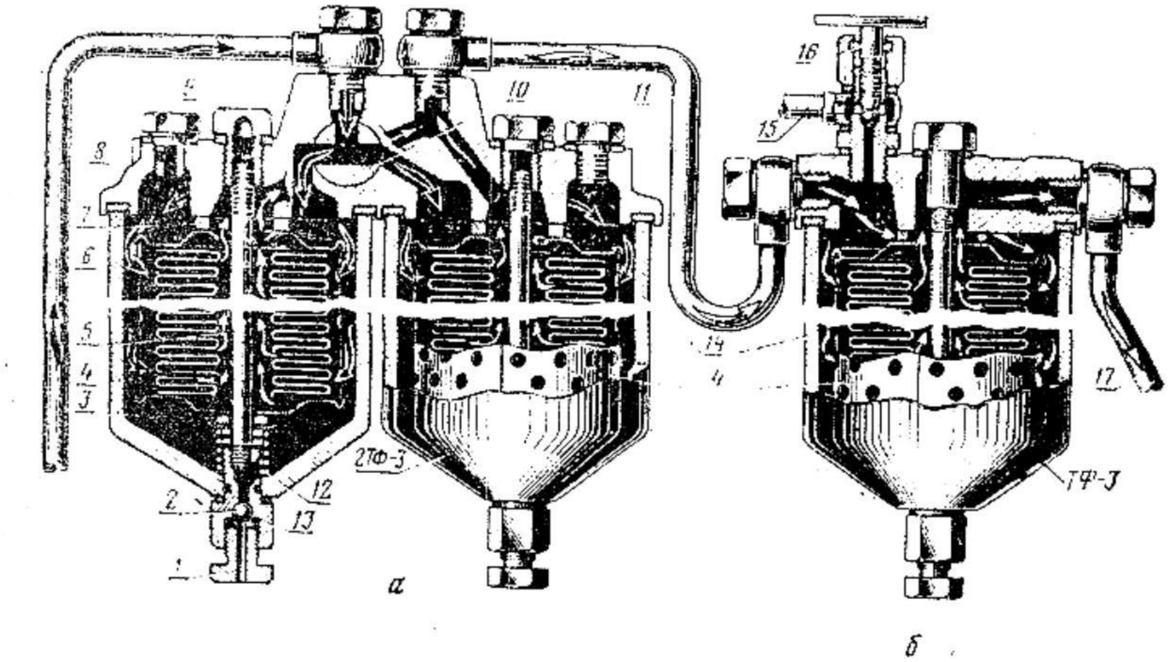


Figure 30. Gentle cleaning elephant

a) soft cleaning valve b) three-way cleaning valve; 1-cap; 2-ball; 3-valve; 4-valve element; 5-rod 6,11 and 17-fuel injector; 7-ring; 8-valve cover; 9-nut; 10-three-way valve; 12-spring; 13-fitting; 14-body valve; 15-pipe; 16-cock.

A lever pump is mounted on the pump housing, above the inlet valve. The pump is driven by the piston of the fuel pump shaft 9 or by a separate eccentric.

The diaphragm fuel pump with a plunger cup (Fig. 32, a) is used in carburetor engines and is driven by the camshaft eccentric 1.

When the right end of the eccentric two-arm lever 2 is raised, the left end pulls the diaphragm 6 down through the rod 4. At this time, the diaphragm spring 5 is compressed, a rarefaction occurs above the diaphragm, the inlet valve 8 opens, and fuel enters the cup 9, passes through the wire mesh, and fills the space above the diaphragm.

If the eccentric lever is not pushed, the diaphragm spring 5 is stretched, the diaphragm is bent upwards, the inlet valve 8 is closed, and the exhaust valve 7 is opened, allowing fuel to flow from the pump to the carburetor. The diaphragm spring creates a pressure of 0.10-0.30 kgG'cm2.

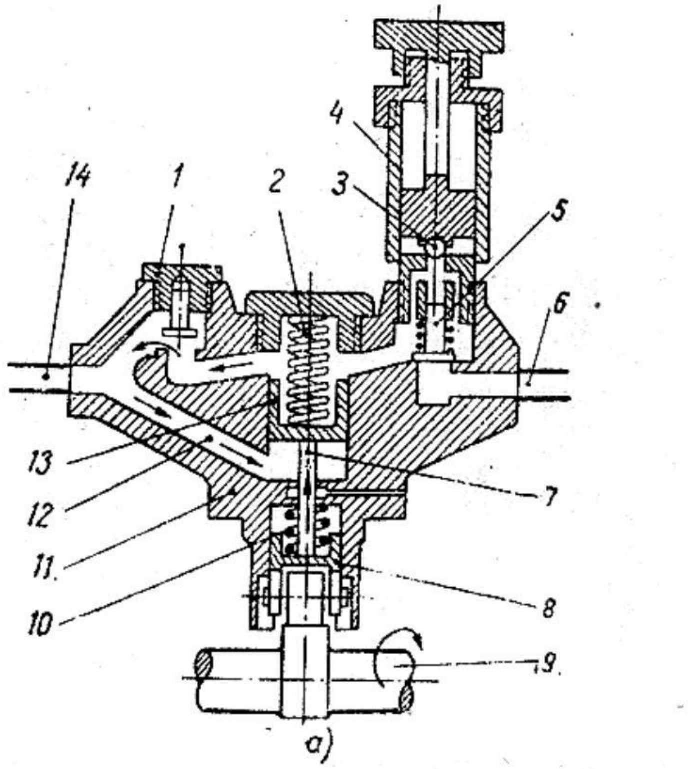


Figure 31. Piston drive pump.

1-drive valve; 2-spring; 3-locking ball; 4-handle 5-inlet valve; 6-tube; 7-rod; 8-tappet; pump cylinder; 10-spring; 11-body; 12-channel; 13-piston; 14-filament channel. 9-pump shaft;

Diaphragm fuel pump without a pressure cup (Fig. 32, b) has cylinders arranged in a "V" pattern. used in cars with a fixed axle, the movement is transmitted from the eccentric 1 to the rod 11 The number is transferred to 10.

**5. Structure and operation of a multi-plunger fuel pump.**

The fuel pump delivers fuel at high pressure to the injectors of the engine cylinders. The fuel is sent after a certain period of time, at a certain time, and to the diesel fuel tank. It is sent in the appropriate amount and at the same rate and sprayed into the combustion chamber through the nozzle.

Tractor diesels mainly use multi-plunger pumps, which are used to pump several liters of fuel per hour. If there are cylinders, the pump will have that many elements (Figure 33).

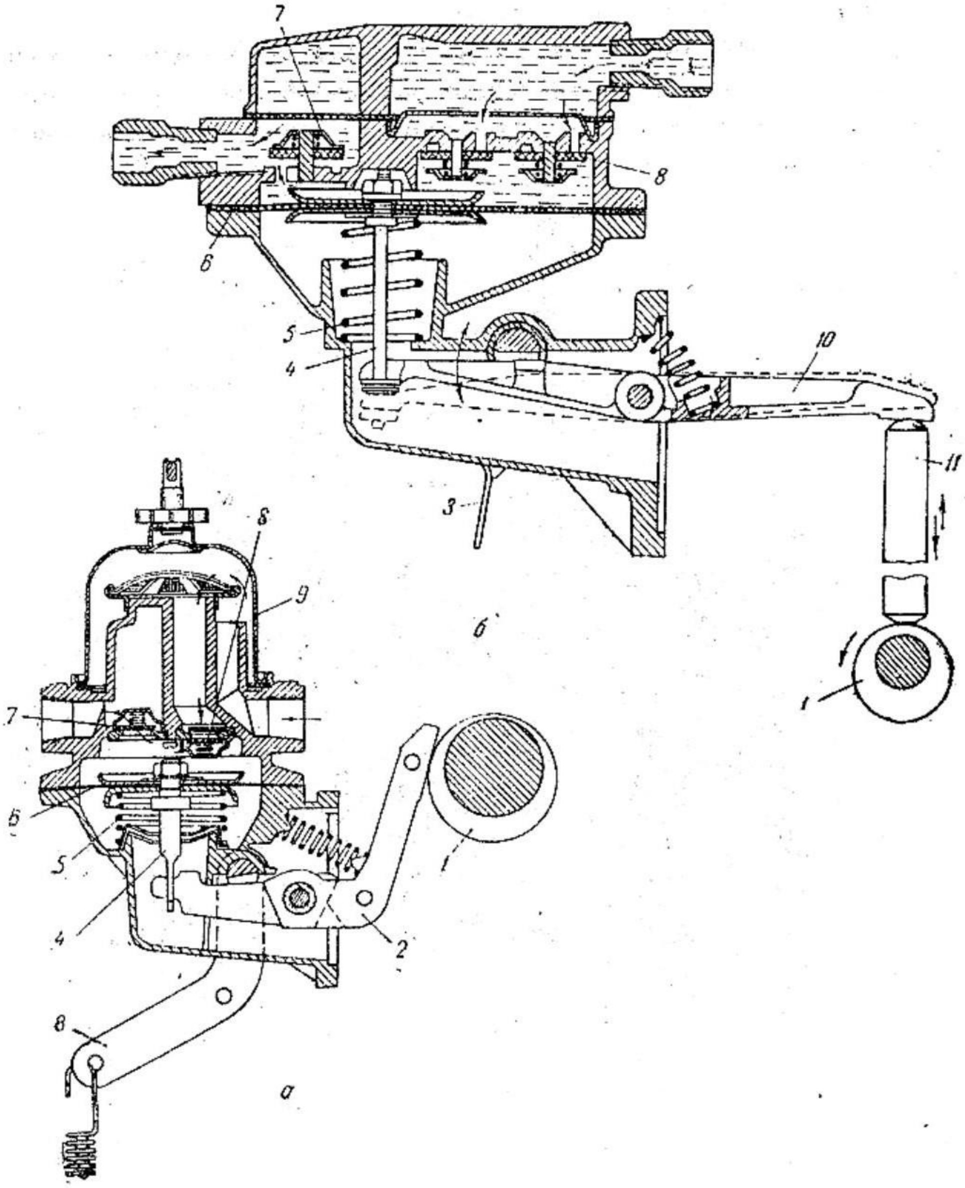


Figure 32. Diaphragm fuel pump.
a-with plunger cup; b-without plunger cup; 1-eccentric, 2-lever; 3-manual lever; 4-rod; 5-spring; 6-diaphragm; 7-drive valve; 8-inlet valve; 9-cup; 10-rocker; 11-rod.

A multi-plunger fuel pump consists of a head containing the pump elements, a mechanism for driving the plungers, and a mechanism for changing the amount of fuel delivered. The pump section and its elements are shown in (Figure 34).

The pump element consists of a plunger 4 that moves reciprocatingly in a cylinder 7 and a drive valve 8 with a spring 9. The pump camshaft 13 is driven by the diesel engine crankshaft through a distributor gear 10.

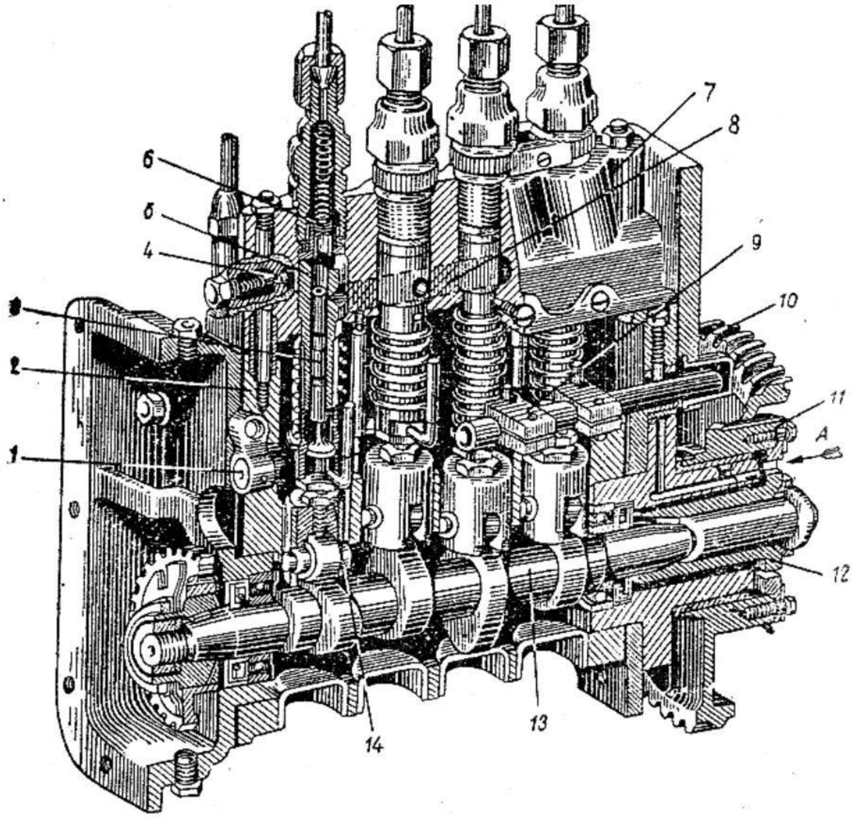


Figure 33. Multi-plunger fuel pump.
1st rail; 2nd corps; 3- plunger; 4-valve; 5-gil za; 6-drive valve; 7th head; 8-"P"-shaped channel; 9th yoke; 10th gear; 11-slot disc; 12th clutch; 13-punched shaft; 14-
pusher;

When the plunger moves down (Fig. 34, a), a rarefaction occurs above it and The fuel from the fine filter enters the upper hole 14 of the cylinder 7 and fills the space above the plunger 4. The plunger rises and closes this hole.
Then, the plunger begins to compress the fuel above it. The fuel pressure increases rapidly, causing the spring to Overcoming the force of 9, the drive valve 8 opens and the fuel flows upwards through the nozzle 10. passes from the pressure pipe to the nozzle. (Figure 34, b)

The plunger is connected to the lower hole of the clay pot by a slanted groove. The fuel at the top flows through vertical 15 and radial 16 channels to the "P" symbol channel 5 in the pump head 6.

As a result, the fuel pressure above the plunger decreases, the drive valve 8 closes under the force of the spring, and the fuel supply to the injector stops (Fig. 34, b).

The drive valve belt 11 fits snugly into the hole 12 of the seat, and the high pressure separates the tube from the space above the plunger, so that the fuel pressure in the tube decreases sharply, and the injection of fuel from the injector into the cylinder quickly stops.

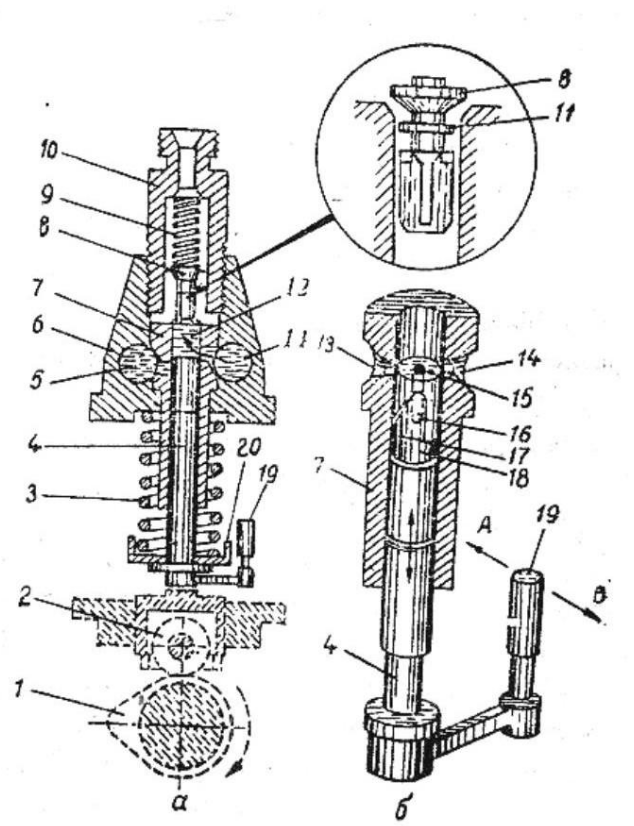


Figure 34. Pump section (a) and its elements (b).
1-knob; 2-push rod; 3- and 9-spring; 4-plunger; 5- "P"-shaped channel; 6-head; 7-shim; 8- drive valve; 10- nipple; 11- drive valve belt; 12- drive valve housing; 13-lower hole; 14-upper hole; 15-plunger vertical channel; 16-plunger radial channel; 17- screw-shaped groove; 18- ring-shaped groove; 19- guide; 20-washer.

