GAS SUPPLY SYSTEMS
LPG MODEL

INSTRUCTION

https://autoedu.lt/

https://bads.lt/

https://automotivetrainingequipment.com/

2024 Kaunas Lithuania

CONTENTS

1. WORK SAFETY

Attention:

Familiarize yourself with the instruction manual of the training equipment before starting any work on the equipment.

The educational equipment may only be used for the educational purposes specified in the instructions.

The personnel conducting the training (teacher, teacher, instructor and others) must be familiar with the instruction of the training equipment, know the methods and principles of using the equipment, settings, management, and be able to turn off (stop) the training equipment in an emergency.

The personnel conducting the training (teacher, teacher, instructor and others) acquaints those working and learning with the training equipment with work safety requirements s.

When working with high-voltage systems (hybrid power plants and electric cars), it is mandatory to comply with electrical safety requirements and use personal protective equipment against electric discharge.

It is forbidden for children and unqualified personnel to work with the educational equipment.

Persons under the influence of alcohol or other psychotropic substances are prohibited from working with the training equipment.

Unqualified persons are prohibited from opening electrical input boxes, connecting or changing anything there.

It is prohibited to improve, modify or otherwise change the design of the educational equipment without the written consent of the manufacturer.

Power sources for educational equipment are connected according to the instructions in the " Power Sources" section.

Do not ignore the warning signs on the training equipment about potential hazards. Beware of the dangers indicated in the warning signs.

When cleaning educational equipment, it must be completely switched off.

It is forbidden to wash educational equipment with running water or any chemical cleaning agents.

It is forbidden to clean the electronic components of the educational equipment with wet cloths.

When performing maintenance and repair work on educational equipment, the equipment must be completely switched off.

If the educational equipment consists of several parts, the parts are first connected to each other and only then the power supply is connected.

It is forbidden to disconnect the power cords of the electrical elements of the educational equipment. Careless or repeated disconnection of these wires leads to damage to the connectors and loss of contact. The desired electrical measurements can be made in specially designed banana connectors installed in the training equipment. Banana type connectors are resistant to multiple connections.

Before working with the training equipment, check that:

- The equipment is mechanically undamaged, unbroken;
- All protective shields are assembled;
- All hot, rotating parts (such as heating candles, pulleys, gears, etc.) are covered;
- There are all the components (e.g. wires, jumpers, fuses, knobs, etc.);
- Sufficient technical fluids (eg brake fluid, oil, coolant, etc.);
- Liquids do not seep through joints;
- There are no foreign bodies in the equipment components;
- Undamaged electrical wires;
- Neat power sources (battery or bench power unit);
- Are the power sources properly connected (e.g. the battery terminals of the batteries are screwed, the polarity is not mixed, the correct power source is used according to the local electrical network installation standards);
- Using training equipment with internal combustion engines ensures the removal of combustibles from the audience;
- The training equipment is properly placed and locked (e.g. the equipment is placed on a sufficiently strong base, the transport wheels are locked);
- During operation, the equipment will not cause any danger to the working personnel;
- There are other factors not provided for in the manual that may cause health hazards to personnel working with the equipment and other persons.

When working with the equipment, observe whether:

- Equipment with internal combustion engines removes fuel from the audience smoothly;
- The noise emitted by the equipment is typical for such a work process (there are no extraneous sounds);
- The equipment did not start leaking liquids;
- The amount of technical fluids is sufficient;
- There is no smell of smoldering, burning things;
- Power supplies are working properly;
- Any other factors or processes not provided for in the instruction, which may cause health hazards to the personnel working with the equipment or other persons, do not take place.

2. GENERAL INFORMATION

2.1. Purpose of educational equipment

Educational equipment is intended for educational activities. It is a visual tool for explaining and demonstrating the structure and operation of various automotive parts, assemblies, structures, systems. The equipment is used as a teaching and learning tool for monitoring and analyzing work processes of various car systems. It is possible to carry out various measurements of the parameters of the system installed in the training equipment, of the ongoing processes, to carry out fault simulations, and to diagnose. Various laboratory tasks can be performed using educational equipment. The equipment is prepared and manufactured in order to provide students with information about the structure of the unit, the system composition and the principle of operation as clearly and comfortably as possible.

The educational equipment is intended for demonstration, teaching and learning of the construction, structure, principle of operation, settings and adjustments of the Liquefied Petroleum Gas (LPG) system for supplying car engines.

2.2. Parameters of educational equipment

Length	980 mm;
Width	500 mm;
Height	1820 mm;
Power source	12 V battery

2.3. Transport and storage conditions

The training equipment is mounted on a dedicated stand, frame, platform or chassis. When transporting equipment that contains an internal combustion engine or any other technical fluids, it is forbidden to tip or lie down. During transportation, it is mandatory to protect the equipment from falling, overturning, shocks, moisture, temperature effects, and vibrations.

Training equipment with its own chassis must be equipped with locked transport wheels during training and storage (as well as during transportation). It is allowed to unlock the castors only when moving the educational equipment to another place.

Educational equipment that does not have its own stand or chassis must be placed on a suitable, solid base (table, cabinet).

When carrying out export or import procedures, it is mandatory to take into account the legal acts between the countries. Import-export procedures and various taxes apply to various technical fluids, oils, batteries, tires and more.

Training equipment must be stored in a room with a minimum ambient temperature of at least +10 °C. Relative humidity not more than 60%.