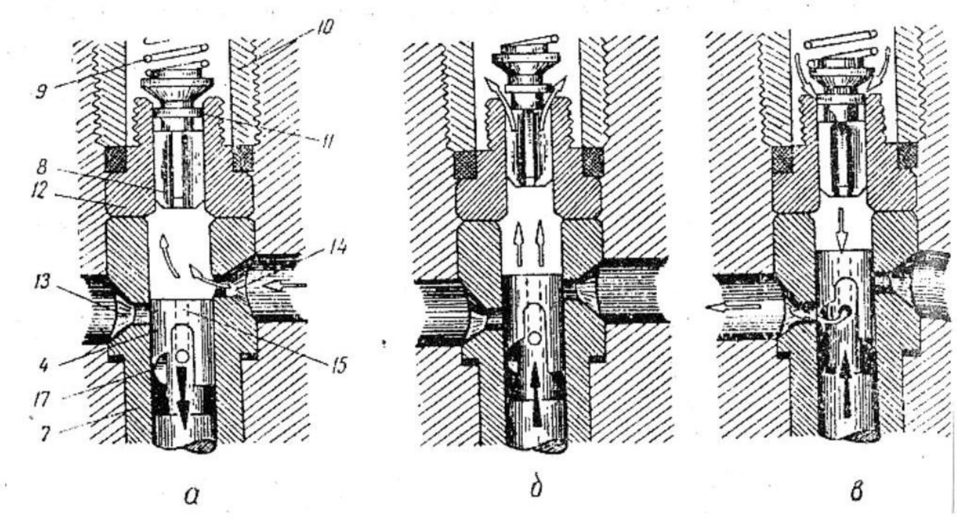


Figure 35. Diagram of the operation of the pump element.
a-filling of the fuel tank; b- start of fuel delivery; c- end of fuel delivery;

6. **Nozzle and fuel pipes** The

nozzle sprays fuel from the pump into the diesel combustion chamber at a certain pressure. There are open and closed nozzles. Closed nozzles are divided into pin and pinless nozzles depending on the structure of the nozzle they cover.

The pin injector (Fig. 36, a) consists of a housing 4, a filter 1, a filter nozzle 2, a clamping nut 3, a rod 5, a spring 6, a set screw 8, fuel inlet and fuel outlet nozzles.

Fuel enters the injector from the high-pressure pipe through channel 12. Fuel passes through channels in the injector body and the diffuser and enters the annular gap in the lower part of the diffuser nozzle. (Fig. 36, b) The fuel pressure overcomes the compressive force of the spring 6 and raises the nozzle by 0.35 - 0.40 mm. Then an annular gap is formed between the diffuser hole and the end of the nozzle body, and fuel is sprayed through this gap.

The nozzle opens only when the fuel pressure reaches a set level, and as soon as the fuel supply from the pump stops, the nozzle closes immediately, that is, the nozzle of the injector opens and closes abruptly.

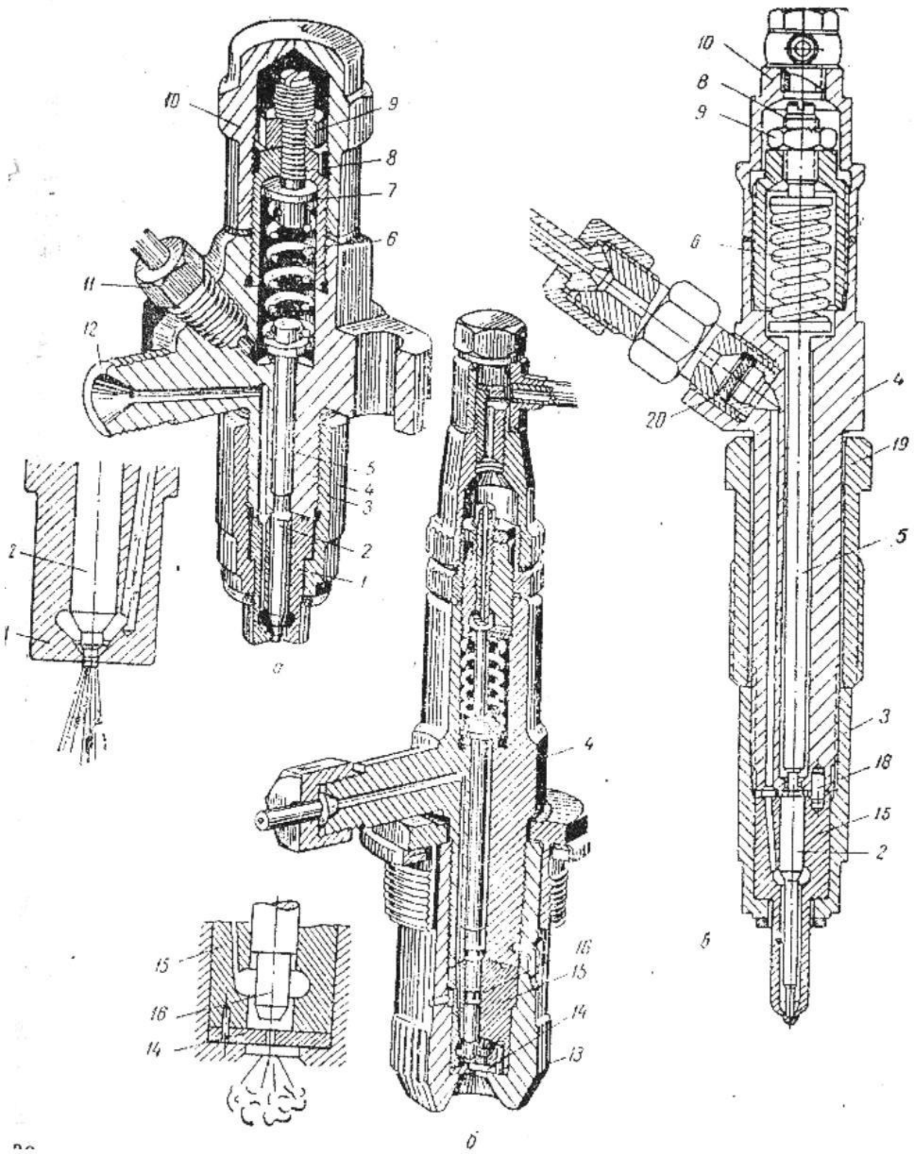

Figure 36. Nozzles

a - pin; b - without pin; v - multi-hole; 1 - cleaner; 2.16 - the name of the cleaner; 3 - tightening nut; 4 - body; 5 barbells; 6 - spring nut; 8- adjustment screw; 9 - counter nut; 10 - cap; 11 - nozzle; 12 - channel; 13 and 19 - nut; 14 - disc; 15 - straightener; 18- pin; 20 - elephant tr.

The pinless injector (Fig. 36 b) is fitted with a disc 14 that is frictionally fitted to the nozzle 15 and secured with two mounting pins. A nozzle 16 is inserted into the nozzle hole and is connected to the disc.

The filter, together with the disc, is clamped to the housing 4 using a nut 13.

The supply system devices are interconnected by fuel pipes. They are divided into low-pressure and high-pressure pipes.

Low-pressure pipes are used in carburetor and diesel engines to supply fuel to the fuel tank, filter pump, and carburetor. These pipes are made of copper, brass, or steel and are connected to fittings with nuts.

**7. Diesel fuel system control** The smooth operation of the engine fuel system depends on the proper operation of the fuel and air supply devices. The most common defect of the fuel tank, filter and pump is their contamination. Failure to comply with the rules for storing, transporting and filling fuel leads to contamination of the fuel tank and filter.

To prevent fuel from spoiling, it is necessary to pour less fuel into the tank, let it stand for at least 2-3 days before pouring it into the tractor, and pour it into the tank with a pump of the elephant type.

Cleaning of the fine filter and coarse filter consists of removing the sludge that has formed in them, washing the filter housing and the filter element. The coarse filter is washed in kerosene and diesel fuel.

Caring for a soft-bristled elephant involves emptying its body, washing it, and replacing the elephant's tugging element.

If the pump valves are not tightly closed, the diesel will not run smoothly and the pressure gauge will fluctuate. To eliminate these problems, the pump valve springs and other parts are washed in diesel fuel.

Defective pumps and injectors have a significant impact on diesel engine performance, It becomes difficult to start, it does not work smoothly, it runs intermittently, and its power decreases.

Defects in the diesel fuel supply system are often caused by fuel contamination, improper installation of pumps and injectors, improper alignment, wear of parts, and violation of maintenance rules.

The pump and nozzles are cleaned of dust every day, and fuel leakage and air intake from the outside are absolutely not allowed.

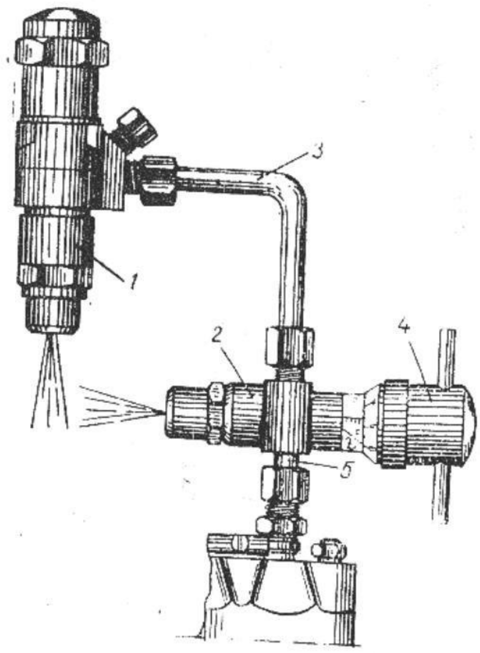


Figure 37. Determination of spray pressure with a
maximeter 1- nozzle to be tested; 2- maximeter; 3- pipe; 4- adjustment drum; 5- short pipe.

The fuel injection pressure of the injector is checked with a maximeter. The maximeter The difference from the injector is that it has a calibrated spring (Figure 37).

If you do not have a pressure gauge, you can check the fuel injection pressure of the injector with a control injector. Each injector is checked separately and the others are isolated (Figure 38).

A malfunctioning injector can be identified by repeatedly disconnecting it from the running engine. If the injector's filter cannot be cleaned or the screw adjusted to make it work properly, the injector can be readjusted by replacing the filter and nozzle.

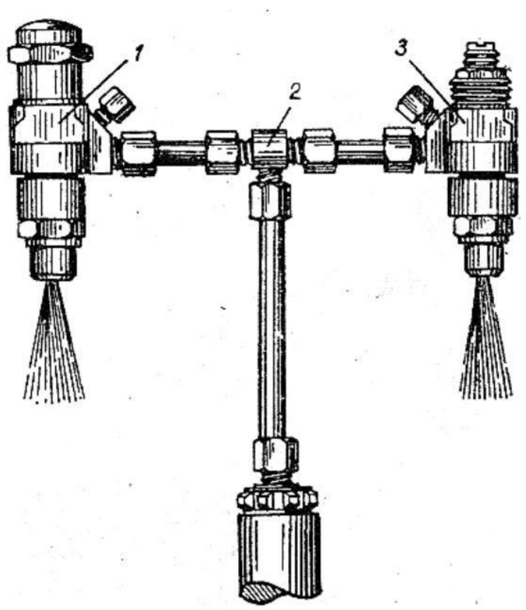


Figure 38. Determining the spray pressure with a control nozzle.

TEST QUESTIONS

1. What devices are included in the diesel fuel supply system? Explain their installation on the tractor and their principle of operation.

2. Describe the methods of mixture formation in diesel engines.
3. What is the fuel injection timing? When is the fuel sent from the pump and sprayed from the injector? When is it sprayed?
4. Explain the structure and function of coarse and fine fibers.
5. Describe the types of driving pumps, their structure and operation.
6. Explain the structure and operating principle of a multi-plunger fuel pump.
7. Describe the structure and operation of a single-piston pump.
8. Explain the types of injectors, their structure, operation, and how to adjust them. give.
9. How the fuel tank and pipes are constructed.
10. How to check and adjust the fuel injection timing.

## **Lecture 8: Speed regulator** Plan: 1. The need

for a regulator and its type.
2. Single-mode regulators.
3. Multi-mode regulators.
4. Limiting maximum engine revolutions.
5. Supervision of regulators.

### **1. The need for a regulator and its type**

When using a tractor with agricultural machinery attached or towed, the terrain, soil texture, crop yield, and other factors constantly change the resistance to the engine.

The driver of a tractor or self-propelled agricultural machine does not notice and cannot predict these changes in advance, therefore he cannot adapt the engine power to the load on it. At the most economical engine speeds, its power is slightly less than its maximum. At the speed appropriate for powering the engine, the relative fuel consumption increases slightly.

It is technically and economically advantageous for the engine to operate at the most economical and power-producing speed specified in the speed characteristic. The speed controller automatically changes the amount of fuel sent to each engine cylinder, maintaining its specified speed.

When the engine load changes, the governor does not change the crankshaft speed. When the engine load decreases and the number of revolutions increases, the governor reduces the amount of combustible mixture or fuel sent to the cylinders, and vice versa, when the load increases, it sends more mixture or fuel up to a certain limit. Therefore, the governor is driven by the engine crankshaft and, acting on the carburetor throttle valve, changes the amount of fuel.

Engines are mainly equipped with single-mode, dual-mode and multi-mode centrifugal governors and pneumatic governors. Single-mode governors are set to the main engine mode and do not allow its rotation speed to exceed the set one, but do not operate in other modes. Such governors are installed on diesel propulsion engines and tractor engines of earlier releases.

A two-mode governor limits the engine to the lowest rpm when it is idling and the highest rpm when it is running under load, i.e. it operates in only two engine modes. A two-mode governor is used in automotive diesels.

Multi-mode regulators operate in whatever mode they are set to, that is, at all crankshaft revolutions. When a multi-mode regulator is installed on an engine, performance increases, fuel is saved, the machine becomes easier to operate, and its parts wear out less and are better maintained.

## 2. Single-mode regulators

Two bearings are hingedly attached to the splines of the gear that transmits motion from the engine crankshaft to the regulator. A sliding clutch is attached to the end of the shaft on which the gear is mounted, and the bearings, with the inner ends of the bearings inserted into its grooves, rotate together with the gear and can rotate on the axis of their splines. (Figure 39)

The clutch rotates with the governor shaft and slides on the shaft when the loads are applied. At the end of the coupling is a ball bearing, to which the lower end of a lever, which is attached by a spring, is always held.

Let's assume that the engine is operating at a specified speed. In this case, the centrifugal force of the bearings and the tensile force of the spring are balanced, and the bearings, clutch, lever, and throttle valve are in contact with each other.

When the engine's load decreases, its crankshaft and the gear that drives the governor begin to rotate faster, increasing the centrifugal force of the loads.

The load is stretched, overcoming the force of the spring and pushing the clutch to the left. The clutch begins to close the throttle valve by turning the lower end of the lever to the left and the upper end to the right. Less mixture enters the engine cylinders and the crankshaft speed decreases.

The upper end of the lever is the throttle valve in the four-wheel drive and the transmission. connected to the axis of the lid.

When the engine load is increased, the crankshaft speed begins to decrease, and the centrifugal force of the loads decreases. The spring tension forces the lever and clutch in the opposite direction, and the throttle valve opens wider. The amount of mixture entering the cylinders increases, but the crankshaft speed does not decrease.

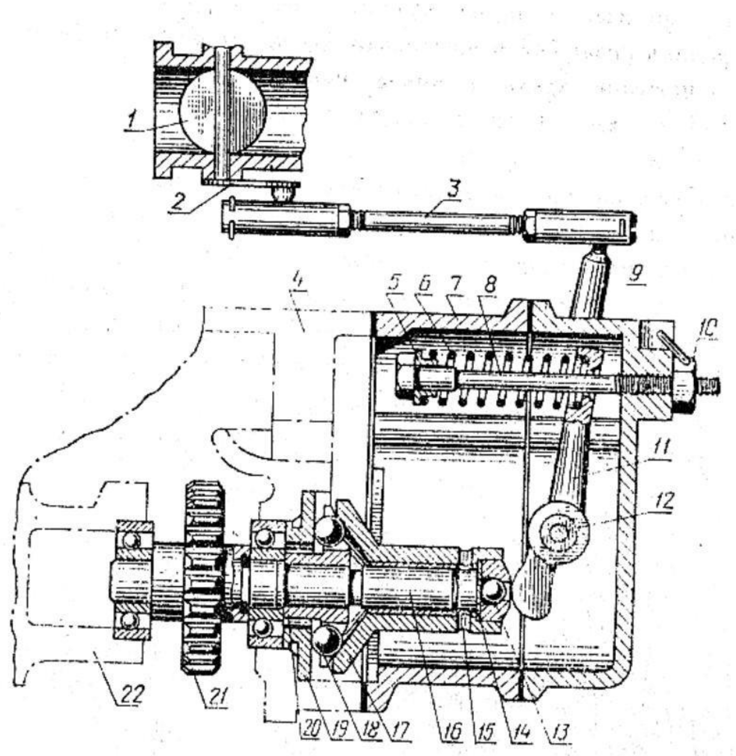


Figure 39. Scheme of a single-mode regulator 1-throttle valve cover; 2-lever; 3-plate; 4-plate; 5-spring bushing; 6-spring; 7-regulator body; 8-adjusting bolt; 9-outer lever; 10-locking nut; 11-double-arm lever 12-lever axis; 13-ball stopper; 14-washer; 15-hub hole; 16-regulator shaft; 17-moving disk; 18-ball; 19-stop disk; 20-main disk; 21-regulator gear; 22-front half of the crankcase.

Thus, a single-mode regulator maintains the nominal engine speed without changing it. By changing the tension of the regulator spring, it is possible to change the nominal engine crankshaft speed, that is, to make the regulator operate in a different mode.

### *3. Multi-mode regulators*

Multi-mode regulators also operate under the influence of centrifugal force. The main difference between these regulators and single-mode regulators is that the tension of the spring that balances the centrifugal force of the loads is adjusted by a lever on the handle. If we change the tension of this spring and move the engine to operate in a different mode, the regulator maintains the engine's revolutions in that mode.

A diagram of a multi-mode regulator is given. (Fig. 40). The regulator consists of a shaft 1, driven by the engine crankshaft through gears, a bearing 2, pivotally attached to the output of the gear, and a sliding clutch 3 mounted on the end of the shaft, which, in addition to rotating with the shaft, can also slide on it. A lever 5 is inserted into the pin 6 of the clutch and a regulator spring 7 is attached to it. The lower end of the lever 5 is pivotally attached to the accelerator lever 10 through the tail 4 and the throttle, and the upper end is pivotally attached to the fuel pump rail 9 through the throttle 8.

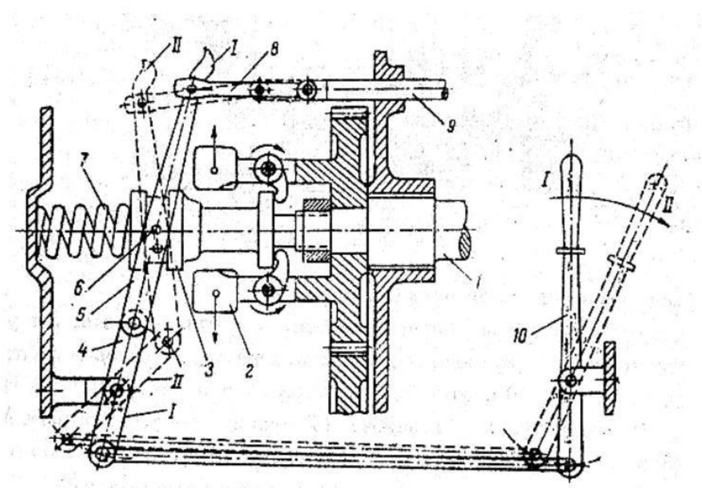

Figure 40. Schematic diagram of a multi-mode regulator.

1-shaft; 2-shaft; 3-slip clutch; 4-tail; 5-lever; 6- 8-gear; 9-rack; 10-accelerator pin; 7-spring; lever

If the accelerator lever position is not changed, the engine load
If the torque is reduced, the engine speed increases. In this case, the load 2 is stretched more, pushing the clutch 3 to the left, the clutch pushes the lever 5, pushing the rack to the left, and as a result less fuel is sent. Conversely, if the engine's load increases, its revolutions
decreases, the loads approach. The clutch spring is pushed to the right by the force of 7, and the rack is also pushes and more fuel is sent.

So, when the engine is running, the centrifugal force of the loads is always is balanced by the elastic force of the spring. Therefore, the accelerator lever
It is possible to change the speed of the diesel by setting it to different positions, and the regulator is always maintains this mode.

Some tractor diesels are equipped with a small multi-mode (RV) regulator (41-picture).

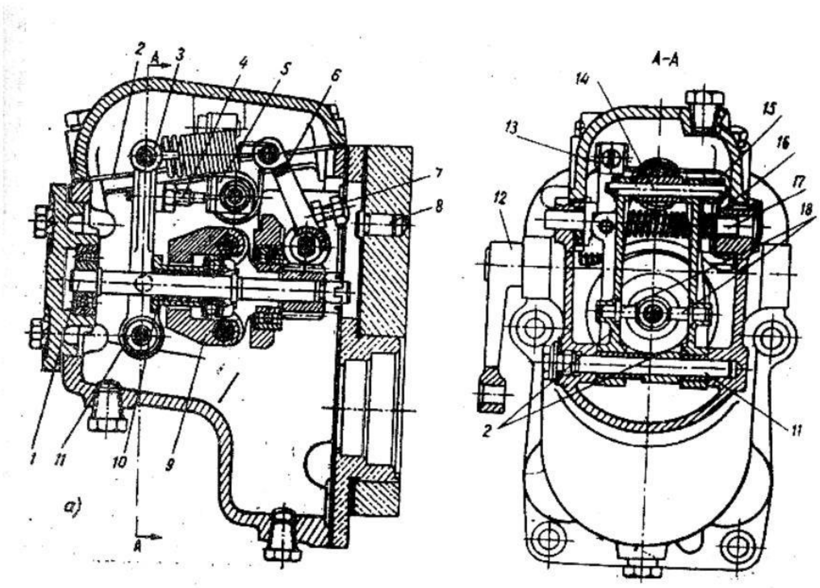

Figure 41. Multi-mode regulator (RV)

1-regulator shaft; 2, 6 and 12-lever; 3 and 16-spring; 4-screw; 5-plate; 7-bolt; 8-support; 9-luggage; 10-sliding clutch; 11th and 14th axis; 13th bracket; 15th traction; 17th row; 18-leader

Driven by a gear from the fuel pump's crankshaft
The regulator shaft 1 is fixed to the cross member. Bearings 9 are mounted on its axis.
The loads are connected to the sliding clutch 10 through a thrust bearing. The clutch acts on the levers 2 through the bushings 18. One end of the regulator spring is attached to the lever 2 and the shaft 14, and the other end is attached to the lever 6. The shaft 14 is connected to the fuel pump rail
The regulator is placed in the housing and covered with covers on the sides and top.
closed with.

When the diesel engine is not running, the lever 12 is in a position where the adjusting bolt 7 is pressed against the support 8. is pushed. When the engine load decreases, the roller 1 rotates faster. The bearings 9 are stretched, overcoming the resistance of the spring 3 and moving the clutch 10 to the left. In this case, the levers 2 are Turning around 11, the pump rail turns the four 15 to the left. As a result, the fuel
Less fuel is sent, and the engine speed decreases to the specified value.

When the engine load increases, the bearings come closer and the screw 4 moves towards the plate 5. All details return to their original state until the end.

When the engine is running under load, the regulator's corrector starts working. Corrector screw 4 screwed into the left lever 2, bracket on which the thickener shaft 17 is mounted 13 and a plate spring 5 attached to the bracket. Luggage
The spring 3 is compressed, and the screw 4 bends the plate 5.
It moves its rail and sends additional fuel.

## 4. Engine speed limiter

A car with a carburetor engine in low gear on a bad road, in good gear on a good road
The crankshaft may rotate too fast when operating in high gear. This
increases fuel consumption and leads to rapid wear of engine parts, even the transmission and causes the running parts to move at a dangerous speed. Therefore, the load
Car engines are equipped with a maximum speed limiter (single-mode regulator), which acts on the carburetor throttle valve.

The rev limiter is mounted directly on the throttle body or on the carburetor. installed between the inlet pipe and the fuel flow, and is driven by the force of the combustible mixture flow is brought, therefore it is called a limiter of the number of pneumatic revolutions.
Pneumatic maximum revolutions mounted on the carburetor throttle valve
The side of the mixed flow of the barrier valve 1 on the limiter (Fig. 42)
The other thicker side is fixed with a hook 3 and a spring 4 using a fixing nut.
It is tightened to 5. The spring tension can be changed by turning the nut and moving the bushing 6.

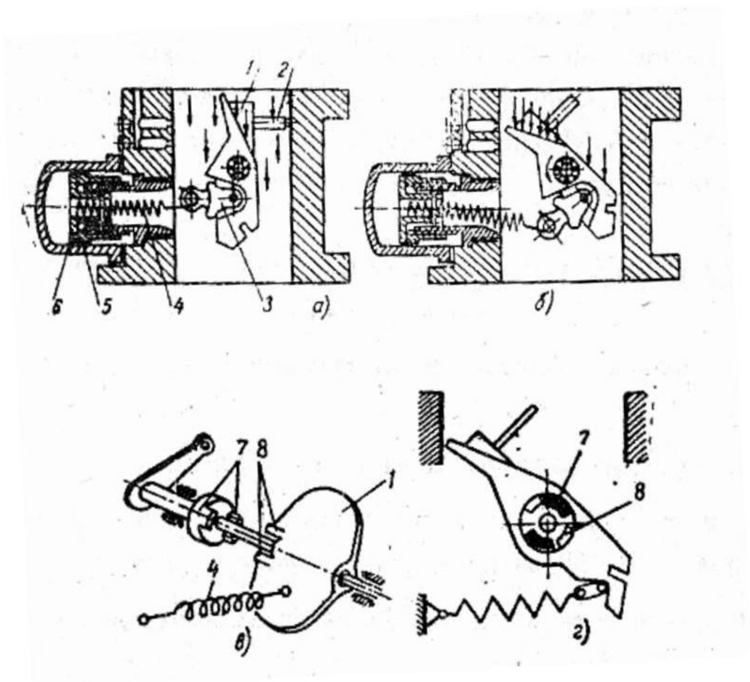


Figure 42. Pneumatic limiter of the maximum number of revolutions and its operation scheme. a-throttle valve fully open, b and g-throttle valve closed; c- scheme of transmission of motion to the throttle valve; 1-throttle valve; 2-pin; 3-hook; 4-spring; 5-locking nut; 6-sleeve; 7-knob; 8-outlet.

Spring 4 tends to fully open the valve, but pin 2 is not in the mixing chamber. It rests against the wall and restricts the opening of the barrier lid.

As the crankshaft speed increases, the mixture flow presses against the groove in the intake valve and begins to close the valve, overcoming the force of the spring. As a result, less mixture is sent to the cylinders, the engine shaft rotates more slowly, and the spring opens the valve again.

When a car is accelerating down a hill, the crankshaft speed may increase even if the throttle valve is not fully open.

## 5. Checking the governors Checking

the governor during operation consists of inspecting it, tightening its bolts and nuts, cleaning it from dust and mud, checking the oil level and changing it at the specified times. The engine speed maintained by the governor is checked.

The regulator is filled with oil of the appropriate brand up to the level of the control cover. If there is not enough oil, the parts will wear out quickly, if there is too much, the resistance to the bearings will increase, and the crankshaft of the engine may rotate too quickly before the regulator starts working in time, which often causes an accident. If the elasticity of the regulator springs changes, if the details are worn out and damaged, the set speed of the engine will change.

The regulator is installed together with the fuel pump in special workshops.

## Test questions

1. Why is it necessary to install a regulator on tractor and agricultural engines?

2. How does the regulator affect engine operation?

3. Explain how single-mode and multi-mode regulators work in different modes and how they differ from each other?

4. Why is a regulator corrector and a flow thickener needed and how does it work?

5. Explain the function, structure, and operation of the engine speed limiter?

6. How is the operation of regulators changed?

**Lecture 9: Lubrication system of tractor engines** Plan: 1. Function and

type of lubrication system.

2. Oils used for tractors and automobiles and their properties.

3. Lubrication system devices and mechanisms.

4. Control the lubrication system.

**1. The function and type of the lubrication system** When engine parts move, the roughness of their surfaces rub against each other, creating friction. As a result, the parts heat up, expand, wear out, and even seize up and fail. The more the parts move, the more the friction surfaces press against each other, and the more energy is required to overcome the friction force.

To reduce the friction force of the parts, their surfaces are made as smooth as possible, heat-treated, coated with tin, chromium and other metals, antifriction alloys are used. Sliding bearings are installed and an oil film is formed between the rubbing surfaces. In this case, the surfaces are separated from each other by an oil film, and instead of rubbing solid surfaces, they rub against particles of a liquid oil layer.

When the rubbing surfaces are separated from each other by a layer of oil, such friction is called liquid friction. In this case, the oil is viscous and the faster the parts move, the thicker the oil film, and the thinner the oil film becomes under the applied load. In both cases, a lot of effort is spent to overcome friction.

If the oil layer is squeezed out of the gap between the parts, leaving only a very thin layer of oil due to the molecular forces of the surfaces, such friction is called finite friction.

If the thin oil film of finite friction is broken, the surfaces of the parts will partially come into direct contact with each other, resulting in dry friction.

Depending on the operating conditions of the engine parts, they can be lubricated by spraying oil on them or by applying pressure. can be sent forcibly.

When splash lubrication is applied, the oil in the engine crankcase is sprayed onto the moving parts, forming tiny droplets of oil mist that settle on the rubbing parts and lubricate them. When the oil level is low, the parts are lubricated less when the movement slows down and when working on slopes, so this lubrication system is not used.

When oil is forced to the parts, it is called pressure lubrication, but it is much more difficult to supply oil to all parts of the engine under pressure. Therefore, modern engines mainly use a combined lubrication system.

**2. Oils used for tractors and cars and their properties** Oils used for engines must withstand the high pressure and high temperature that the parts are subjected to, must not ignite when mixed with hot gases, and must not leave dry or wet residue when burned in the combustion chamber. Oils in the crankcase and pipes must not liquefy or solidify in the cold. Also, the oil must not corrode the parts and must not deteriorate when stored for a long time.

The viscosity of oils changes slightly depending on the temperature of the air,
That is, it liquefies in heat and solidifies in cold.

Engine and transmission oils are made from the residual fuel oil left after the extraction of fuel oil. Engine oils are made by re-distilling fuel oil and are called distillate oils. Transmission oils are made by separating and purifying fuel oil residues and are called residual oils.

The life of an engine oil without wear depends on the design of the lubrication system, proper maintenance, and its quality. The viscosity, pour point, stability, and corrosion resistance of the oil are the main indicators that determine its quality.

Oil stability refers to the resistance of a thin layer of oil adhering to metal to oxidation and the formation of various harmful substances due to the effects of temperature and oxygen in the air.

The reason oil is not corrosive is because of the acid it contains. Acid causes corrosion and wear of parts.

The viscosity of transmission oils is 2-3 times higher than that of engine oils. The viscosity of an oil characterizes the resistance of its particles to sliding relative to each other.

The pour point of the oil is the temperature at which it becomes insoluble and is of great importance for starting a cold engine and for moving oil through the lubrication system. will be excessive. Summer transmission oils are used until the
temperature reaches 0 0C, and winter transmission oils up to minus 200 C. In extreme cold, 20-25% diesel fuel can be added to the transmission oil.

### *3. Lubrication system devices and mechanisms*

The oil pump supplies oil under pressure to the rubbing surfaces of engine parts. Gear oil pumps are mainly used in tractor and automobile engines.

The pump (Fig. 43) consists of a cast-iron housing 5, inside which are located the leading 1 and driven 2 gears. The leading gear of the pump is mounted on a roller driven by the crankshaft through the distribution gears or the worm gear of the distribution shaft. The driven gear rotates on an axis mounted in the housing. The gear teeth are in contact with the housing.

The oil pump works as follows. When the gears rotate in different directions, oil enters It enters through canal 6 and fills the space between the teeth. When the teeth bite each other, the wall of the body Oil is squeezed between the teeth and is forced out of the drive channel 3 under pressure.

The oil enters the pump through the wire mesh of the receiver 7. The float and There are fixed oil receivers. A floating oil receiver floats on the surface of the oil, It gets clean oil.

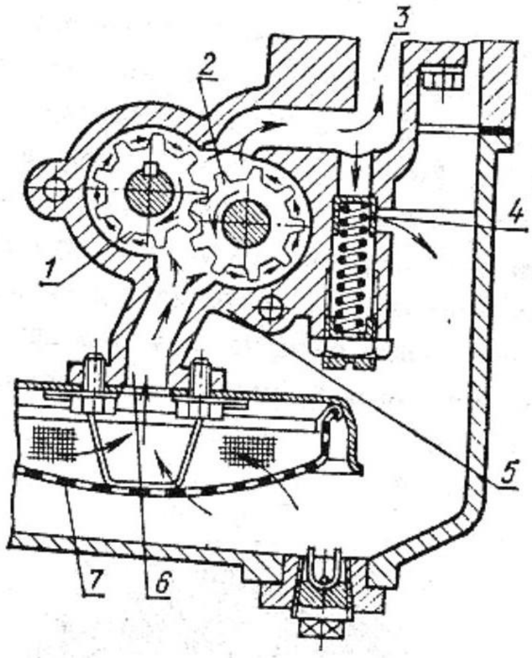


Figure 43. Oil pump operating diagram.
1-leading gear; 2-driven gear; 3-drive channel; 4-reduction valve; 5-housing; 6-oil inlet channel; 7-cable net.

To prevent the oil pressure from exceeding the specified value, a reduction valve 4 is installed on the oil pump. The valve spring is adjusted to a certain pressure. The engine When driving, the pressure is reduced more than intended when the oil is cold. The valve opens, and excess oil returns to the crankcase. The spring is compressed by the excess pressure, pushing the ball and plunger-shaped valve, and opening the oil hole through which the excess oil returns.

Most engines have a single-section oil pump, sometimes two or three-section. pumps are used.

Oil filters. To reduce wear on engine parts, add oil during operation. It is necessary to delay the wear of the oil by continuously trapping falling metal shavings, soot, tar, dust, and other contaminants.

The oil is filtered through a wire mesh as it enters the engine and passes through the pump's oil receiver. filtered, black metal shavings on the magnet in the crankcase drain plug It sticks, but the oil purified in this way cannot be considered clean enough, so For this reason, coarse and fine filters are installed in modern engines.

The rough elephants pass all the oil pumped through them, mainly into the large cleans from mechanical impurities.

Coarse filters are available in tape and plate types. When the filter element becomes dirty, The oil reservoir valve 6 is opened to allow oil to flow into the main line, and the oil enters and connects the output channels.

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Soft filters are installed in almost all tractor and some automobile engines as a soft filter in a jet centrifuge. Some tractors do not have a filter installed immediately, but only a jet centrifuge. In the first case, it is called a centrifuge connected in parallel to the main, in the second case, it is called a centrifuge connected in series.