Training equipment must not be exposed to direct sunlight. The equipment must be covered with protective equipment if the equipment is exposed to direct sunlight.

2.4. Maintenance and service

Training equipment is maintained as normal mechanical, hydraulic, pneumatic, electrical machines and systems. Educational equipment requires minimal maintenance and service.

It is necessary to constantly monitor the presence of fluid leakage from the components of the training equipment.

It is necessary to control and ensure that all the components belonging to the educational equipment are present.

Damaged, broken parts, blown fuses, damaged connecting wires and other parts are replaced with new ones.

In training equipment with internal combustion engines, gearboxes, conditioning systems, maintenance and service is carried out in accordance with the technical requirements and conditions of the manufacturer of the vehicle used in the training equipment.

Engine oil and filter are changed using good quality parts and oils that meet specifications once a year.

In equipment with internal combustion engines, the level of engine oil and coolant must be constantly controlled.

In the stands - the cars must have the engine oil level, the coolant level, the brake fluid level, the clutch fluid level, and the oil level in the gearbox under constant control.

The drive element (chain or belt) of the gas distribution mechanism of the internal combustion engine is changed according to the recommendations of the engine manufacturer. The criterion is time.

In training equipment with pneumatic wheels, the air pressure in the tires is constantly monitored. If the air pressure in the circle is constantly decreasing, the leaky places must be repaired - sealed.

It is necessary to regularly check and monitor the battery charge of 12 V batteries. Strong battery discharge (voltage below 10.5 V) is not allowed. It is forbidden to store a discharged battery for more than 10 days (in a lead-acid battery, irreversible sulphation processes can begin, which causes the battery to fail).

It is necessary to regularly check the battery charge level of high-voltage batteries (hybrid cars and electric cars). The charge level must not be lower than the minimum allowable battery voltage specified by the battery manufacturer. If necessary, the battery pack must be charged with the appropriate means and equipment.

Training equipment with internal combustion engines or equipment demonstrating the operation of car systems (systems: interior air conditioning, fueling of gasoline or diesel engines, ignition, etc.) must be switched on at least once in a 30-day period and run for at least 20 minutes. It is a preventive measure designed to reduce the likelihood of stalling and jamming of various engine or car system components.

When performing technical maintenance and servicing of educational equipment, it is mandatory to use only technical fluids of suitable quality and meeting the technical specification

(engine, transmission oil, coolant, brake fluid, etc.), high-quality filters and other spare and complete parts

2.5. Energy sources

Electric power

12 V battery;

The 12 V battery must meet the technical conditions of the training equipment: battery terminal arrangement, capacity (Ah), starting current (A), size (length (mm), width (mm), height (mm)).

When working with training equipment powered by a 12V battery pack, disconnect the battery charger. The charger can emit electromagnetic noise that affects the operation of training equipment and can be recorded by sensitive measuring devices (oscillograph).

Attention:

When connecting the 12 V battery to the bench, the control key and all other consumers must be turned off. First, the "+" battery contact (terminal) is connected and tightened. Then the "-" battery contact (terminal) is connected and tightened.

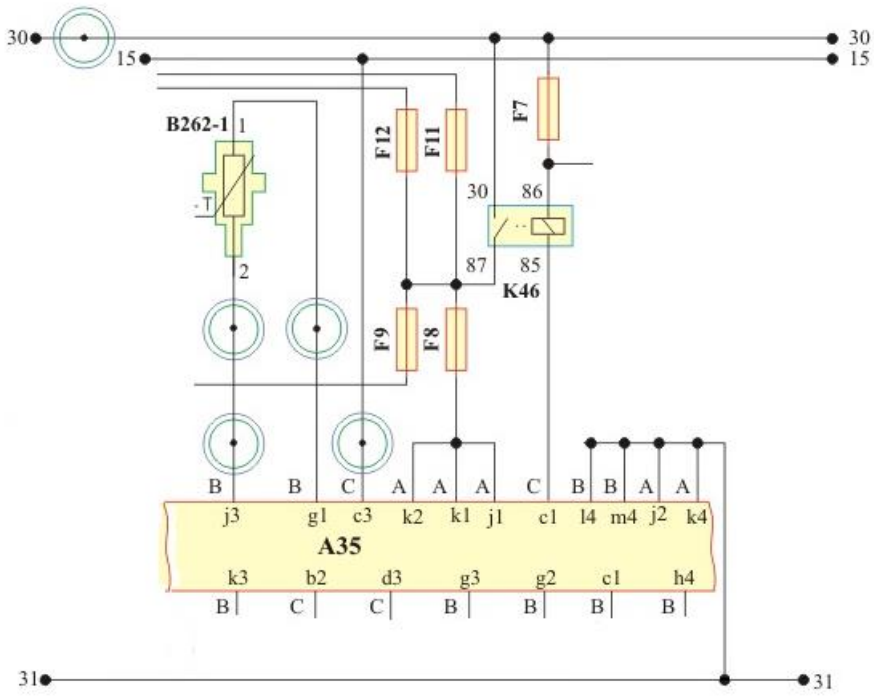
When disconnecting the 12 V battery pack from the stand, the stand must be switched off. First release and disconnect the "-" battery contact, then release and disconnect the "+" battery contact.