The relative gravity of oil under the action of centrifugal force in a centrifuge It removes oxidation products and tars that are heavier than oil.

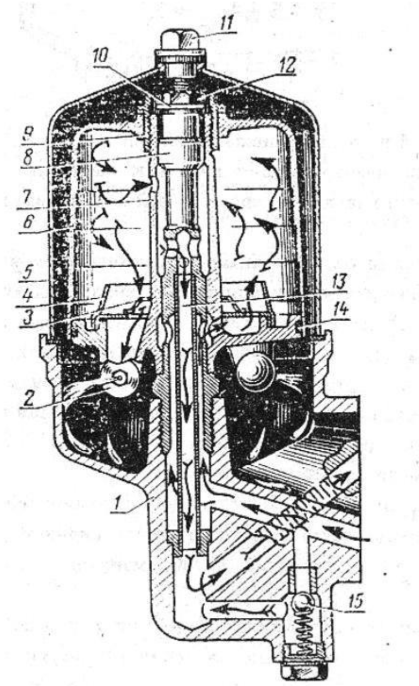


Figure 44. Reactive centrifuge.

1. centrifuge body; 2-nozzle; 3-oil screen; 4-nozzle; 5-cap; 6-rotor cover; 7-rotor base; 8-rotor shaft; 9-rotor nut; 10-washer; 11-special nut; 2-nut; 13-oil pipe; 14-ring; 15-valve.

A centrifuge (Figure 44), connected parallel to the engine oil line, consists of a rotor mounted in a filter housing that can rotate smoothly on a vertical axis and cleans part of the oil discharged by the pump.

The rotor housing and its cover are made of aluminum alloy and are fastened together with two bolts. Two bronze bushings are pressed into the hollow support in the middle of the housing, the axis of which rotates. Two steel tubes are pressed into the housing. The housing is closed with a cover. The cuts in the upper part of the tubes are closed with wire mesh caps. The lower ends of the tubes are connected to channels drilled perpendicular to the rotor housing. At the ends of the channels there are nozzles with calibrated holes.

The centrifuge works as follows. A small part of the oil from the oil pump passes through the vertical and radial channels of the shaft into the rotor housing. Then it passes into the tube and from there to the nozzles, where it flows out with force through their holes. The pressure of the flowing oil forces the rotor to rotate in the opposite direction to the direction in which the oil flows.

Oil radiators - on hot days and when the engine is running hard, the oil temperature rises above the target, liquefies and reduces its viscosity, details

The oil film on the surface disappears. As a result, wear of parts and oil consumption increase. To prevent this, a special oil radiator is installed in the lubrication system.

The oil radiator is installed in front of the water radiator and reduces the temperature of the oil by 10-120 with the air flow generated by the fan . Some cars also use oil radiators that are cooled by the water flow in the cooling system.

In this case, the oil is not only not cooled, but also heated when its temperature is lower than the temperature of the water in the cooling system.

The oil radiator (Fig. 45, a) installed in front of the water radiator consists of a core assembled from round or oval tubes, upper and lower tanks. Cooling plates are welded to the surface of the tubes or tapes are installed. The lower tank is separated by a barrier 6. Oil enters the radiator through a pipe from the oil pump or oil filter and fills the volume of the lower tank up to the barrier. Then it rises through part of the tubes and fills the upper reservoir. From the second half of the tubes, the oil is directed to the lower tank and from there through a pipe to the oil main.

A special tap was installed to prevent oil from flowing into the radiator on cold days, and it was closed. or a self-operating automatic valve is installed.

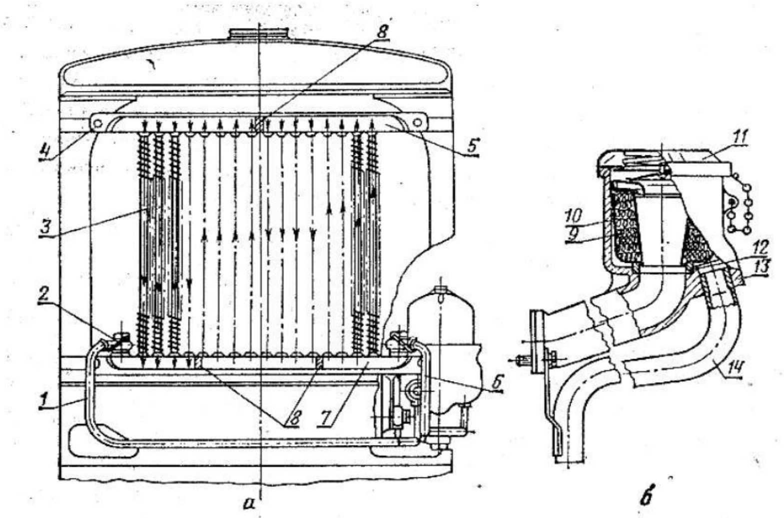


Figure 45. Oil radiator and soap.

a-oil radiator; b-soap; 1-exhaust oil line; 2-hole; 3-pipe; 4-bolt; 5-upper tank; 6-inlet oil line; 7-lower tank; 8-barrier; 9-plug; 10-cassette; 11-cap; 12-ring; 13-housing; 14-gas outlet pipe.

### *4. Checking the lubrication system*

For the lubrication system to function properly, it is necessary to use recommended oils for each engine depending on the season. Checking the lubrication system consists of checking the oil level in the crankcase, monitoring the oil pressure and temperature in the system, washing the centrifugal and coarse filter elements, replacing the fine filter elements, and renewing the engine oil.

The oil level in the crankcase is measured 15-20 minutes after the engine has stopped. If necessary, oil is added to the upper mark on the dipstick. Adding oil above the mark causes soot to accumulate on the piston rings, sticking to their grooves, and excessive oil consumption.

If the piston rings are stuck in the piston grooves, the rings and other parts are corroded, or the piston ring seal is damaged, the oil will burn along with the combustible mixture.

If the oil seals and gaskets are not tight, oil will leak. In both cases, the oil in the crankcase will quickly decrease, resulting in excessive waste.

If the coarse filter is clogged, the oil flows into the main without being cleaned and cooled, which causes the oil temperature to rise. The coarse filter and centrifuge are cleaned and washed at regular intervals. The oil in the engine crankcase is drained and replaced with new oil.

*TEST QUESTIONS* 1.

Why is it necessary to lubricate engine parts and how are they lubricated?

2. What is meant by fluid, semi-fluid, finite, and dry friction?
3. Describe transmission oils?
4. What mechanisms and devices are included in the engine lubrication system and how are they located?

5. How is the oil pump constructed and how does it work?
6. How are ribbon and plate coarse filters constructed and how do they work?
7. How do soft toys work?
8. Describe the structure and operation of an oil radiator?
9. What are the tasks involved in monitoring the lubrication system?

## Lecture 10: Cooling system of tractor engines.

*Plan:* 1.

Function and types of cooling systems.

2. Structure and operation scheme of the cooling system.
3. Structure of the elements of the cooling system.
4. Control the cooling system.

### *1. Function and types of cooling systems* In

order to make the most of the thermal energy in an engine, the temperature of its cylinders, combustion chamber, pistons, and other parts must be at the most comfortable level.

If the engine overheats, less fuel enters the cylinders, the oil becomes thinner and its viscosity decreases, the mixture burns before the spark is ignited, and engine parts expand excessively and seize up. If the engine is overcooled, the oil viscosity increases, a high-quality fuel mixture is not formed and the mixture does not burn completely, the fuel turns into droplets and dilutes the oil. In both cases, engine parts wear out quickly.

The cooling system consists of mechanisms and devices that cool engine parts, and modern engines are cooled by air or water.

When the engine is air- or water-cooled, each cylinder is made separately, and the cylinder and head walls are ribbed. The cylinders are cooled by the air flow that blows through the engine during operation or by the air flow generated by a fan.

Air-cooled engines do not have radiators, water jackets, or water pipes.

Most tractor and automobile engines are water-cooled. In this case, the cylinder and head walls are made of two layers, and cooling water circulates in the space between them (water jacket). When the engine is water-cooled, the details are more

It does not heat up. It is possible to leave a smaller gap between the cylinder and the piston, which reduces oil consumption.

The water cooling system, depending on the water circulation method, can be thermosiphon or forced water. divided into convertible systems.

### *2. Structure and operation scheme of the cooling system*

In a thermosiphon cooling system (Fig. 46, a), water circulates based on the difference in relative weights of cold and hot water in the system. When the engine is running, the water in the water jacket of the cylinder heats up and its density decreases, so it rises through the upper short pipe and goes to the radiator. Under the influence of the air flow created by the fan in the radiator, it cools down and its density increases, and the water enters the jacket through the lower short pipe, lifting the hot water upward.

An engine with such a cooling system heats up faster after starting, the speed of movement of the cooling water depends on the engine load, that is, the higher the load, the more the water heats up and moves faster. However, since the water moves relatively little, the capacity of the cooling system is larger. As a result, the weight of the engine increases, and if the water level decreases, the engine will not be cooled. The thermosiphon cooling system is used only in tractor drive engines.

The forced water cooling system (Fig. 46, b) is used in most tractor and automobile engines, and the water is pumped from a centrifugal pump. This pump sucks the water cooled in the radiator and pumps it into the water jacket of the cylinders, while the water heated in the jacket enters the radiator under pressure through a short pipe at the top.

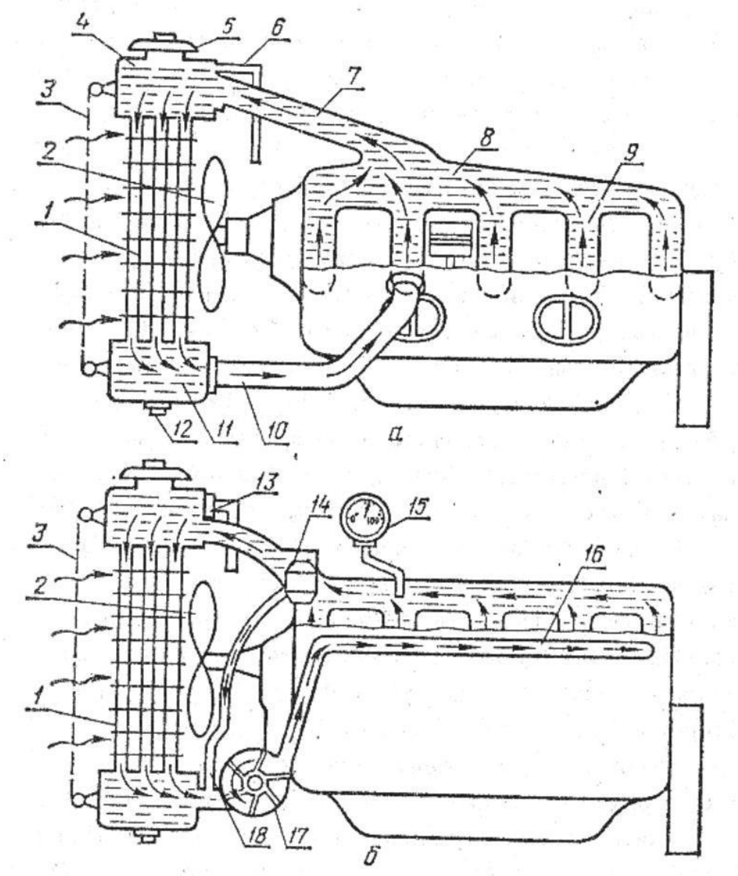


Figure 46. Schemes of water cooling systems. a-thermosiphon cooling system; b-forced water circulation cooling system; 1-radiator; 2-fan; 3-curtain; 4-upper radiator tank; 5-cap; 6-pipe; 7-short upper

pipe; 8-cylinder head; 9-block crankcase cover; 10-lower short pipe; 11-lower radiator tank; 12-water drain hole; 13-steam-air valve; 14-thermostat; 15-thermometer; 16-distribution channel; 17-water pump; 18-pipe.

The faster the engine crankshaft rotates, the faster the pump and fan rotate, cooling the engine more rapidly. To prevent the engine from overheating, the front of the radiator is covered with a blind or curtain, and a thermostat is installed on the short upper pipe.

Until the engine is warm enough, the thermostat returns the water to the pump through a pipe, without passing it to the radiator.

If a pipe with an open end is installed above the radiator, allowing water vapor to escape into the atmosphere, it is called an open cooling system. If the cooling system is isolated from the atmosphere by a special steam-air valve, it is called a closed cooling system.

### *3. Structure of cooling system elements*

The radiator (Fig. 47, a) consists of an upper tank 1, a lower tank 6 and a core 3, which cools the water by dissipating the heat of the water into the air through the walls of the tubes. The core is assembled from several rows of brass tubes and plates. The tubes are round or elongated in cross-section (Fig. 47, b). To increase the cooling surface and make the tubes stronger, thin brass plates 8 are inserted into them and welded.

The radiator cores are bolted or welded to the tanks.

The radiator's water inlet is closed with a plug 2. The lower tank has a drain cock 4. The upper 7 and lower 5 short pipes connect the radiator to the water jacket of the engine head and block.

The thermostat (Figure 48) maintains the temperature of the water in the cooling system within a certain range and accelerates the heating of the water. The thermostat consists of a main valve and an auxiliary valve mounted on a short pipe with a body made of corrugated brass cylinder rod.

A small amount of a readily evaporating liquid - a solution of ethyl alcohol in water - is poured into the cylinder, which is sealed with gypsum. Some engines use thermostats filled with a solid substance.

When the water in the system is cold, the cylinder is compressed, the main valve closes the thermostat housing housing, preventing water from passing through the upper short pipe. In this case, the auxiliary valve is open, and water enters the channel through the holes in the thermostat housing and returns to the water pump from there, that is, it moves in a small circle. When pouring water into the system, a small hole is made in the main valve to release air from the water jackets.

The fan creates an air flow. The fan consists of four or six blades attached to a hub. The hub is mounted on a water pump housing and rotates on two ball bearings. The hub pulley is rotated by one or two PoniSimon shear bands.

The fan belt is tensioned by turning the tension roller mounted on the bracket or by lifting the bracket on which the fan pulley is mounted. The water pump

forces water into the cooling system. In tractor and automobile engines, a centrifugal type water pump is mainly used. The water pump (Fig. 49) is a cast iron housing mounted on the engine block crankcase through a water pump.

A fan consists of a blade that rotates with a shaft attached to the hub.
A small notch is installed on the shaft to prevent water from leaking out through the gaps in the pump.

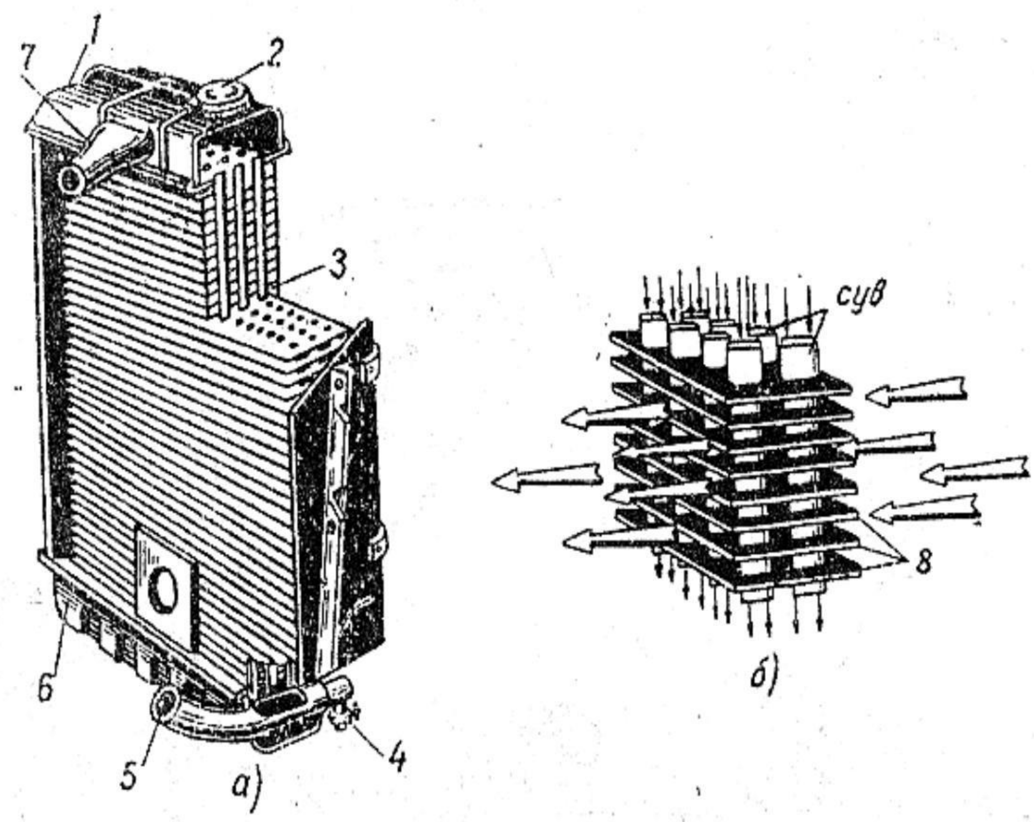


Figure 47. Radiator and its pipes. a-radiator; b-elongated cut pipes; 1-upper tank; 2-plug; 3-core; 4-draining tap; 5-lower short pipe; 6-lower tank; 7-upper short pipe; 8-brass plates;

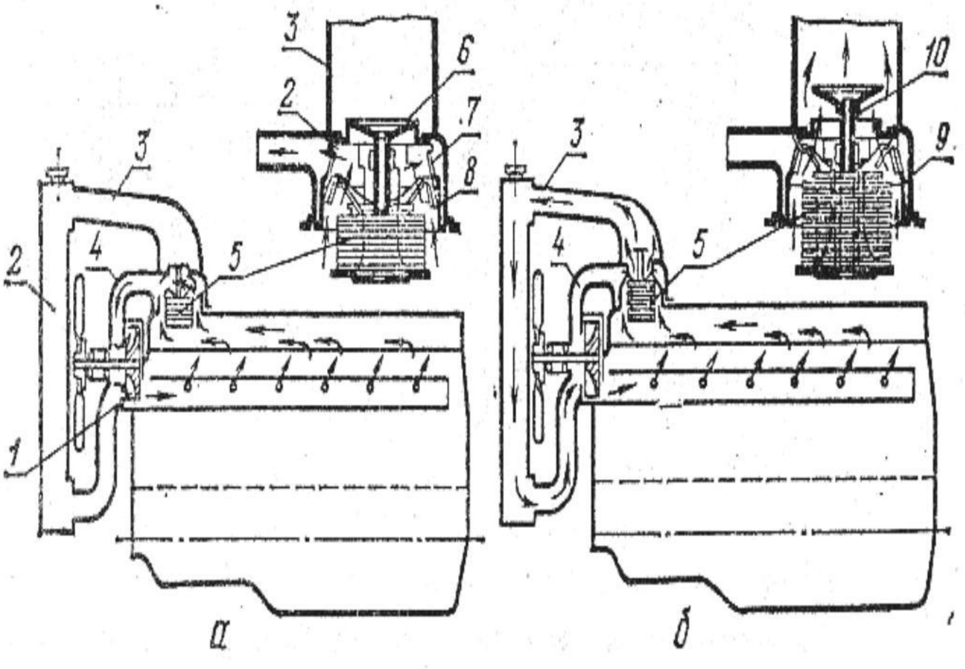


Figure 48. Thermostat and its operating diagram.

a-water movement along a small circle; b-water movement along a large circle; 1-water pump; 2-radiator; 3-pipe; 4-pipe; 5-cylinder; 6-main valve; 7-hole; 8-auxiliary valve; 9-thermostat housing; 10-rod;

.