Attention:

Do not mix up the polarity of the wiring to the 12V batteries. On the battery pack, the wire connectors are marked with "+" (positive) and "-" (negative) contacts (terminals). The contact of the wire marked with the "+" (positive) sign (the color of the wire insulation is red) is connected to the contact of the battery marked with the "+" (positive) sign. The contact of the wire marked with the "-" (negative) sign (the color of the wire insulation is black) is connected to the contact of the battery marked with the "-" (negative) sign.

2.6. Symbols and markings

The training equipment uses automotive symbols for marking electrical diagrams and components. The figure below shows an example of marking components in an electrical diagram.



Example of wiring diagram and component labeling.

Designation of car electrical diagrams:

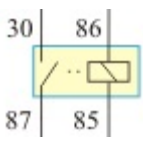
Black line connecting cables;

wires connected together;

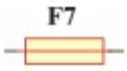
30 the wire marked with a number is the wire of the electric circuit that has a constant voltage of +12 V from the battery;

15 the cable marked with a number is the type of electric circuit cable in which +12 V DC voltage is activated with the help of the ignition key;

31 the wire marked with a number is the wire of the electric circuit that is connected to the car body and the negative terminal of the battery (ground ⏚);

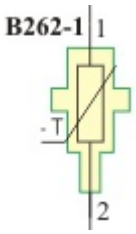


4-pin relay . The numbers 86 and 85 represent the contact numbers on the relay, through which the relay electromagnet connecting the 30 and 87 contacts is controlled. The numbers 30 and 87 indicate contact numbers through which a current of 30 A (or more) can be transmitted;



Fuse . F8, F9, F11 and F12 are also labeled fuses.

A35 car control computer (eg: engine, airbags, ABS brakes or other). The letters A, B, C denote the connector used to connect the wires of the electrical installation to the control computer. Symbols g1, c3, k2, b2, d3 denote the contact of the corresponding (A or B or C) connector.



B262-1 temperature sensor1. Numbers 1, 2 are the temperature contact numbers. Accordingly, contact 2 of the sensor is connected to contact j3 of connector B of the control computer. And the contact 1 of the sensor is connected to the contact g1 of the connector B of the control computer.

A banana 4 mm is installed in the training equipment and connected to that cable. connector (socket) for connecting measuring equipment or a jumper.

Two banana connectors (sockets) are installed on the cable for connecting a jumper. A jumper pulled out of the connectors breaks the circuit of this wire. Electric current cannot flow. The bench wiring diagram doesn't show this wire break because real cars don't have banana plugs. These connectors are installed in the electrical circuit of the training equipment, making it possible to perform measurements and simulate faults.

Shortener. Connector with 2 banana-type 4 (2) mm contacts (plugs) at the bottom and one banana-type 4 (2) mm contact (socket) at the top. All three contacts inside the jumper are connected together.

Attention:

It is recommended to connect measuring cables with 4 (2) mm banana-type contacts (plugs) to the training equipment when performing various measurements of electrical parameters.

2.7. Equipment preparation and use

General information about the educational equipment produced by the company.

When preparing training equipment for work, it must be properly positioned and secured. Equipment that does not have its own chassis or stand is placed on a suitable table or cabinet. The furniture must withstand the load of the educational equipment. Equipment with its own stand or chassis is placed on a flat and solid floor. The transport wheels of the equipment are locked by locking the brakes.

Before working with the educational equipment, a suitable power supply source is connected: household electrical network, charged battery, 12 V DC power supply.

The technical condition of the equipment, the fixing of protective shields, the equipment and other things are checked. More detailed information about safe work requirements in the section "Occupational safety →Before working with training equipment, check whether:".

Checking the position of the emergency stop switch. If the training equipment has been stopped in an emergency, the emergency stop switch remains pressed and the equipment does not start. When the emergency stop switch is unlocked, it pops out when the top part is turned clockwise (the top part moves to the right).

Emergency stop switch

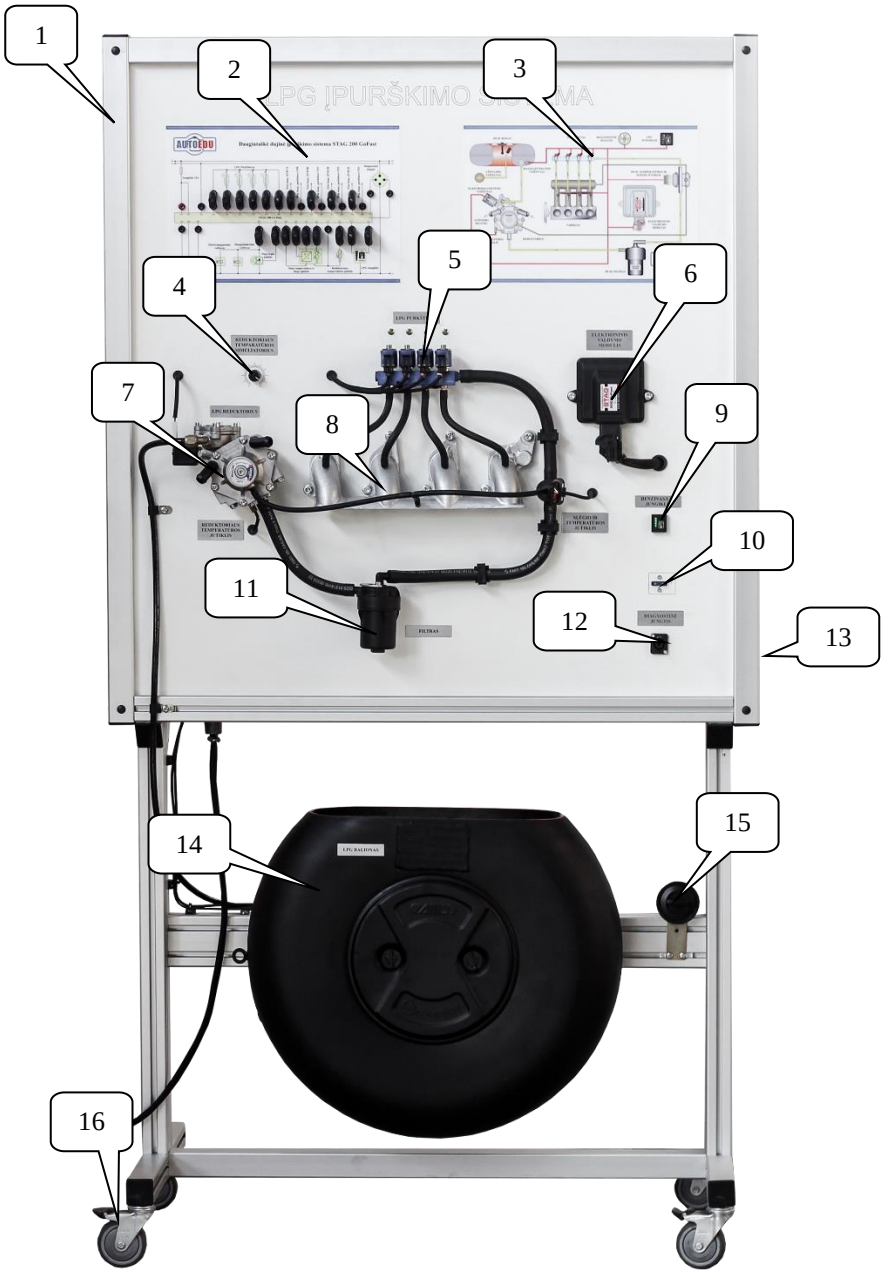
If the emergency stop switch needs to be used, it is pressed with a finger or palm. There is no need to spin anything.

Educational equipment is made for the study and demonstration of details, assemblies, systems, structure, construction and operation of engines. The cuts made in the equipment allow to see the structure more clearly, to understand the principles of operation. The systems installed in the training equipment are fully operational. In the equipment, where it is not possible to have the real working parameters of the car (for example: air mass, coolant temperature, driving speed, etc.), these parameters are simulated. Adjustment and setting tools are provided for the simulation of real work parameters.

3. EDUCATIONAL EQUIPMENT

3.1. General overview of educational equipment

A general view and structure of the training equipment is presented in the illustrations below.



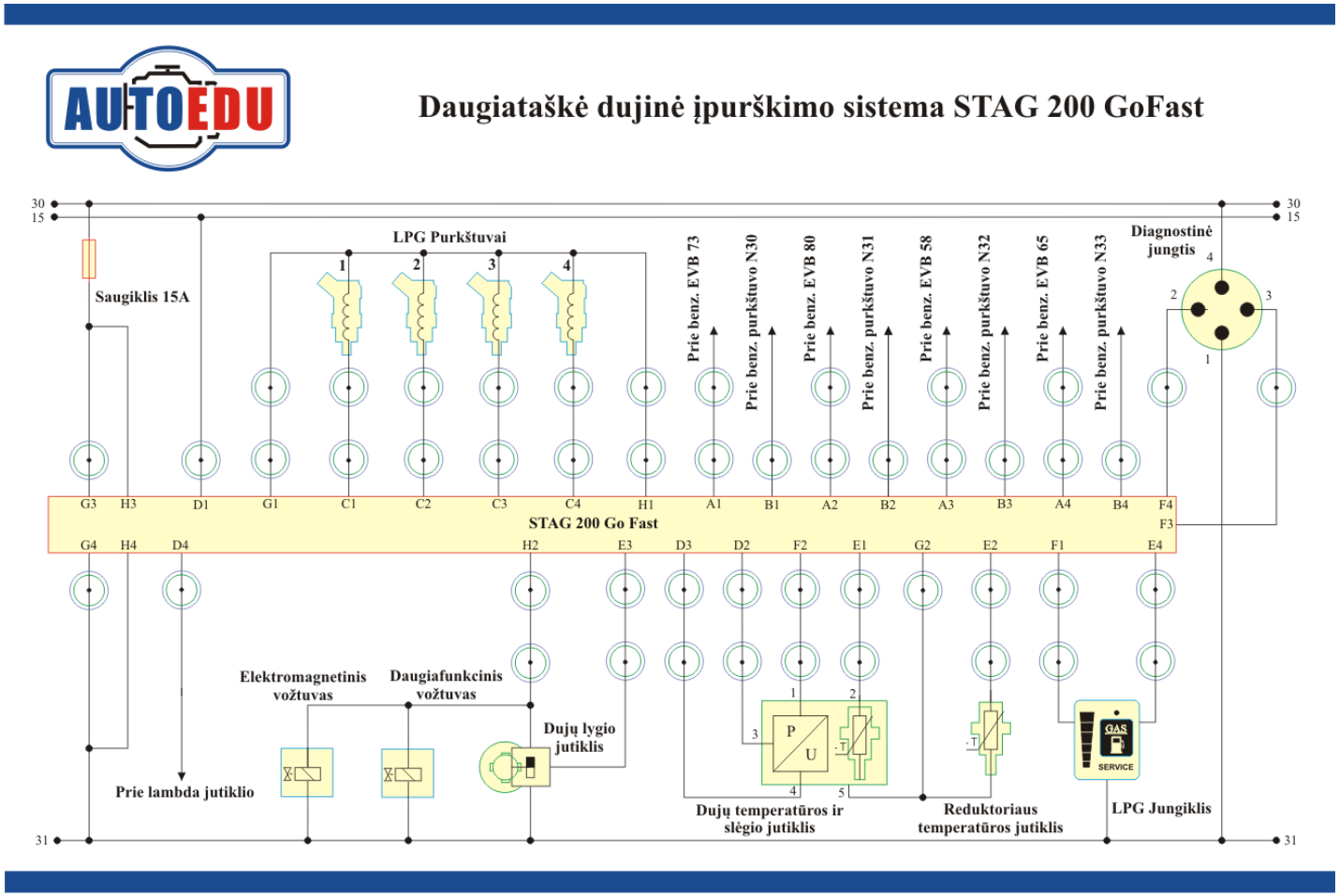
General view of the gas power system educational stand