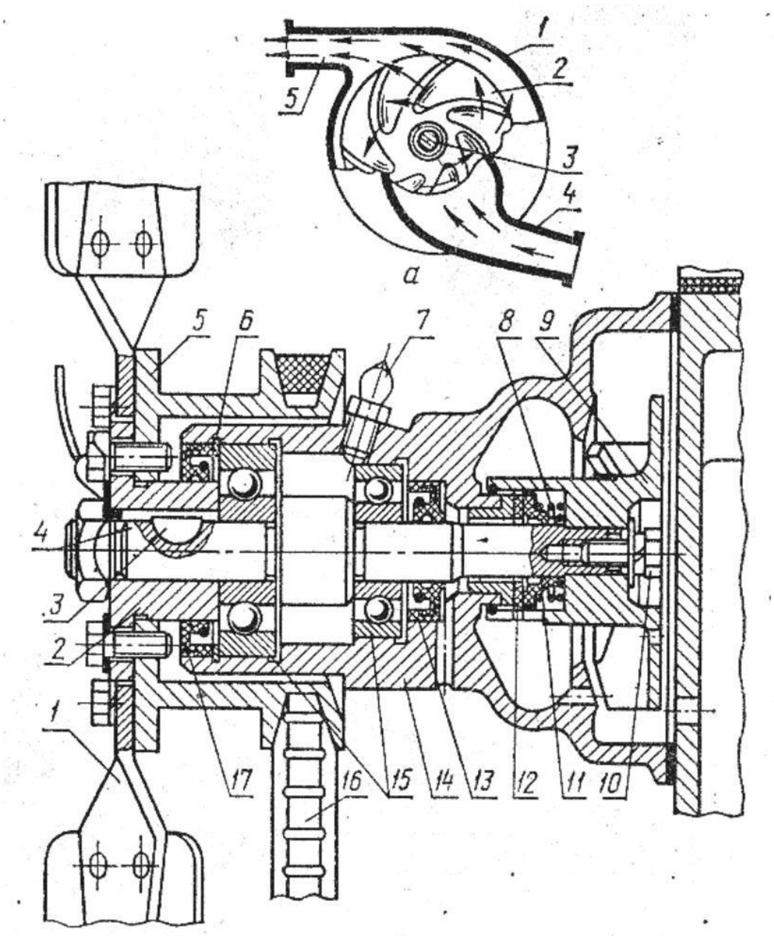


Figure 49. Centrifugal water pump.

a-pump structure; 1-pump housing; 2-vane; 3-shaft; 4-and-5-pipe; b-water pump and fan; 1-fan; 2-hub pulley; 3-nut 4-water pump shaft; 5-pulley; 6-ring; 7-lubricating point; 8-sal nick spring; 9-pump vane; 10-bolt; 11-gasket; 12-sal nick washer; 14-pump housing; 15-ball bearing; 16-belt; 17-sal nick.

The operating diagram of a centrifugal pump is presented (Figure 49, a). Water comes in through a short pipe in the middle of the housing. The impeller, which rotates with the shaft, drives the water into the pump housing under the influence of centrifugal force, forcing it into the cooling system. The water is distributed to the casings through a pipe located perpendicular to the water pump housing.

### *4. Control the cooling system.*

Checking the cooling system includes adding water, tightening fan belts, tightening loose parts, stopping water leaks, lubricating the fan and pump, and cleaning the cooling system from debris. In an air-cooled system

The wire mesh through which air enters the fan and the cooling fins of the cylinders are cleaned.

If the thermostat is not working properly, or if blinds or curtains are not used in time, the engine will not warm up sufficiently.

Always fill the cooling system with clear, clean water. Do not allow water to leak or reduce its level.

When checking and tightening loose parts of the cooling system, it is necessary to inspect the radiator, hoses and clamps, water pipes and water pump seals, fan, and tensioner pulley.

The tension of the fan belt is checked by pressing it with your thumb or by hanging a stone on the end of the blade. The belt should bend 15-20mm when pressed in the middle with a force of 3-4kg in car engines and 5-7kg in tractors.

To flush the coolant system, a mixture is prepared by adding 100g of baking soda and 50g of kerosene to 1 liter of water. The cooling system is filled with this mixture and left for 10-12 hours. Then the engine is started and used at high speed for 10-15 minutes, after which the mixture is drained, and then the cooling system is flushed with clean water. On cold days, it is necessary to heat the water and pour it into the engine.

To check if the thermostat is working properly, it is tested by placing it in water.

*TESTS AND QUESTIONS I.*

1. Why is it necessary to cool the engine?
2. How are tractor and car engines cooled? How do the cooling methods differ?

3. How to check and adjust the correct operation of the cooling system.
4. What are the reasons why an engine can overheat or underheat?
5. What parts are included in the cooling system?
6. What tasks are performed when monitoring a cooling system?

## ***Lecture 11:*** **Ignition and propulsion system.**

*Plan:*

1. Fuel combustion methods and combustion time.
2. Magneto ignition system. Magneto structure and operation.
3. Battery ignition system.
4. Transmission system of tractor and automobile engines.
5. Power transmission parts of the drive system.
6. Control the ignition and propulsion system.

### ***1. Methods of fuel combustion and combustion time.***

In piston internal combustion engines, fuel is burned in the following ways.

Combustion from the heat generated by air compression is used in tractor and automobile diesel engines. Due to the high compression ratio of the engines (13-20), the air drawn into the cylinder heats up to (500-6500) at the end of the compression stroke.

The fuel, sprayed into fine particles by the nozzle, ignites upon contact with the heated air.

Electric spark ignition. Used in carburetor and gas engines. This system consists of a power source, a spark plug, and a wire connecting them. The power source may be a special device that generates high-voltage current (magneto ignition) or a low-voltage power source and a device that converts the source current to high-voltage current (battery ignition).

Improper installation or adjustment of the ignition system components can cause the mixture to ignite too early or too late. The spark plug is screwed into the engine head and creates an electric spark to ignite the compressed working mixture in the combustion chamber. The spark plug works by withstanding the effects of high temperature, high pressure, electric spark and other chemical substances in combustion. There are detachable and non-detachable spark plugs.

A non-separable spark plug (Fig. 50) consists of a metal housing with side electrodes and a ceramic insulator with a central electrode. The insulator is inserted into the housing with a clamp and a compression ring is installed on it. A sealing gasket is placed on the insulator to ensure the insulator is firmly attached to the housing and the spark plug is firmly installed. The high-voltage wire is attached to the spark plug by means of a ferrule, or the wire ferrule is screwed in and tightened with a n

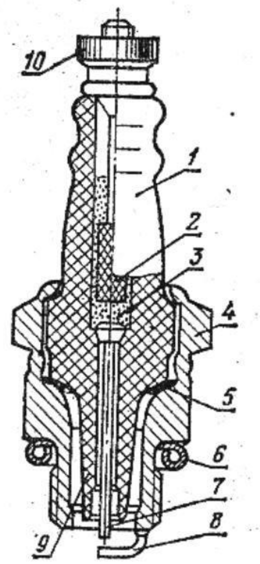


Figure 50 Spark plug

1-insulator; 2-contact rod; 3-conductor; 4-body; 5-gasket; 6-sealing ring; 7-central electrode; 8-side electrode; 9-heating body; 10-nut.

***2-Magneto ignition system. Magneto structure and operation***

A magneto-magnetic electric machine generates low-voltage alternating current, converts it into high-voltage current, and in multi-cylinder engines distributes the high-voltage current to the spark plugs according to the order of operation of the cylinders.

A magneto (Figure 51) consists of a housing with two pole pieces, a rotating magnetic rotor, an induction coil, a spark plug, and a capacitor.

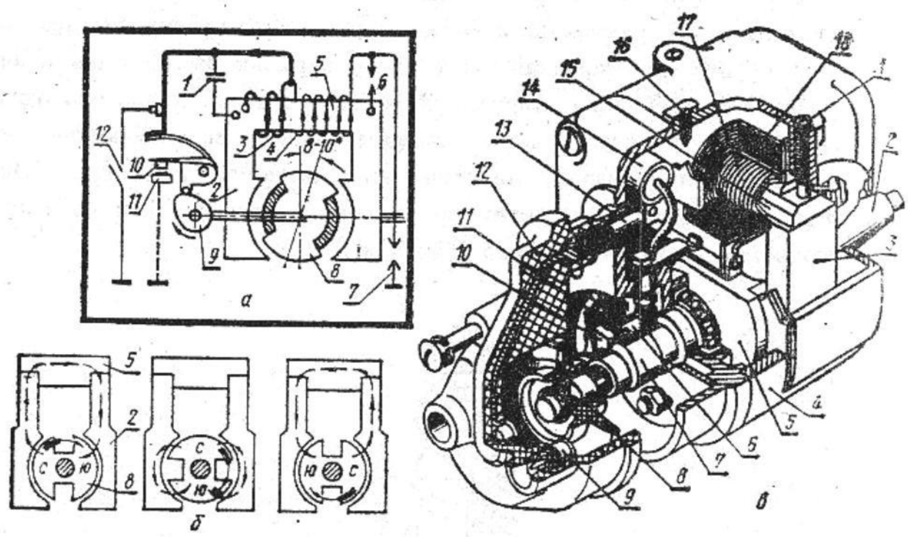

Figure 51. Magneto and its circuit.
a)-magnet circuit; b)-magnet operation circuit; 1-capacitor, 2-stand, 3-primary winding, 4-secondary winding, 5-core, 6-fuse, 7-spark plug, 8-rotor-magnet, 9-fist, 10-moving contact, 11-non-moving contact, 12-ignition vklyuchateli; v)-magneto structure: 1-screw, 2-shaft, 3-rack, 4-case. 5-magnetic rotor, 6-stand, 7- fist, 8- ball, 9- electrode, 10- lever, 11- movable contact, 12-distributor cap, 13-tocoiler, 14-condenser, 15-core, 16-storage, 17-primary winding, 18-secondary winding.

The magneto housing is made of aluminum alloy. The rotor shaft is located in the housing with two rotates in a ball bearing.

Induction coil, core mounted on pole pieces, primary wound around it Consists of a primary and secondary primary.

The capacitor is connected in parallel with the primary coil, with one end connected to ground, and the other end is attached to the switch.

The switch has a movable contact connected to the ground, an insulated fixed contact consists of a contact and a disk with contacts mounted on it. The contacts are pressed together by a spring. The fist separates them.

The magneto rotor is driven by the engine crankshaft via gears. The generation of current in the primary coil is due to the phenomenon of electromagnetic induction. founded.

When a magnet rotates and its poles face the pole, the magnetic field is directed north. from pole to south pole, the left pole of the housing, to the induction coil itself and passes through the right pole socket. When the magnet is rotated a quarter of a circle from this position In the neutral state, the rotor's magnetic field is the lower part of the housing pole pieces. passes through the coil core and does not pass through the coil core. When the magnet rotates another quarter turn, the rotor The poles again face the steps, but with respect to the previous one The magnetic field that appears in the core due to the change of position is also the direction changes.

### *3. Battery ignition system*

The battery ignition system is used in carburetor automobile engines. Figure 52 shows a diagram of the ignition system of a V-shaped eight-cylinder engine. This system consists of a low-voltage power source - a battery or generator, an ignition coil, a capacitor circuit breaker, a distributor, spark plugs, an ignition switch, and low and high voltage wires.

The current from the battery to the primary winding of the ignition coil high voltage circuit breaker using a low voltage circuit breaker and capacitor The distributor transfers high voltage current to the engine cylinders. The spark is generated in the combustion chamber and the The mixture ignites. The switch cuts off the low-voltage circuit and stops the engine. turns off.

The ignition coil converts low (12V) voltage into high (15-20 thousand V) voltage. The ignition coil consists of a core, a primary winding, a secondary winding, a carbolite cover, external terminals, additional resistance, and a tin sheath.

A cardboard tube is placed on the core of the reel, which is made of tin sheets, and its A secondary winding with 16-23 thousand turns is wound over it. The secondary winding is wound over A primary coil of 300-330 coils is wound, and they are insulated from each other with a paper and cardboard tube.

Additional resistance when the starter circuit is connected while cranking the engine is disconnected from the primary circuit. At small revolutions of the crankshaft, the switch contacts are in contact with each other for a long time, so the primary winding As more current flows through, the additional resistance wire heats up and its resistance increases, causing the primary from overheating the switch and sparking between the switch contacts keeps.

At high engine speeds, the breaker contacts close briefly, creating additional Less current flows through the resistor, it does not heat up and its resistance does not increase, which is the secondary Ensure that the ignition system generates sufficient voltage and is reliable. allows it to work.

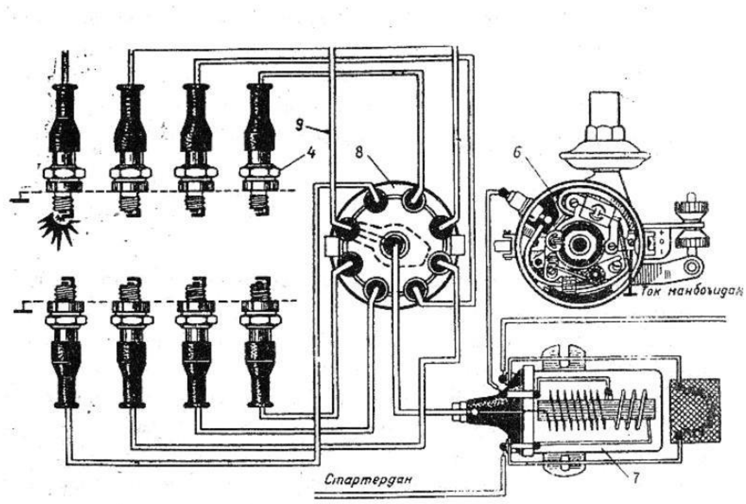


Figure 52. Eight-cylinder engine with cylinders arranged in a V-pattern Battery ignition system diagram.

The switch-distributor (Fig. 53) is located on the secondary winding of the ignition coil. It distributes the high-voltage current to the engine spark plugs. low voltage circuit breaker, capacitor, ignition advance center exhaust vacuum regulators, octane correctors and high voltage current consists of a distributor.

The switch is a fixed disc placed in a cast iron housing, with a consists of a movable disk mounted on a ball bearing. A movable disk The switch contacts are placed on it. The switch and the actuated contact disc attached to a vibrating lever mounted on a finger, isolated from the mass and the primary winding of the ignition coil is attached to the connecting terminal. The fixed contact of the switch is connected to ground.