1. Stand frame
2. Electric scheme
3. Schematic diagram of the power supply system
4. Gearbox temperature simulator
5. Sprinklers
6. Electronic control module
7. Gas reducer
8. Intake manifold
9. Gasoline / LPG switch

10. Fuse
11. Filter
12. Diagnostic connector
13. STOP switch
14. Gas baloon
15. Filling valve
16. Transport wheels

3.2. Electric scheme

All elements are presented in the electrical diagram: sensors, execution components, data transmission lines, diagnostic connection. According to this scheme, you can see the connection circuits of the elements, the numbers of the connection contacts, the numbers of the components, the installation locations of the jumpers



Electrical diagram of the multi-point gas injection system

4. COMPONENTS

Reducer

Engine gas supply system assembly. It uses the heat of the coolant to change the gas from a liquid state to a gaseous state. In the reducer, the pressure of the gas is also reduced. Heat is required to change the state of a gas from a liquid to a gas. The gas reducer is heated by the liquid circulating in the cooling system of the car engine.

Gas sprayers

Electric injectors spray gas into the intake manifold. Injectors can be used to accurately dose the required amount of gas according to the engine load. They are controlled by the final stages integrated into the electronic control module and the signal values calculated by the system. The working principle of gas injectors is similar to the operation of petrol injectors. When the electromagnet is energized, the needle is raised, which opens the way for gas to the intake manifold. Due to the lack of space on the intake manifold, gas injectors are often installed a little further from the intake manifold. From the injector to the intake manifold, the gas travels through tubes,

Gas injectors are selected according to the power of the car engine. At a gas pressure of 1 bar, injectors are selected according to the following sequence: one cylinder power 11 – 16 Ag, nozzle hole diameter 1.7 – 1.8 mm, power 17 – 28 Ag – diameter 1.9 – 2.2 mm, 29 – 34 Ag - 2.3 - 2.5 mm, 35 - 40 Ag - 2.6 - 2.8 mm, 41 - 48 Ag - 2.9 - 3.0 mm, and 49 - 55 Ag - 3.1 - 3.2 mm.

Electronic control module

The electronic control module is responsible for the operation of the entire engine gas supply system. The module collects information from temperature, pressure sensors, lambda probe, gasoline injectors and the gasoline system control unit. According to the written algorithm, the gas injectors are controlled and controlled so that the engine operates stably at the set load. The control module evaluates the proper fuel type switching process to avoid an excessively oily mixture when both gasoline and gas are supplied to the engine. Or to avoid conditions where no fuel, gasoline or gas is supplied to the engine. The process of changing the type of fuel is coordinated so that the engine runs stably. The gas is turned on a little earlier so that all the gas supply pipes are filled with gas and the engine does not stop when the gasoline supply is interrupted.

Gas tank

The gas tank is designed to store liquid gas. A gas cylinder is usually only filled to 80% of its capacity. This is necessary so that as the balloon heats up, the increasing volume of gas in the liquid state does not tear the balloon. Several valves are installed in the cylinder. The non-return valve sits on the fill line and prevents gas from escaping through the fill hose. There is another non-return valve at the end of the fill hose that prevents gas from the fill hose from escaping into the environment when the fill gun is disconnected at the gas station. The second valve installed in the gas cylinder is electromagnetic. It is designed to control the gas supply from the cylinder to the reducer. Without electricity, this solenoid valve is closed. This valve is controlled by an electronic control module.

Electromagnetic valve

The valve is mounted on the reducer. Without electricity, it is closed. The opening is controlled by an electronic control module. This valve is required when starting a cold engine. The valve is opened even before starting to turn the crankshaft with the starter. A momentary actuation of the valve opens the reducer's second stage valve and allows gas to freely fill the lines from the reducer to the gas injectors.

Gas filter

Designed for catching various impurities and garbage.

Filling valve

It is a mechanical check valve to which a gas filling gun is connected. Between the valve of the gas filling gun and the filling valve in the car, a small cavity remains, in which the liquid phase gas remains. This gas evaporates quickly when the spray gun is disconnected. This release of gas into the environment is minimal.

Temperature sensor

The sensor is used to measure the temperature of the reducer. The information is provided to the electronic control module.

Gas temperature and pressure sensor

Information from the gas temperature and pressure sensor is transmitted to the electronic control module. Here, the information is used for accurate gas volume calculation and dosing.

Switch

Intended for changing the type of fuel.

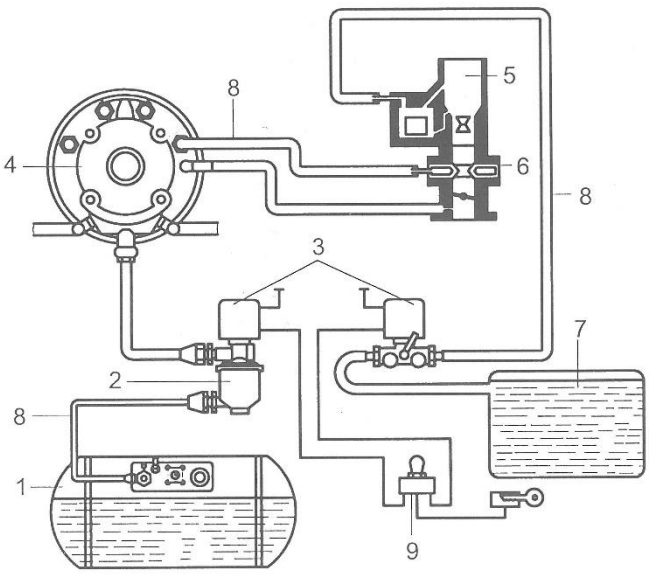
5. PRINCIPLE OF OPERATION OF THE GAS SUPPLY SYSTEM

internal combustion engines saves traditional fuel and pollutes the environment less. Currently, liquefied petroleum gas (a mixture of propane and butane) or compressed natural gas is used. Using gaseous fuel improves the conditions for the preparation of the combustible mixture: the gas mixes more evenly with the air, and the combustible mixture with a more uniform composition enters the individual cylinders of the engine. Liquid fuel does not get on the cylinder walls, which reduces oil film washing and wear of cylinder and cylinder group parts.

The calorific value of gas-air mixtures is lower than that of gasoline-air mixtures. Due to this reason and due to the reduced filling factor of the cylinders (part of the air is replaced by gas), the engine power is reduced by 5-20%. The gas is stored in cylinders, which increase the mass of the car. When the car is kept in a closed garage, there is a risk of explosion if even small gas leaks occur. Therefore, greater reliability of fuel hardware is required.

Most of the time, cars are converted to run on both gasoline and LPG. In this case, the possibility of increasing the compression ratio, which is provided by the high octane number of gas fuel, is not used. This is usually done only in special engines designed to work only on gaseous fuels.

The traditional power supply system consists of a gas cylinder 1 (see the figure below), a two-stage reducer - vaporizer 6, a mixer 6 or gas sprayers, control and connecting devices, gas supply lines. Liquid gas from the cylinder passes through the tap, filter 2 and valve 3 to the reducer - vaporizer 4. Here the gas is vaporized (turns from a liquid state into a gas) and its pressure is reduced. Heat is required to evaporate the gas. It is taken from the internal combustion engine cooling system. In order for the gas reducer-evaporator to work properly, it must be heated. If the reducer is not heated, the moisture in the air freezes into ice, which blocks the movement of the membrane in the reducer, and the reducer stops working. Therefore, when using cars with gas equipment, it is necessary to start the engine using gasoline and warm it up. Only after the engine has warmed up can the engine be switched to work with gas fuel. The vaporized gas in the reducer continues to the mixer or gas nozzles. In the mixer or through the gas injectors, the gas entering the intake manifold is mixed with air and enters the engine cylinders.

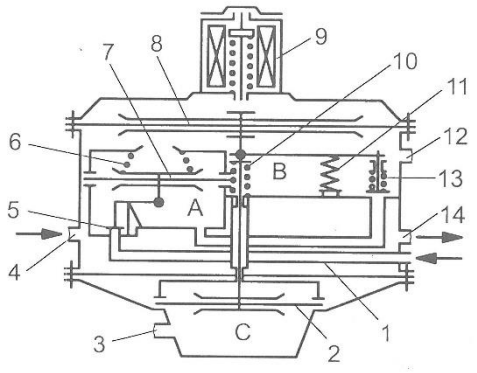


Gas power system

1 – gas cylinder, 2 – gas filter, 3 – electromagnetic valves, 4 – reducer – evaporator, 5 – carburetor, 6 – mixer, 7 – petrol tank, 8 – tubes, 9 – switch.

The working pressure of cylinders for propane butane liquefied gas is usually 1.6 MPa , and the maximum possible pressure is 3 times higher. Filling, gas supply, control and protection devices are attached to the cylinder: filling and gas supply taps, safety valve, maximum gas level tap, gas level gauge. The cylinder is filled with liquefied gas no more than 80% of the volume. This is done to ensure that as the balloon heats up, the expanding liquid phase of the gas has room to expand and does not tear the gas balloon. The gas pressure in the cylinder is always equal to the saturated vapor pressure, regardless of the amount of liquid phase in the cylinder.

The reducer reduces the gas pressure supplied to the mixer or gas injectors, doses the gas, and disconnects the gas line after the engine is turned off. Most often, two-stage reducers with gas heaters (evaporators) are used.