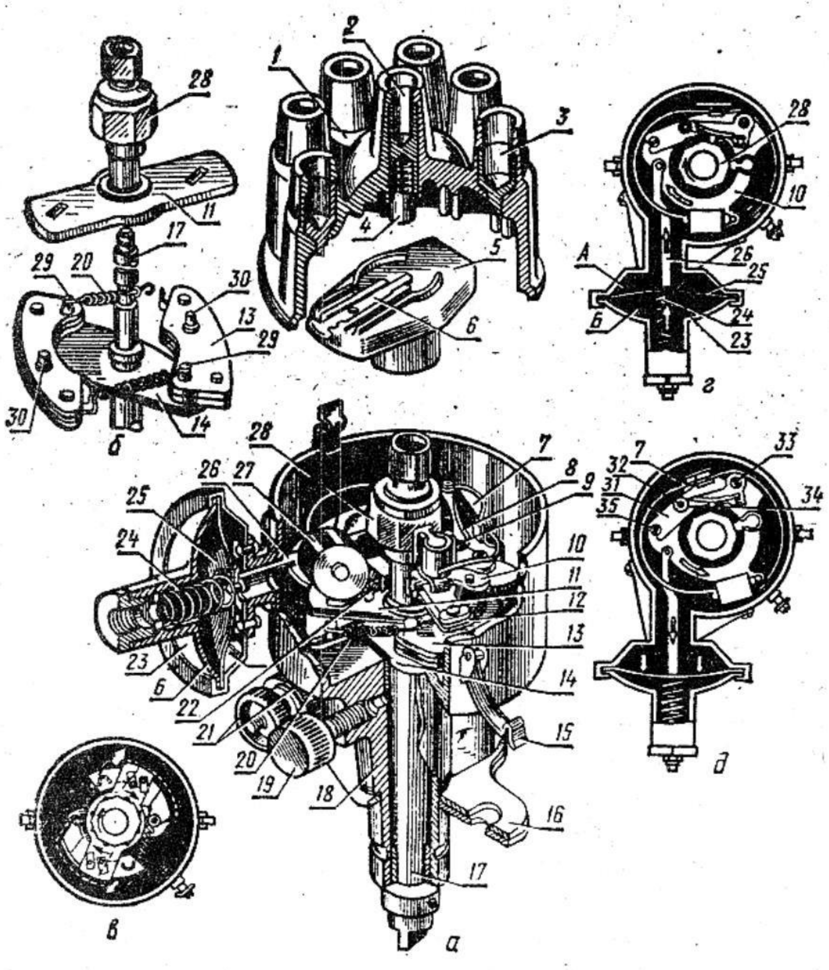

Figure 53. Switch-distributor.

a)-switch-distributor, b)-center-controlled regulator, c)-center-controlled exhaust regulator working diagram, g)-state of vacuum regulator details, d)- The details of the vacuum regulator are in the state of changing the ignition angle. 1st distribution cover; 2-ignition coil wire outlet; 3-wire connection to the spark plug; 4- contact; 5-distribution rotor; 6-distributing plate; 7-plate spring; 8- lever contact; 9-fixed contact; 10-moving contact; 11-center 12-fixed disc; 13-carrier; 14-centerless guide plate; 15-distribution cover

fastener; 16-octane corrector; 17-roller; 18-body; 19-field; 20-bag spring; 21-octane corrector adjustment nut; 22-ball bearing; 23- vacuum regulator housing; 24-vacuum regulator spring; 25-vacuum-

regulator diaphragm; 26-vacuum regulator bushing; 27-condenser; 28-
punch puck; 29-bullet bag; 30-load pin; 31st bracket; 32-os; 33rd screw; Textolite 34;
35th eccentric.

The capacitor is connected in parallel to the circuit breaker contacts. The capacitor is enclosed in a metal casing. located and fixed to the surface of the switch-distributor housing, its structure and The operation is similar to that of a magneto capacitor. The shaft of the switch-distributor is the shaft of the oil pump. It is driven by a lever.

The distributor is placed on the breaker and consists of a metal plate rotor that distributes the current and consists of a cap with a terminal. The rotor and cap are made of carbolite. Rotor sleeve It is attached to a bushing on the drive shaft and rotates with it.

The eccentric regulator is mounted under the fixed disk and is attached to the shaft. A load pin mounted on a fixed plate and pulled by springs It consists of a traverse that enters.

The vacuum regulator that advances the ignition timing adjusts the ignition advance angle. automatically changes depending on the engine load. The engine is small When working under load, the cylinders are not cleaned well from the used gas and the work The mixture burns slowly because of the high amount of gas used in the mixture. The vacuum regulator is mounted on the surface of the switch-distributor and consists of a housing, cover, diaphragm, spring, and valve.

When the throttle valve is opened slightly and the engine is running at low load in the mixing chamber and the vacuum regulator chamber connected to it The diaphragm overcomes the elasticity of the spring with the force of atmospheric pressure and, by means of a lever, moves the actuated disc of the switch, causing the rotation of the handle. As a result, the combustion advance angle increases.

*4. Drive system of tractor and automobile engines.*

Friction of various mechanisms and systems when driving engines overcoming resistance, generating kinetic energy in rotating parts and in cylinders The crankshaft is driven with a certain force and a certain speed to compress a combustible mixture or air. It is necessary to rotate at a speed. This rotation speed is the number of revolutions during the drive. The colder the air, the more and larger the cylinders, and the The higher the compression ratio of an engine, the more force it takes to turn the crankshaft. It takes a lot of effort.

Engines can be started manually, by electric starter or by auxiliary engine. can be sent.

When the engine is started by hand, the pin at the end of the starting lever The crankshaft is rotated by engaging the groove of the ratchet at the end of the crankshaft. Carbureted Engines can be turned and driven manually.

When the engine is started with a starter, the starter's drive shaft The pinion gear engages with the flywheel's toothed flange and rotates the crankshaft. This is the most This is a very common method and is used in all cars (Figure 54).

The propulsion system with an auxiliary gasoline engine consists of a propulsion engine, a power transmission, a decompression mechanism, and diesel heating devices.

The propulsion engine is the power source that turns the diesel crankshaft. Power
The transmission part transfers the rotational motion of the engine crankshaft to the shaft of the diesel engine.
The decompression mechanism removes the compression in the diesel cylinders, i.e.
Makes it easier to turn the crankshaft.

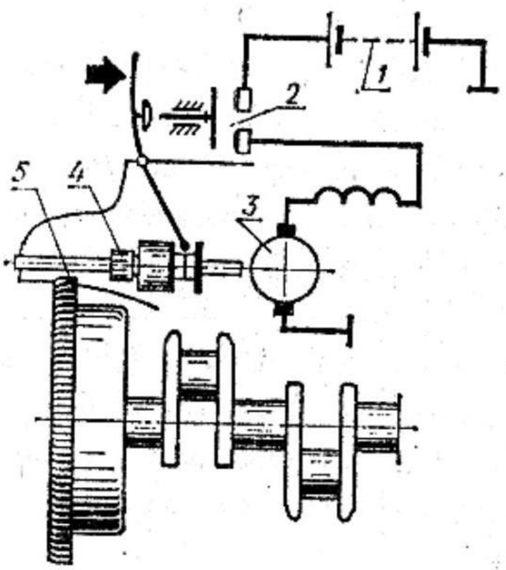


Figure 54. Electric starter drive scheme. 1-battery; 2-switch; 3-electric starter; 4-starter pinion gear; 5th flywheel gear.

To start carburetor engines, it is enough to rotate the crankshaft at a speed of 40-50 times per minute.

To run carburetor engines, a rich mixture and strong
It is necessary to create a spark. To facilitate the start-up, a supply system
Mixture thickening devices: skimmer, gasoline pump, and
An airlock is installed. To make diesel engines run, air is drawn into the cylinders.
heating the sprayed fuel to a temperature where it ignites and then spraying the fuel into small
It is necessary to clean and mix it with air. When driving a diesel engine, the crankshaft is sufficient.
If the engine is not running at high speed, the compression stroke is lengthened, heat is distributed to the cylinder walls, and compression
At the end of the stroke, the temperature is low and the fuel is refined, as well as the mixture.
The production process deteriorates. Therefore, when driving and sending diesels,
The shaft must be rotated at a speed of 200-300 times per minute.

Heating the water in the cooling system and the intake air when driving diesel engines,
It is also useful to improve fuel ignition.

### *5. Power transmission parts of the drive system.*

The power transmission parts connect the crankshaft of the propulsion engine to the shaft of the diesel engine.
It connects and transmits motion, and after the diesel is driven, the motion is transmitted
The power transmission parts: clutch, reducer and drive.
consists of a sending mechanism.

The clutch (Fig. 55) connects the crankshaft of the drive engine to the crankshaft of the diesel engine.
gradually engages and disengages from the crankshaft. This is a multi-disc, wet-type, temporary clutch

It is a clutch with five leading gears rotating with a drum of 3 gears.
disc 4, five driven discs 5 rotating together with the clutch shaft 1, a support disc 2, a compression disc 6, a compression mechanism, and a brake.

The clamping mechanism consists of three clamping jaws 7, a separator 9, and a control lever 10 mounted on a crosspiece 8. The crosspiece is mounted on a groove on the coupling shaft. The brake housing 11 is mounted on a fixed disc 13 and a shaft 1 together with
consists of two rotating discs 12 mounted on a rotating hub.

Some tractors do not have a gearbox in their drive system, so the movement
The power from the engine is transmitted directly to the drive mechanism through a clutch.

The propulsion mechanism is driven before the diesel engine is started.
engages its gear in the flange of the diesel engine and the diesel engine operates independently automatically disengages the drive gear when it is gone. Drive
The mechanism (Fig. 56) consists of a handle 9, two bolts 4 mounted on the axles fixed to it, a double spring 6, a pusher 10, a guide bushing 11 and a transverse spring 3.
The drive pinion 7 is attached to the hub with the pusher bolts.
The spring 6 and the pusher 10 are inserted into the gearbox output shaft 5, and a guide bushing is screwed onto the threaded rod at the end. This bushing
ensures the movement of the pusher and the extension of the spring.

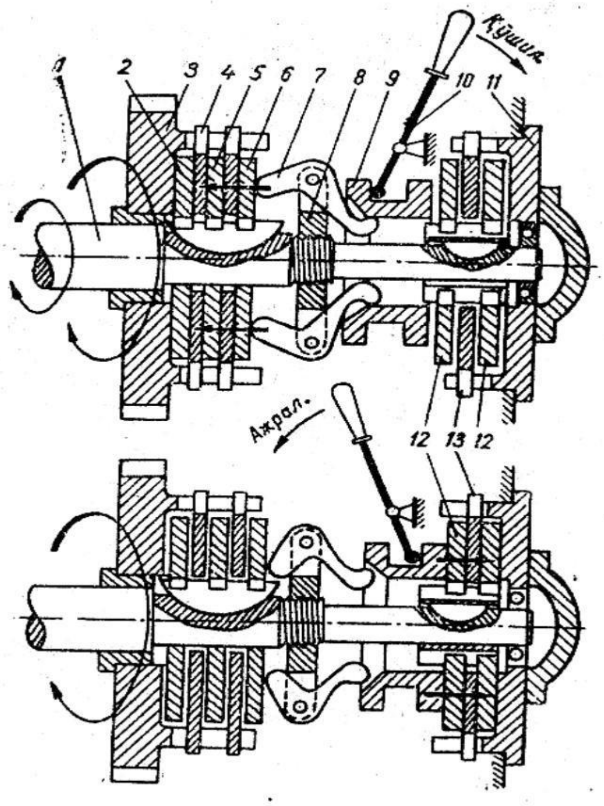


Figure 55. Operating diagram of the drive system clutch.
1-clutch shaft, 2-thrust disk, 3-gear, 4-driving disk, 5-driven disk, 6-compression disc, 7-compression punch, 8-crosshead, 9-extension, 10-control lever, 11-housing, 12-rotating disk, 13-fixed disk

The compression is achieved when the engagement lever 12 of the drive mechanism is pressed down and turned.
The lever 1 presses the lever, pushes the handle and moves the drive gear to the flywheel.
The flange is threaded to 8 (Fig. 56, a).

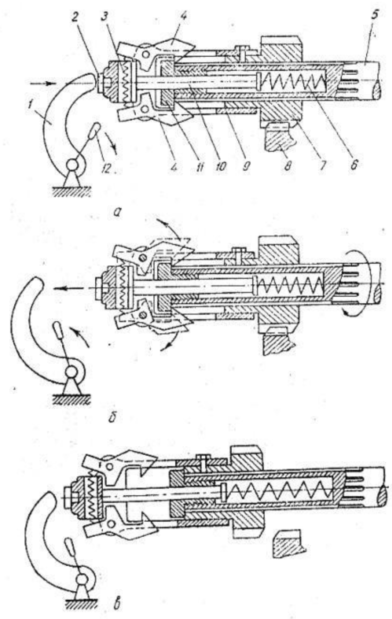

Figure 56. Operating diagram of the automatic transmission mechanism.
a)-drive gear is added; b)-centrifugal of the luggage
The driving gear is starting to separate from the force of the driving force; v)-driving
The transmission gear is separated; 1-lever, 2-support, 3- and 6-springs, 4-bag, 5-shaft, 7-drive gear, 8-flywheel flange, 9-handle, 10-pull, 11-guide bushing, 12-injection lever.

If the clutch is engaged while the drive motor is running, the drive
The transmission gear starts to rotate the flywheel. Gearbox, decompression
Using the engine and other tools in the appropriate order, the crankshaft of the diesel
When rotated at cruising speed, the diesel ignites (Figure 56, b).

*6. Control the ignition and propulsion system.*

The magneto is connected to the engine to ignite the mixture in the cylinders at the right time.
To do this, prepare the engine and magneto, then install it.
It is necessary to attach it to the engine drive shaft. Correct installation of the magneto
Remove the wire from the spark plug, spin the flywheel, and see if a spark forms.
is checked.

Wipe the magneto every shift, removing dust, mud, and oil, and thoroughly
It is necessary to check whether it is attached.

Magneto wires should be tightly connected and kept clean, especially from petroleum products.
It is necessary to protect it from contact.

Battery ignition system control. Keep ignition system equipment clean.
storage, check the gap between the switch contacts, adjust if necessary, and
consists of cleaning the contacts.

Also, the circuit breaker, the wiring, and their terminals were inspected and thoroughly checked.
is checked to see if it is installed.

The gap between the switch contacts is adjusted as follows: the crankshaft is gradually
Turn it so that the edge of the 6-finger grip touches the contact pad that is being moved.
The screw that secures the fixed contact plate to the disk

is released and the eccentric is turned to make the gap 0. 35-0. 45 mm. Then
The fixed contact plate is secured with a screw.

During operation, the switch contacts are exposed to oil pressure, oxidation, and contact gap change, mass contact of the switch lever, distributor cap and rotor cracking, capacitor insulation perforation, rotor plate erosion possible.

All of these defects disrupt the smooth operation of the combustion system, and they must be found and corrected. repair or replacement is necessary.

To operate the propulsion system, the propulsion engine and power
It is necessary to clean the transmission parts every shift and tighten any loose parts.

Before starting the engine, fill the carburetor with gasoline mixed with oil. and it is necessary to rotate the motor shaft several times.

The power transmission parts are lubricated with diesel oil. In winter, diesel oil is replaced with diesel. The fuel is mixed.

*TEST QUESTIONS*

1. How is fuel burned in internal combustion engines?
2. How is a spark plug constructed and what is its maintenance?
3. What are the main parts of a magneto, and what is its operation based on?
4. Describe the main parts and structure of a battery ignition system?
5. How is a switch-distributor constructed and how does it work?
6. What resistances must be overcome when starting an engine?
7. In what ways are engines driven?
8. How are the power transmission parts of the drive system arranged?

## Lecture 12 Electrical equipment of tractors and automobiles

Plan

1. Function, type and structure of the battery
2. Types and structures of generators for tractors and automobiles
3. Relay - function and type of regulator
4. Electric - the function and main parts of starters
5. Lighting, control and measuring instruments and auxiliary electrical equipment.
6. Control of tractor and vehicle electrical equipment

Working mixture in cylinders by means of electrical equipment of tractors and automobiles is ignited, the crankshaft is turned when the engine is running, the road and work tools
The lighting and control devices are also powered by electricity. Electricity to electrical equipment sources, current consumers, and various wires, fuses, and control devices connecting them together.

All cars and most tractors use batteries as a power source.
battery and an alternator are used. In some tractors and agricultural
In electric motors, a magneto and an alternating current generator are installed as a power source.

1. Function, type and structure of a battery.

The battery powers the starter and engine when the engine is running. When it is not working and when it is working at low speeds, it will power all consumers. When the battery is charged from an uninterruptible power source, the electricity energy is used to form a chemical compound.

Lead-acid batteries are mainly used in tractors and automobiles. (Fig. 57). It consists of a tank 6 divided into three or six chambers by barriers 13. Each container is closed with a separate lid 5.

Each container contains one positive 8 and one negative 11 plates separated by separators 10. There is a layer of fiberglass 9 between the separator and the positive plate. The plates are supported by ribs 12 at the bottom of the tank.

There are negative plates at two ends, with positive plates between them. placed, so there are one more negative plates than positive ones. A different The plates are connected with bars 7 and are connected to terminals via wires. The most Parts are attached to the negative 1 and positive 3 terminals on the outside. One battery The positive (ÿ) terminal is connected to the negative (-) terminal next to it with jumper 4. The outermost positive terminal of the battery is connected to the electric starter, and the negative terminal Each battery is filled with electrolyte through a hole in the lid. is poured in and a lid is screwed onto this hole.