Two-stage reducer - evaporator

1 - evaporator channel, 2, 7, 8 - membranes, 3 - vacuum channel, 4, 14 - coolant inlet and outlet, 5, 13 - valves, 6, 10, 11 - springs, 9 - electromagnet, 12 - gas supply pipe to the mixer.

When the solenoid main valve is turned on and the engine is not running, the gas fills the vaporizer channel 1 (see figure above) and is vaporized there. The heat of the engine coolant circulating through the evaporator is used for gas evaporation. Gas from the evaporator fills the cavity A of the first stage of the reducer through the opened valve 5. When the gas pressure in the cavity A increases, the membrane 7 bends upwards, and the valve 5 closes the inlet channel. The pressure in the first chamber is reduced to about 0.2 MPa. It is adjusted by changing the advance of spring 6. The gas outlet from the first to the second stage is closed by the valve 13, pressed by the spring 11, the membrane 8 of the second stage and the spring 10, kinematically connected to the membrane 2 of the discharge chamber C.

When the engine is started, rarefaction from the intake manifold is transmitted through the connecting channel 3 to the cavity C. The diaphragm 2 bends, compressing the spring 10, which now no longer presses on the valve 13. Therefore, under the influence of the gas pressure from the cavity A, the valve 13 opens, and the gas flows into the second stage cavity B , from which channel 12 is pumped into the mixer. The opening size of the valve 13 depends on the gas consumption, because as the pressure in the cavity B decreases, the membrane 8 bends and opens the valve 13 more. This automatically maintains the required composition of the combustible mixture when the engine load changes.

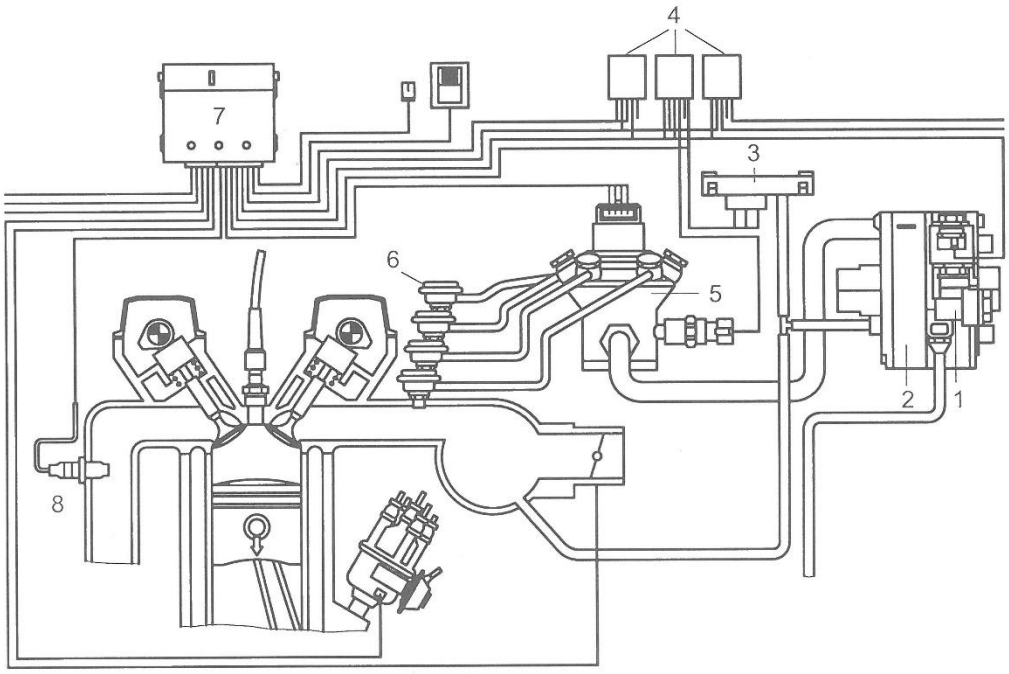
When starting a cold engine, the solenoid valve 9 is briefly turned on. Its armature forcibly opens the second-stage valve and gas freely fills the lines from the reducer to the mixer before the engine starts to rotate. Gas and air are mixed in a mixer. In carbureted engines that run on both petrol and gas, the gas can be supplied to different parts of the carburettor.

In engines with gasoline injection, the gas is supplied to an additional diffuser installed in front of the throttle valve. In some gas supply systems, a dispenser is placed between the reducer and the mixer. It regulates the amount of gas supplied to the engine depending on the load. The pneumatic chamber of the dispenser is connected to the intake manifold. When the load is low, the diaphragm bends and lifts the plunger attached to it, which closes the gas supply channel. As the load increases, the rarefaction in the intake manifold decreases and the spring pushes the diaphragm and plunger down, increasing the gas supply.

The composition of the combustible mixture depends on the composition of the gas. In order to control the composition of the mixture, the gas power systems of the engines were supplemented with electronic control units. In these systems, the main metering of the gas flow is still done by a reducer or dispenser, but they are controlled by an electronic control unit. They are suitable for cars with gasoline injection systems and three-component catalysts and a λ probe control circuit.

The electronic control unit receives input signals from the engine speed sensor and the λ probe. It controls a digital actuator (stepper motor) that regulates the main gas flow and is installed between the reducer and the mixer. These systems are often adaptive - they adapt to changing operating conditions and the changing composition of the propane-butane gas mixture. Such systems do not need to be regulated. The λ adjustment loop is used for adaptation.