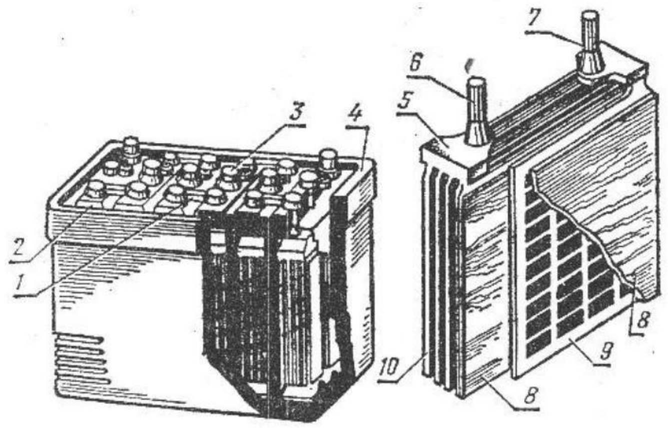


Figure 57. Battery. 1-negative terminal;
2-cap; 3-positive terminal; 4-connector; 5-
plate; 6 and 7- rod; 8-separator; 9-negative plate; 10-positive plate.

The voltage of a charged battery is 2 volts, and as a result of discharge, The voltage drops, which should be charged before it drops below 1.7 volts. The tractor and car battery 3- ST-60; 3- ST- 70-PD; 3-
Marked with TST-135-PMS and other marks.

If the electrolyte is contaminated, that is, if it contains salts, alkalis, and other substances, the battery will quickly self-discharge.

2. Types and structures of generators for tractors and automobiles

A generator converts mechanical energy into electrical energy and produces electricity. The generator is driven from the crankshaft via a belt or gear.

Direct current generator - rotation of the armature in the field of an electric magnet
As a result, the alternator is connected to the stationary coil of the starter.
an electromagnet produced by the rotation of a relatively permanent magnet
It generates current based on the phenomenon of induction.

On tractors without an alternator or battery installed
supplies power to the lighting system.

This generator (Figure 58) consists of a stator with fixed coils, a rotating magnet, front and rear covers, and a drive pulley.

The generator stator is made of steel plates, with six or twelve windings.
The coils, each with a length of insulated copper wire wound around it, are connected in pairs, forming three or six sections. One end of the section coils is connected to the mass in the housing.
is attached to the terminal. The wire connected to this terminal is attached to the starter. Each
The other end of the section cable is connected to some terminals on the housing. This
The wire connected to the terminals is connected to the electric lamps through the corresponding starters.

Connecting or disconnecting the generator from the electrical circuit, adjusting its voltage, and
A relay-regulator is installed to prevent overvoltage. Relay-regulator automatic
three working devices: voltage regulator, current limiter and reverse current relay
The voltage regulator is connected to the generator excitation winding circuit from time to time.
Even if the engine speed changes by adding additional resistance, the engine will still work.
a special electromagnet that keeps the voltage of the output current constant
is a regulator.

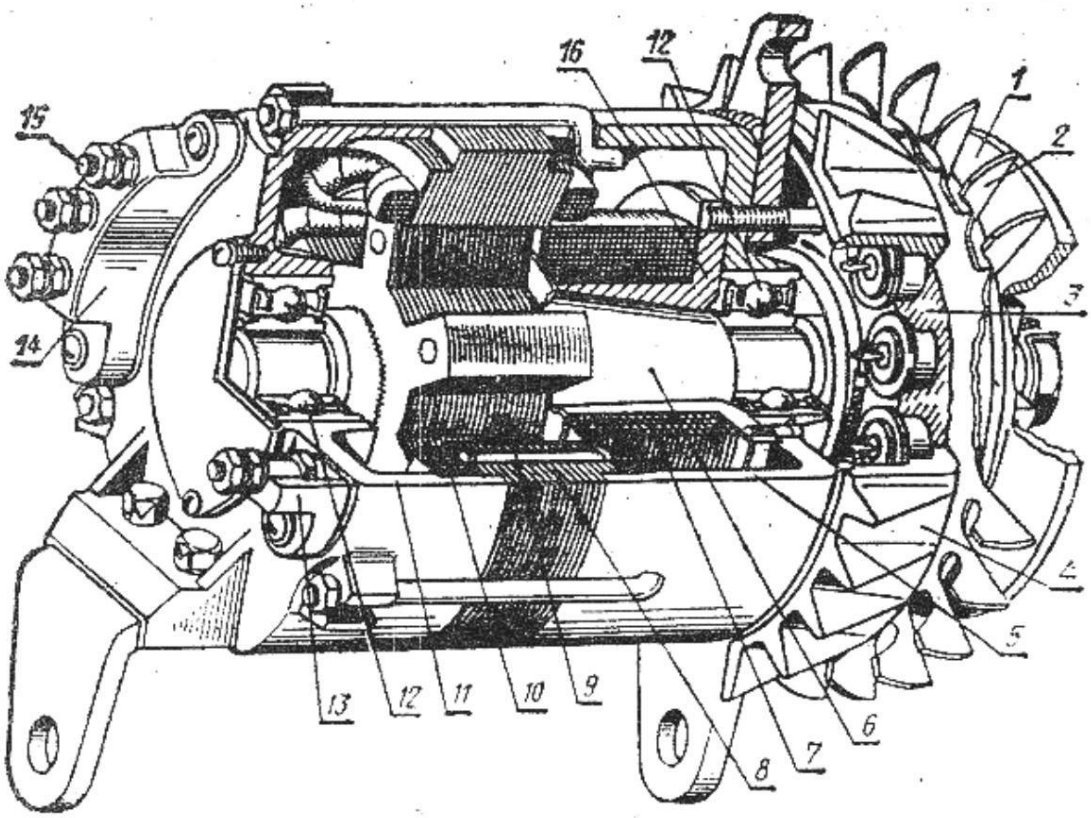


Figure 58 Generator.

1-pulley; 2-fan blade; 3-flattener; 4-flattener housing; 5-front cover; 6-shaft; 7-starting pulley; 8-stator; 9-rotor; 10-stator pulley; 11-rear cover; 12-ball bearing; 13-panel and 14-panel; 15-bolt; 16-core.

Figure 59 shows the generator and voltage regulator, battery 1 and The connection diagram of the external circuit is presented. Voltage regulator spring 5 armature 4 consists of contacts 7, a coil 8 connected in parallel to the generator circuit, and resistances 9. Until the generator voltage reaches the required value, the contacts 7 are in contact with each other by the force of the spring 5, and the current is supplied to the excitation coil 15 from the generator collector. The positive current from 13 comes through contacts 6 and 7 of the brush 14 terminal, the armature 4 terminal, and returns from the generator ground to the armature coil.

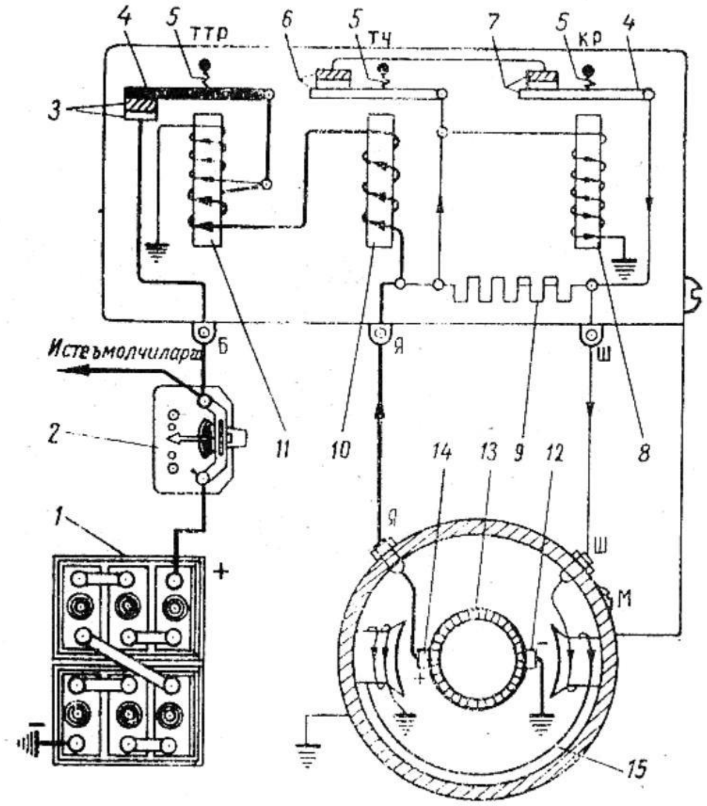


Figure 59. Alternating current generator, relay-regulator and battery connection diagram.

1-battery; 2-ammeter; 3-reverse current relay contacts; 4-armature; 5-spring; 6-current limiter contacts; 7-voltage regulator contacts; 8, 10 and 11-cores; 9-resistance; 12-negative brush; 13-collector; 14-positive brush; 15-excitation coil.

4. Function, type and structure of electric starters.

All cars, some tractors, and most self-propelled agricultural machinery When starting the engine of their cars, their crankshaft is turned by an electric starter. is converted.

An electric starter is a constant current generator that draws power from a battery. Consists of an electric motor, a drive and a coupling mechanism.

The starter electric motor housing consists of an armature 5 and a housing cover 9. The housing The excitation winding 13 consists of a wound-pole electric magnet 12, the armature consists of a shaft 2, a core 4,

consists of a coil 3 and a collector 6. 4 pole pieces fixed to the housing
The excitation windings are made of copper tape and connected to each other in series.
One end of the starter wire is connected to the positive brush of the starter, and the other end is connected to the removed from the housing, the insertion mechanism and the battery of the batteries connected by wire connected to the positive terminal (Figure 60).

The ends of the copper tape coils wrapped around the armature core are connected to the collector plates. connected. Two positive brushes mounted on brush holders on the housing cover 8 is isolated from "ground", and two negative brushes 7 are connected to "ground".

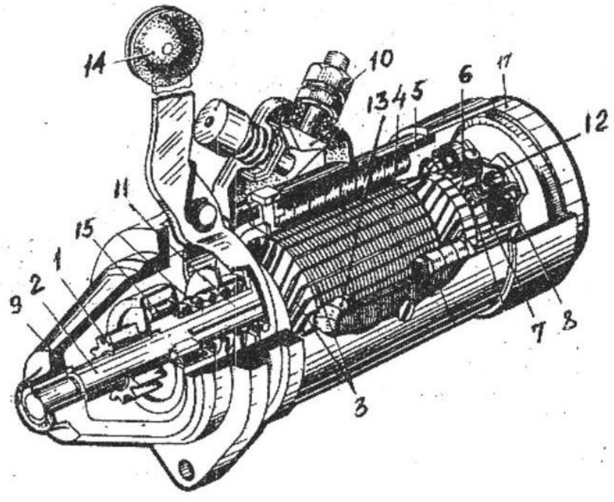


Figure 60. The structure of the electric starter. 1-gear; 2-shaft; 3-armature pulley; 4-core; 5-housing; 6-collector; 7-negative brushes; 8-positive brushes; 9-housing cover; 10-terminal; 11-connector mechanism; 12-pole shoes; 13-wake-up pulley; 14-lever; 15-free walking clutch.

The brushes are held in place by springs on the collector. The armature shaft is a housing
The starter rotates in three bronze bushings mounted on the caps and intermediate bearing.
A gear 1 with a freewheel clutch 15 is mounted on the splined end of the shaft.
The connecting mechanism is fastened to the starter housing, and its two surface terminals are connected. There is a contact. One of the contacts is connected to the battery of the accumulators with a thick wire. to the positive terminal, and the other end is connected to the starter terminal 10 through a plate.

*5. Lighting, control and measuring instruments and auxiliary electrical equipment.*

When operating a tractor or vehicle at night, the road lighting and the signal on the light vehicle must be turned on. Lighting equipment is installed to provide. Lighting fixtures include plugs and sockets for connecting headlights, taillights, taillights, trailer lamps, and a control panel. lamp, cabin or body ceiling, underhood lamp, starters, wires and includes storage.

The headlight (Figure 61) is a projector-type flashlight with a metal body 3 and a cartridge 4. consists of a reflector 6 and a light diffuser 1. The inner surface of the reflector is coated with aluminum or It is chrome-plated and reflects the light of 2 of the 4 bulbs.

The vibration type sound signal consists of an electromagnet armature, a contact vibrator, a membrane and a capacitor. The signal is sounded when the button is pressed. The rod
The installed membrane, anchor, and resonator are glued together.

The fuel level indicator (Figure 62) is a sensor mounted in the fuel tank and
consists of a receiver mounted on the instrument panel. When the ignition system is connected
works, if there is little gasoline in the tank, the flap 1 is down and the rheostat 3 is connected to the circuit
Both ends of the right coil 5 are connected to ground and the current flows through the resistor 6.
After that, the current will only flow through the left coil 8.

The left coil core is magnetized, pulling the armature 4. The arrow 7 swings to the left and points to 0.
When the tank is full, the flap rises and the slider 2 opens the rheostat 3.
The current passes through both coils, and the core of the right coil is stronger.
magnetized.

As a result, the anchor is pulled to the right, the arrow moves to the "P" side, indicating that the tank is full.
The resistance of rheostat 3 changes depending on the fuel level in the tank, the cores of coils 5 and 8 are
magnetized differently, and the armature is moved according to the fuel level in the tank.
moves it to the appropriate position.

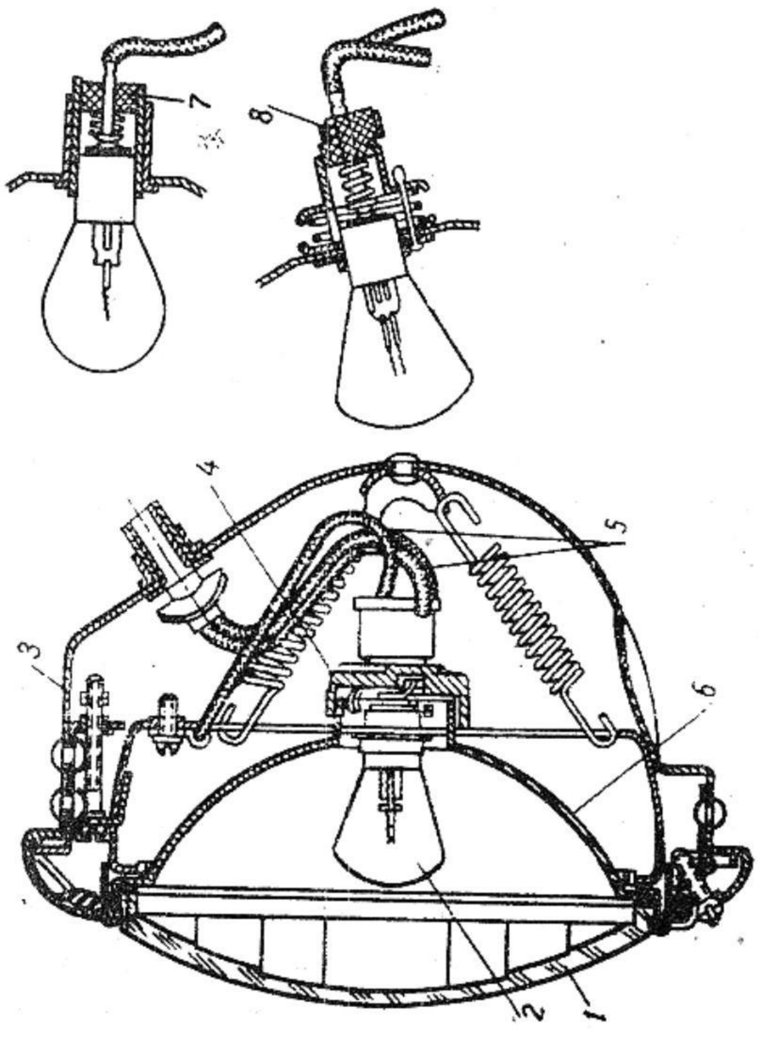


Figure 61. Electric headlight and bulbs. 1-beam
diffuser; 2-bulb; 3-housing; 4-cartridge; 5-wires; 6-return; 7-one
contact light bulb; 8-two-contact light bulb.

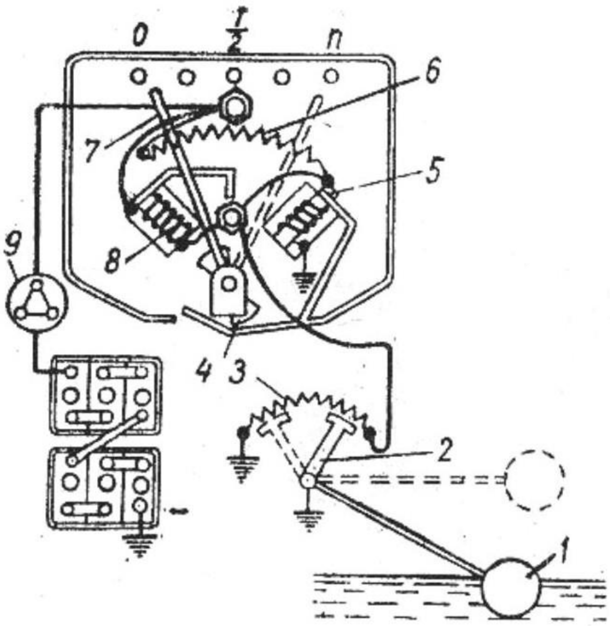


Figure 62. Fuel level indicator. 1-valve; 2-
slider; 3-rheostat; 4-armature; 5 and 8-reel, 6-resistance, 7-
arrow, 9-switch.

6. Control of tractor and automobile electrical equipment.

Regularly inspect, clean, and tighten the battery.
attached, the electrolyte level and specific gravity, the battery
It is necessary to check whether the battery is charged and the ventilation holes are open.

If the battery is undercharged, stored with electrolyte in an uncharged state, or allowed to over-discharge, the electrolyte level will be low.
If the relative gravity is high, the plates will be coated with large amounts of lead sulfate.
The grains settle down and its color turns pale, meaning the plates are saturated. The saturated
The plates do not participate in the chemical reaction and the battery fails.

To prevent damage to the battery, handle it carefully, especially when using the starter.
It is necessary to follow the rules of use because the starter battery can last for several hundred years.
amperes. When starting the engine, the crankshaft is turned with the starter for more than 5 seconds.
It doesn't work to convert.

Do not allow the battery to discharge more than 25% in winter and more than 50% in summer.
It is necessary not to.

TEST QUESTIONS

1. What are the main components of tractor and automobile electrical equipment?
2. How is a battery constructed?
3. What happens during charging and discharging?
4. What is the capacity of a battery?
5. Describe the structure and operation of an electric starter.
6. Explain the structure and operation of lighting devices.
7. Describe the structure and types of generators.
8. Explain how a relay-regulator works.

## **Lecture 13:** Engine braking testing

Plan:

1. Brake testing methods and brake devices
2. Brake test technique
3. Development of test results. Characteristics of engines.

*1. Brake testing methods and brake devices.*

Tractor, automobile, and agricultural engines are tested for various purposes. There are three types of tests depending on their content, duration, and nature.

Control tests are performed on products that have been manufactured, repaired, or used for a certain period of time. is carried out to determine the technical and economic performance of engines. In this The engine's mechanisms and systems are fully checked and adjusted, with maximum power, relative fuel consumption are determined.

Standard tests determine the main parameters of the engines and determine their design. are conducted for evaluation. As a result of such tests, various engine characteristics, i.e. mixture composition, combustion time of the mixture or fuel The engine speed is determined during spraying, and when the load is changed, its diagrams are drawn up showing how it works.

Special tests are conducted for scientific research purposes and involve various factors affecting engine performance. The influence of factors, the most favorable operating conditions of the engine, and others are studied. As a result of special tests, the design of engines can be improved.

Mechanical, hydraulic and electric brake devices for testing engines is applied.

The mechanical brake (Figure 63) is of simple construction, and the engine power is divided into frictional force The mechanical brake is used to overcome the work of the tractor's drive pulley. The pulley 1 is fixed in place, the wooden blocks 2 that hold it in place, and the scales 5 composition.

The pads are tightened to the pulley by turning the wing nut 3. Between the pulley and the pads The resulting friction force tends to turn the pads in the direction of rotation. The moment of the friction force is transmitted to the balance through lever 4, with a moment Rl is balanced. This torque is equal to the torque of the engine. The value of the force R The number of revolutions per minute of the pulley is measured with a tachometer through a rod 6. is determined.

Water is pumped through special pipes to cool the pulley.

It is impossible to accurately test an engine with a mechanical brake because friction The coefficient, scale reading, and number of revolutions are constantly changing, so also applies to.

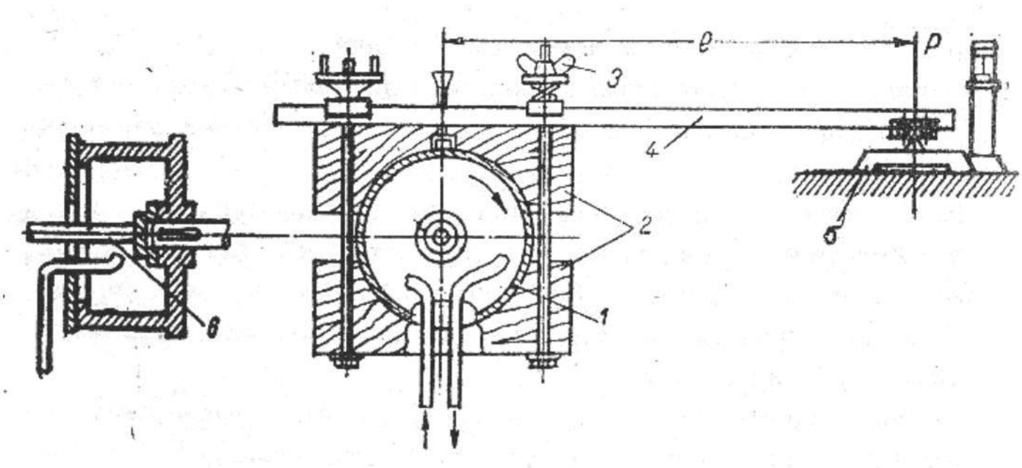


Figure 63: Schematic diagram of a mechanical brake

1-pulley; 2-block; 3-ear nut; 4-lever; 5-scale; 6-rod.

In hydraulic braking systems (Figure 64), the engine power is the brake shoe. The water between the rotor and the disk is heated as a result of its impact and friction. is spent.

Hydraulic disc brake rotor 3 mounted on shaft 4 and brackets 1 mounted on consists of a housing that can rotate on ball bearings 2. The brake shaft is connected to the engine crankshaft It is driven by a lever.

The water poured into the casing from the tap 5 prevents the rotor disk from rotating and The resistance of the water twists the jacket. The shoulder of the jacket is tilted. The water in the jacket By changing the amount, the resistance of the brake is adjusted.

The braking torque of hydraulic brakes is small and rotates slowly, so the engine movement is transmitted to the brake through a reducer. The hydraulic brake The power from the engine cannot be used, which is its disadvantage.

The power generator stator and rotor of the engine tested on the electric brake stand The interaction of magnetic fields produces a braking torque. This torque is equal to the engine's torque, which is The arrow on the scale shows.

The electric brake stand (Fig. 65) consists of a device 5 on which the engine under test is mounted, an electric motor-generator 2, a fluid rheostat 1, and a control knob 3. Control panel with scale, tachometer, manometer and thermometer readings installed.

Thermometer indicators are installed. Repaired engines are installed on such a stand. You can test and test using rotation and testing without moving. Electric motor in the refinement of tractor, automobile and agricultural engines The generator turns the engine, and during the test, the generator brakes the engine.

The electric braking stand is simple in structure, compact, easy to use and maintain, and the electric energy generated by the engine under test is external. It is transmitted to the chain and used. Therefore, electric brakes are widely used, sometimes also used as a power unit that generates electricity.

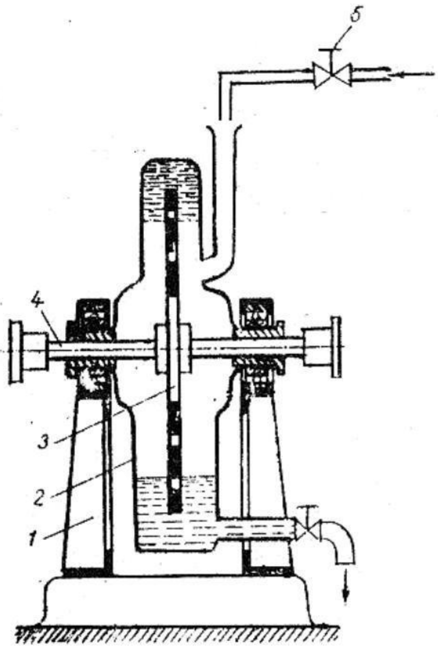

Figure 64. Diagram of a hydraulic disc brake
1st bracket; 2 - kojukh; 3rd rotor; 4th shaft; 5-crane;

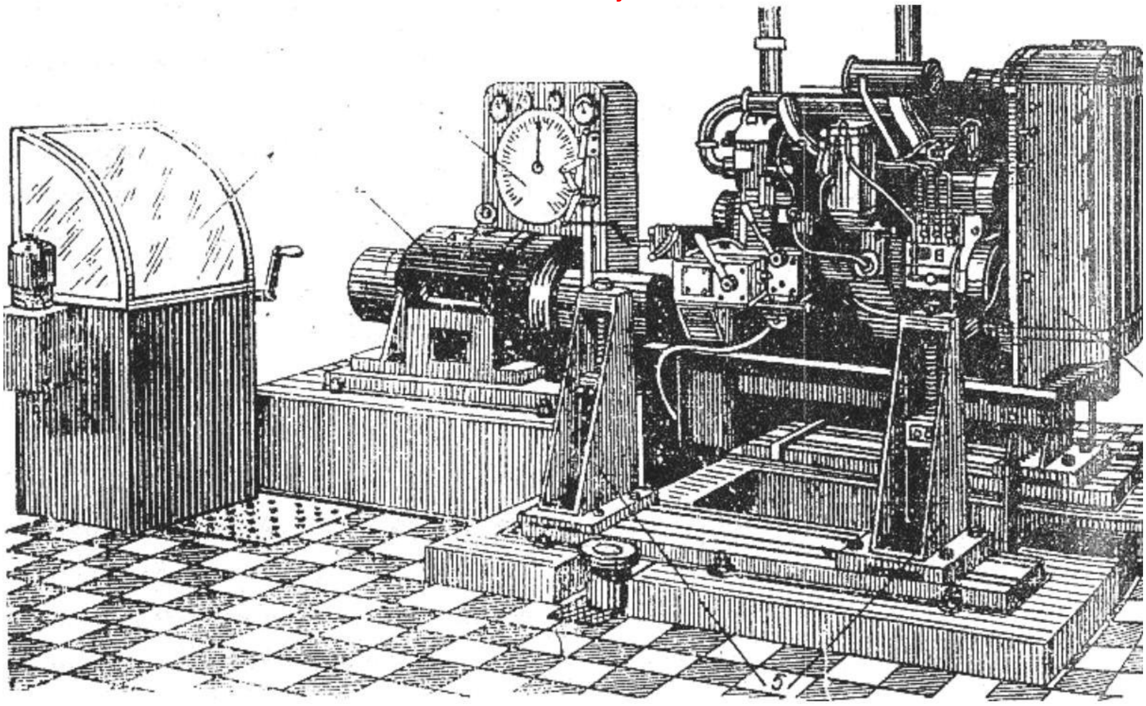

Figure 65. Engine-powered testing and testing stand.
1-rheostat; 2-electric motor-generator; 3-control button; 4-test engine; 5-mounting device.

2. Brake test technique.

Before testing the engine, the braking system is inspected and the necessary measuring and testing instruments are prepared.

The shaft of the engine under test is aligned with the shaft of the brake device.
is condemned.

If the engine is subject to a control test, its technical condition is checked.
It is seen and confirmed.

Initially, the engine is revved and cooled by another energy source.

The engine run-in period depends on the production and repair conditions.
is determined by.

The engine runs smoothly at the appropriate speeds and its power corresponds to the guaranteed power.
If so, measure the fuel consumption during this period and calculate the relative fuel consumption.
Engine parts that have passed the test and met the specified requirements are
are separated and inspected. The identified deficiencies are eliminated, and then
It is reassembled, tested and, after testing, its passport is filled out.

The main criterion for assessing the performance of an engine when it undergoes a type test is
The procedure and content of control and type tests are specified in GOST.
appropriately standardized.

3. Development of test results. Characteristics of engines.

The test logbook should include the engine name, number, which car it was installed on, when and
It is written what kind of braking device it was tested on. Also what kind of engine
changes in fuel and oil consumption and performance: jerking, shaking, or
It is shown that it starts working by knocking.

During the test, the engine alignment was changed in the logbook, and the experience was recorded.
calculated by putting the data obtained as a result of timely measurements and the relevant formulas
The information found is written down.

The carburetor fuel jet, the throttle valve opening, or
change the position of the fuel pump rail, the ignition advance angle
It is called engine tuning.

When conducting any experiment: how long the experiment lasted, the brake shaft
The number of revolutions per minute, the reading of the brake system scale, fuel consumption, air,
water, oil, and fuel pressure, and others are measured.

The result of each experiment is the number of revolutions per minute of the crankshaft during the experiment.
Calculate the power output from the engine, fuel consumption per hour, and relative consumption.
will be released.

The relative fuel consumption is calculated from the amount of fuel consumed per hour.

The engine's position, speed, and load were changed.
characteristics are its main characteristics.

In carburetor engines, the composition of the mixture and the timing of the mixture combustion, and
in diesel engines, the amount of fuel injected and the timing of the fuel injection
The characteristics of the modified elements are called their adjustment characteristics.

The characteristics of the engine when the mixture composition is adjusted are similar to those of a carburetor engine.
The hourly fuel consumption of the engine - the efficiency of the engine when Gc is changed
shows the change in power - Ne and relative fuel consumption - ge. (Fig. 66, a)

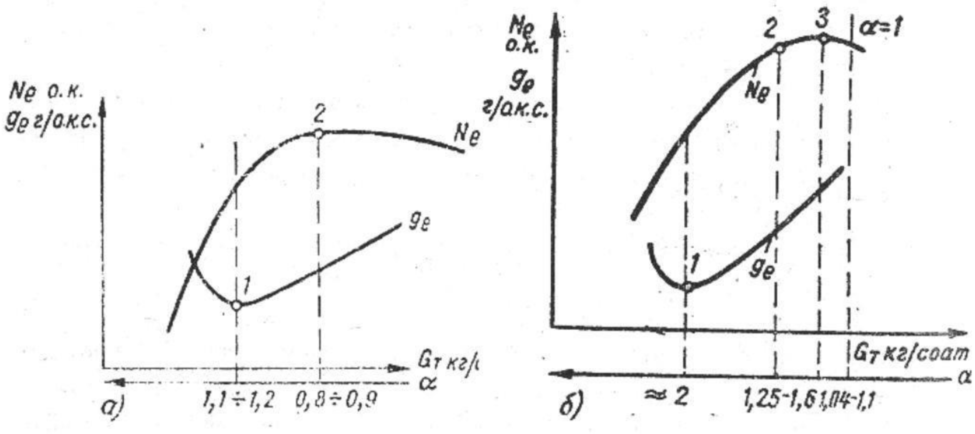


Figure 66. Characteristics of a carburetor engine with the mixture composition adjusted (a) and characteristics of a diesel engine with the amount of fuel supplied changed (b)

When a carburetor engine is adjusted to produce maximum power, the fuel
The relative consumption increases by 12-20% compared to the minimum consumption. The minimum fuel consumption
When adjusted, engine power decreases by 8-15%.

Characteristics of a diesel engine when the amount of fuel supplied is changed
When the diesel fuel pump rail is moved, the fuel consumption per hour - Gt is changed
shows the change in effective power - Ne and relative fuel consumption - ge. (Fig. 66, b)

This characteristic of a diesel engine is the amount of fuel delivered to the engine.
affects power and efficiency and the maximum fuel consumption
allows you to limit the amount of fuel. As can be seen from the characteristics, the minimum fuel
To achieve the maximum power consumption, ÿÿ2, to produce maximum power, ÿÿ1. 04 - 1. 1 should be
but ÿÿ1. 25 - 1. 6 should not be less than.

TEST QUESTIONS

1. Why and how are tractor and automobile engines tested?
2. What brakes are used to test engines, and how do they work?
What is it based on?
3. What is the braking test technique?
4. What information is determined on the basis of test machines and what is it
What can be found from the information?
5. Explain the essence of the main characteristics of engines.

A collection of "Key words and phrases" ***for the II-intermediate and final rating control for students of the "Agroengineering" major in the subject "Tractor and Automobile" .***

1. Structure of tractors 2.
Structure of automobiles 3.
Engines 4.
Carbureted engines 5. Diesel
engines 6. Two-stroke
carburetor 7. Multi-cylinder
(engine)
8. Crankcase 9.
Cylinders 10.
Piston 11.
Piston rings 12. Piston
pin 13. Connecting rod
14. Crankshaft
15. Flywheel 16.
Economizer
17. Multi-chamber
(carburetor)
18. Supply system 19.
Mixture in diesel engines 20.
Fuel tanks 21. Fuel
filters 22. Pumps 23.
Fuel pumps 24.
Injectors 25. Fuel pipes
26. Regulators 27.
Lubrication system 28. Oil
pump 29. Oil filters
30. Oil radiators 31.
Cooling system
32. Radiator 33.
Fan 34. Water pump 35.
Thermostat 36.
Magneto 37.
Electrical
equipment 38.
Spark plugs 39.
Battery 40.
Generator 41. Relay-
regulator

42. Battery ignition (system)
43. Switch - distributor
44. Electric starter
45. Lighting lamps
46. Driving (system)
47. Engine testing
48. Chassis
49. Toothed clutch
50. Intermediate compounds
51. Transmission box
52. Locking mechanism
53. Reverse mechanism
54. Cardan gear
55. Differential
56. Turning mechanism (planetary)
57. The next bridge
58. Walking part
59. Telescopic shock absorber
60. Wheels and tires
61. Steering wheel
62. Brakes.
63. The problem of the test
64. Power supply valve
65. Hydraulic installation (system)
66. Distributor
67. Power cylinder
68. Installation mechanism

II - intermediate for students of the "Agroengineering" major in the subject "Tractors and Automobiles" and options for "Keywords and Phrases" for the final rating control. No. 2 -

| intermediate control No. Final control | | | | | | | | | | | | | |
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## List of basic textbooks and study guides used

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