In multipoint gasoline injection systems, only air moves through the intake manifold. After converting such an engine to work on gaseous fuels, the combustible mixture moves through the intake manifold. If the car's ignition system is not working correctly, the mixture can ignite in the intake manifold. This can damage the fuel injection and air intake systems. In order to avoid this, multi-point gas injection systems have been developed and used.



Schematic diagram of multi-point gas injection system

1 – gas valve, 2 – reducer – evaporator, 3 – pressure sensor, 4 – relays, 5 – gas distributor, 6 – injectors, 7 – microprocessor, 8 – λ probe

Multi-point gas injection systems are controlled by a microprocessor. They are self-learning (adaptive) and do not require manual adjustment. The gas in these systems is injected in a gaseous or liquid state.

6 . CONTROL QUESTIONS

1. As gaseous fuel is used:
    a) Liquefied natural gas;
    b) Compressed natural gas;
    c) Liquefied petroleum gas.

2. The gas cylinder is filled with gas:
    a) 100% of its volume;
    b) 80% of its volume;
    c) 60% of its volume.

3. Reducer - evaporator:
    a) Cooled by engine coolant;
    b) Has no points of contact with coolant;
    c) Heated by engine coolant.

4. Gas in the reducer - evaporator:
    a) Changes its aggregate state from gaseous to liquid;
    b) Changes its aggregate state from liquid to gas;
    c) The gas pressure is increased to 1.6 MPa.

5. The electromagnetic valve installed on the gas reducer is intended for:
    a) Increase the amount of supplied gas during start-up;
    b) Open the gas supply main;
    c) Shut off the gas supply in the event of an emergency.

6. Gas injectors are installed further from the intake manifold:
    a) To allow enough time for the gas to mix with the air;
    b) To avoid high temperature;
    c) Due to lack of space on the manifold.

7. Gas injectors for an internal combustion engine are selected taking into account:
    a) Type of liquefied gas used;
    b) Engine torque value;
    c) Engine power per cylinder.

8. The electronic control unit regulates the composition of the gas-air mixture according to:
    a) λ probe data;
    b) Pressing the accelerator pedal;
    c) Duration of work of sprinklers.

9. Gas temperature and pressure sensors are intended for:
    a) To monitor the work of the reducer;
    b) For gas quantity calculation and dosing;
    c) For gas tank filling level control.

10. Use warm engine starting only:
    a) Gasoline;
    b) Gas;

c) Petrol or gas.

Answers to the questions:

There may be several correct answers to the question.

1. b, c
2. b
3. c
4. b
5. a
6. c
7. c
8. a
9. b
10. c

7 . WARRANTY CONDITIONS

Educational equipment is a complex engineering product that meets the high standards of modern technology. The equipment is made of high quality, using modern materials and technologies.

Educational equipment is granted 13 months. warranty, unless otherwise stipulated in the sales contract. The guarantee starts counting from the day the invoice is issued.

The warranty for educational equipment is canceled if:

- Non-original parts are used;
- Low-quality fuel is used;
- The wrong power source is used;
- When connecting the power source, the polarity was mixed;
- Technical fluids of the wrong quality are used and/or there are not enough of them;
- The design of the equipment has been changed;
- Equipment damaged during transportation or improper storage;
- The equipment was damaged due to illegal actions of individuals (vandalism, hooliganism, theft);
- Safe work instructions were not followed during work;
- Failures of household electrical networks, voltage fluctuations;
- Aggressive chemical cleaning agents were used to clean the equipment;
- Any damage or loss of equipment, defined as a case of Force Majeure, *has occurred* ;
- Educational equipment is broken or otherwise damaged;
- If foreign objects or liquid get into the educational equipment;
- Using incomplete equipment.

The warranty does not apply to equipment wearing parts, fuses, operating fluids, fuel, seals, filters, liners, belts, bearings, etc.

Warranty repairs are carried out at technical service companies authorized by the manufacturer. Defective equipment units are repaired or replaced with new ones free of charge during the warranty period. The decision on the replacement or repair of parts is made by technicians of authorized companies. Replaced parts become the property of the service point.

After warranty repair, the warranty period is not extended and remains valid until the end of the scheduled period.

The costs related to the disassembly, disassembly, packaging and transportation of the equipment to the authorized warranty service company are not reimbursed to the Customer.

The Customer must cover all expenses incurred by the technicians when they come to the Customer (transportation, accommodation, etc.) to perform warranty maintenance work on the educational equipment, when the warranty period of the equipment has not yet expired, but at least one case has been identified that voids the warranty for the educational equipment.

The manufacturer reserves the right to change the design, appearance and equipment of the training equipment.

The warranty conditions are valid only when the educational equipment is used according to the purpose specified in the instructions and in compliance with all work safety instructions.

When applying for a guarantee, the customer must have all the documents for the purchase of the educational equipment: purchase receipt, bill - invoice, acceptance - transfer deed.

Attention:

If the educational equipment breaks down, a "Warranty maintenance voucher" is filled out. The completed document is sent to the manufacturer of the educational equipment.

Warranty service voucher

Name of educational equipment	_____
Product number	
Date of sale	
Owner of educational equipment	_____
Trade partner/representative	_____

Description of performed works

Date	Description of the failure and its elimination process	Technician / Signature
	_____ _____ _____ _____ _____	
	_____ _____ _____ _____ _____	
	_____ _____ _____ _____ _____	
	_____ _____ _____ _____ _____	
	_____ _____ _____ _____ _____	

FOR NOTES

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